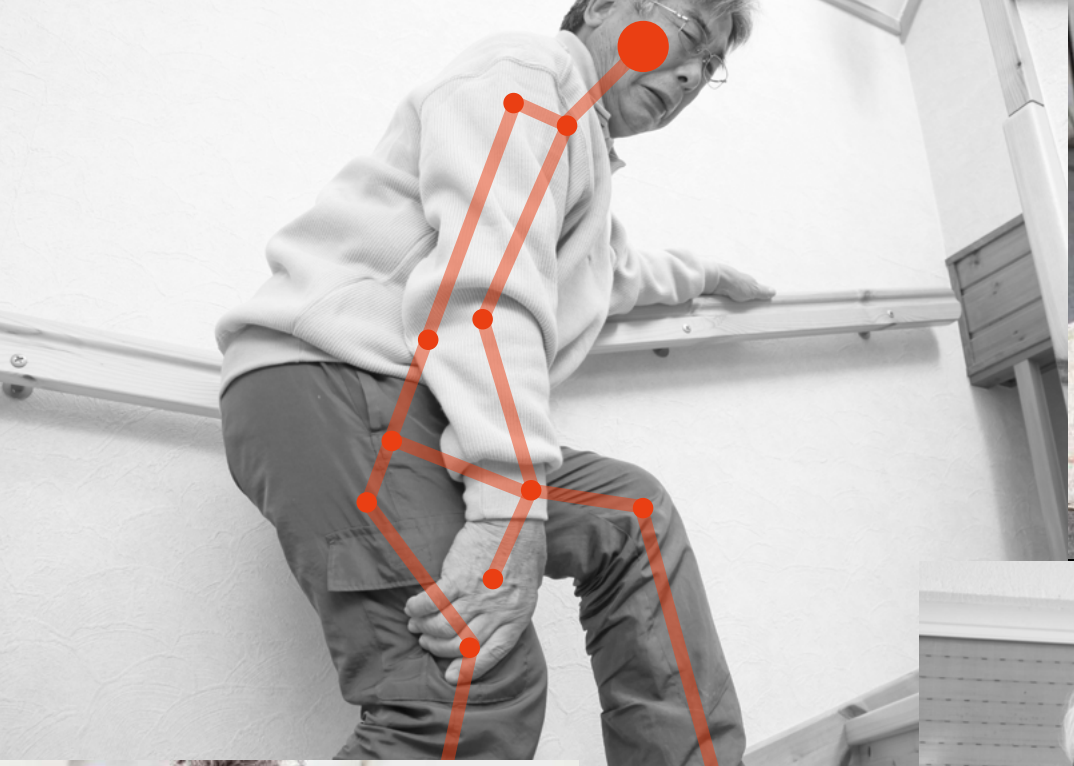



usafe

Designing Usafe: An Analysis System that Tracks Unusual Behavioural Patterns to Support Elderly People Living Safely at Home Alone

Yihao, Zhang

Designing Usafe: An Analysis System that Tracks Unusual Behavioural Patterns to Support Elderly People Living Safely at Home Alone

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Abstract

Many elderly live in their own homes as they age, but their specific challenges in achieving this goal are unknown. The elderly may face daily frustrations and difficulties in their everyday activities. (Clark, Czaja, & Weber, 1990; Rogers, Meyer, Walker, & Fisk, 1998). Unless the elderly take good care of themselves, they may become a burden for their family members and could place them in an unhealthy situation. Almost 90% of older people living alone express a keen desire to maintain their independence (Daniel B. Kaplan, Barbara J. Berkman , 2021). In the case of older people living alone, health and welfare can often be promoted by using some current existing technologies such as Artificial Intelligence (AI) and Internet of Things (IoT), resulting in numerous benefits that enable people to accomplish their goals.

Therefore, this could cause significant safety issues. Today, the lack of an elderly-serving information technology ecosystem needs to develop because home maintenance is essential to support a safe and healthy environment for the elderly. The goal of elderly-serving development is inclined to turn towards Smart Home Technology (SHT) when thinking about how home automation, AI and IoT technologies can build an ecosystem of serving independent-living elderly. For decreasing the physical risk of elderly who live independently and understand how these service-oriented information technologies can benefit to elderly's life, my graduate thesis project focuses on helping the elderly living independently stay safer and healthier at home by monitoring and analyzing their unusual behavioural patterns within the mobile application "system", work on communicating that this is an overall system and the app is just one part of it . Their family caregivers can utilize existing innovative technologies in AI and IoT to help care for their loved ones.

Family caregiver interviews were conducted to learn how family members usually take care of their elderly parents; Conducting elderly interviews helped to learn about the needs, thoughts, demands, behaviours, and activities of ageing people who live live independently; Expert interviews were approached from the fields of AI, Human-Computer Interaction (HCI) and Older Adults & Family Caregiving to 1) inform how decision-making in AI can change the way we behave our daily activities, 2) address the concept of service design and design thinking which utilize the available resources of designers to seek innovative insights to address the current needs while creating solutions to everyday problems and 3) specify a variety of information about caregivers for seniors including family responsibilities, social interaction and living circumstances.

For the proposed design response, a monitoring mobile application as part of the Usafe system is designed for family caregivers to monitor and analyze their elderly loved ones' daily activities. From the elderly's end, the ecosystem of the Usafe platform I designed enables the elderly to live independently at home to stay healthy and safe. Usafe begins with camera-based sensors placed throughout the elderly home and employs safety notification alerts to push to family caregivers' phones when the system catches any usual activities. Employing AI and IoT technologies, The Usafe system can detect unusual activities and lead to safer living.

Technology can be frustrating and daunting for older adults who have not grown up with it as younger generations have. However, the advantages of technology for the elderly who look to live independently are far-reaching, and these creative innovations will inspire and allow individuals to live their better lives longer (Ageing, I., 2018).

Acknowledgement

Without the help of numerous people, my graduate thesis research endeavour at the University of Alberta would not have been feasible. I would want to convey my heartfelt appreciation to Professor Aidan Rowe, the research supervisor of my graduate thesis project, for giving important advice during my graduate study. His energy, vision, honesty, and determination have all left an indelible impression on me. He has taught me the methods for doing research and effectively presenting the results of my research. It was a wonderful honour and privilege to work and learn under his supervision. I am really appreciative for what he has provided for me.

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Finally, I would want to express my gratitude to everyone who has helped me, directly or indirectly, finish my graduate research work.

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Acronyms

AAL ..... Ambient Assisted Living
AHT ..... Advanced Healthcare Technology
AI ..... Artificial Intelligence
DSB ..... Data Security Breaches
EC ..... European Commission
ECASS ..... Encryption Compression Aggregation Security Scheme
HA ..... Health Ageing
HBD ..... Human-Body Detection
HBR ..... Human-Body Recognition
HCI ..... Human-Computer Interaction
IHHT ..... In Home Healthcare Technology
IID ..... Identically and Independently Distributed
LDI ..... Linked Open Data Service Interface
LFM ..... Linear Figure Mode
loT ..... Internet of Things
MoP ..... Methods of Protection
NCHS ..... National Center for Health Statistics
RAI ..... Restful Application Interface
RBVM ..... Real Body View Mode
PRS ..... Passive Infrared Sensors
RTHDT ..... Real-Time Human Data Transmission
SHE ..... Secure Hardware Enclaves
UCD ..... User-Centered Design
UI ..... User Interface
UX ..... User Experience
WSN ..... Wireless Sensor Network

Chapter 1. Introduction

Al-Shaqi, Mourshed, and Rezgui (2016) note that the world's senior citizens population continues to grow, which has a significant influence on the healthcare sector. Seniors are prone to more than one physical chronic illness that causes unintentional-fall or other similar unusual movements, increasing their healthcare service utilization and need. Initiatives like supporting seniors to stay safely at home are welcome since they help reduce hospital utilization and healthcare personnel by assisting senior patients in manageing their health away from hospitals.

The Internet of Things (IoT) is a system that has changed the way we perceive technology (Balancing UX and Privacy With IoT, 2020). The IoT with Artificial Intelligence (AI), has a wide array of uses in the health service sector. These uses may include health monitoring, imageing, and data informatics, among others. Human-Body Recognition (HBR) provides technological supports that involve an algorithm to monitor certain daily activities. The algorithm helps in the automatic identification of the features or patterns of data stored in the database. It uses the established practices to judge and provide results about the HBR or objects. Healthcare Informatics is likely to benefit the most from AI. The healthcare sector generates a massive volume of data that can play a crucial role in providing better care. Human beings and existing technologies have a limitation in the amount of data they can analyze for decision-making. However, the integration of AI technology in Healthcare Informatics will ensure that information related to diagnosis is available in realtime without human intervention.

When used in the healthcare sector, AI technology provides complicated software and algorithms to assist human cognition as far as the analysis of complex medical data is concerned. Using AI technology, patients can get information from a database about what is ailing them and a possible treatment modality for their condition. On the other hand, AI in body detection and sensory monitoring saves on human power and cost. At the same time, AI ensures faster decision-making. The technology provides an opportunity to collect accurate information that enables decision-makers to act as soon as possible.

Nevertheless, sensory monitoring in AI has some limitations when acting on some of the decisions it provides. Healthcare workers must always be involved these decisions. Without an entity capable of

interpreting and performing on the AI's outcomes, this technology becomes less useful. HBR that uses AI technology raises many ethical issues. One of them is a possible violation of the privacy of the users (Rigby, 2019). According to Matthew (2020), preserving privacy and security in the caregiving sector is a challenge when Artificial Intelligence (AI) technology is applied. The problem grows in sensitivity as the public becomes more aware of the consequences of their privacy being violated and misused. As a result, the lack of data privacy protection in AI could result in serious degradation of accuracy for the AI system, thereby undermining their overall value and purpose.

So the question is how to protect users from potential risk in data privacy? What can we do if such data breaches happen? Firstly, users are protected from potential threats to data privacy through the enactment of relevant legislation. The legislation should be specific in guiding the collection, storage, and retrieval of data involved in Human-Body Recognition in AI technology. Also, a combination of approaches may protect consumer data, such as threat monitoring, Secure Hardware Enclaves (SHE), and encryption techniques. The AI technology can detect when data breaches have occurred and render any information the hacker may have obtained from the system in question irrelevant.

In conclusion, people today are more interactive than ever, meaning that designers and developers expect to pay more attention to user privacy and security. Manufacturers may argue that data collection is necessary to develop their products and the IoT and AI business in the long run. The collection of data should be monitored from the outset according to rules and laws established. A new study has shown that 92% of global customers seek to impact their information acquisition (Balancing UX and Privacy With IoT, 2020), this means that today's Internet users are aware of their personally identifiable information each time they share on the webspace. IoT workers should also try to find a consistent approach that blends safety and security with User Experience (UX) and User Interface (UI).

1.1 Background

Historically, technology has played a vital role in shaping the future of design, both in the creation and creative processes (How technology is shaping the future of design 2020). In automation, Artificial Intelligence (AI) can amplify the human experience. However, it is challenging to accomplish designs that anticipate and understand the line separating the users' automation and decisions. This separating line is critical in building design solutions. Users can delegate willingly to smart services. In this context, designers expect to develop transparent systems that give users the control for their information. A new design approach called anticipatory design allows for a plan that anticipates the user's decisions. It removes the need for choices and reduces the cognitive load, letting the system make decisions and perform tasks on behalf of the user. In anticipatory design, standard behaviors to design solutions for services focused on AI (based on machine learning and data analysis), the Internet of Things (IoT), and User Experience (UX) design. It leverages past choices to predict future decisions and is subject to continuous improvement by the designers based on changes in users' behaviors (Philips, 2018).

How User Interface (UI) Design Can Fill the Gap Between their Design Practices and Caregiving Services using IoT and AI

In caregiving services, designers can utilize the Internet of Things (IoT) and Artificial Intelligence (AI) to bridge the gap between design practices and the services provided by using the data available. In this case, data is the basis of support and a crucial factor in developing the service-based design. A data-informed design improves the User Experience (UX) and accuracy of the output. Using AI, designers can analyze vast amounts of data and suggest design adjustments to increase the designs' speed and efficiency (Philips, 2018). In a healthcare setting, the vast amounts of data available include the patient information, symptoms of the diseases, and possible diagnoses. The IoT facilitates the sending and reception of this information over the internet to ensure its availability. The designer can make adjustments based on the data available to facilitate seamless UX and enhance the trust among the users. A data-based design is friendly to the user because it improves the user's familiarity with the interface. Understanding improves decision-making because users can use the system appropriately.

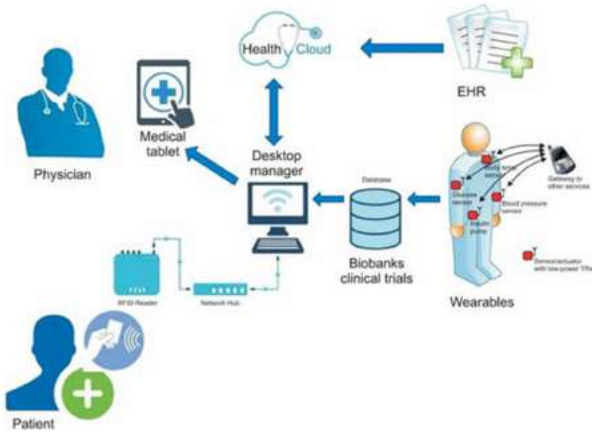


Figure 1: The role played by AI and IoT in healthcare (Finoit Technologies, 2020).

Figure 2: Living in a Smarter World: Why use AI-Enabled IoT in Healthcare (2019, Vilmate LLC)

Discussion of the Advantages of Internet of Things (IoT) and Home Automation in Artificial Intelligence (AI)

The rise in illness and the demand for healthcare creates a need for technologies to facilitate patient monitoring and rehabilitation to improve caregiving industry. Internet of Things (IoT) enables automation and data collection through a network of devices connected over the internet. Apps, devices, and people can interact when delivering healthcare services. The IoT ensures that the errors are reduced by allowing for accurate data collection, minimized waste, and risk of errors by automating workflows. Real-time patient monitoring enabled by IoT cuts down the cost involved in doctors meeting each patient. This reduces re-admissions and hospital stays.

A connected healthcare system results in a better patient experience by creating an environment where each patient's needs are met. The technology is used to develop dedicated procedures, improved diagnosis, and enhanced treatment options that make for a better patient experience (InfiSIM, 2017). For homecare, sensors are installed on medical equipment, and the data gathered are sent to qualified staff to analyze any abnormalities. Using the IoT and Artificial Intelligence (AI) improves disease management where diseases can be spotted before spreading or becoming severe.

1.2 Objective

The research focuses on monitoring and analyzing unusual behavioural patterns of older adults who live alone at home, which will benefit families with service requests on elderly caregiver-services. Therefore, a monitoring system method can be tested, tailored for seniors at home. It can detect crashes or actions that suggest a safety risk, sound anomaly recognition, which offers useful information into how seniors navigate their schedules. Family members can get real-time push notifications if any unusual behaviours occur, which ensures that medical help can intervene if needed. This unique type of service is an innovative approach that can postpone home nursing and assisted living.

Four major features enabling seniors to live independently:

a. The service offers daily/monthly updates that offer visibility about loved ones' general well-being. For example, a short day and night overview will include a summary of how a family loved one spent their day or slept through the night.

b. It is necessary to protect the right of privacy of seniors. The sensors have the potential to be used in what I call the "privacy environment." This implies that instead of a video sensor, every person in the video is seen instead as "Linear Figure Mode (LFM)" (Figure 3). Nonetheless, seniors are offered another choice to switch between LFM and "Real Body View Mode (RBVM)" (Figure 4) as seniors think it is necessary depending on personal needs.

Figure 3: Linear Figure Mode (Sik-Ho Tsang, 2020)

Figure 4: Real Body View Mode (Image by Freepik.com)

c. Private physical mode sensors are placed throughout the, ensuring bedrooms are included as this is where most injuries occur in
seniors' homes.

d. An integration between senior caregiving-service, Artificial Intelligence (AI) technology with the design of User Experience (UX) for the Internet of Things (IoT). Using a complicated task that calls for collaboration and a user-centred design approach to develop a systematic matching mobile

1.3 Research Methods & Analysis

To achieve these goals, the following research methods were conducted:

Semi-Structured Expert Interviews with participants in Artificial Intelligence (AI) Human-Computer Interaction (HCI) and Older Adults & Family Caregiving

I conducted semi-structured interviews by posing open-ended questions, having a conversation with the interviewee rather than a standard question-and-answer style. These conversations supported me to better understand the knowledge of:

a. Human-Body Detection (HBD) in AI and how this technology can provide integration with human factors;

b. Internet of Things (IoT) becomes smart and begin autonomously communicating with each other and humans through networks supported by interfaces.

c. Basic needs/expectations that the elderly need to maintain their daily lives;

Semi-Structured Interviews with Primary and Secondary Target Users (Family Relatives & Elderly)

For my primary target users, family relatives, I needed to better understand the needs and pains they have when taking care of their ageing parents. For my secondary target users, the elderly need to clarify several concerns including, their expectations, demands, pain points, and comfort points. Also, they are often in need of support services but unable to afford them.

Online Survey for Primary and Secondary Target Users (Family Relatives of Elderly)

Because family caregivers are my primary users for the mobile application service that I design for my graduate thesis research project, I need to know how they wish to improve their ageing parents' lives.

1.4 Chapter Overview

My thesis research project is divided into six chapters.

Chapter 1: The introduction outlines the main project's goal, background, objectives, and introduction of all research methods for my graduate thesis research.

Chapter 2: The Literature Review provides a review of relevant literature based on studies in the area of Human-Body Detection (HBD) in Artificial Intelligence (AI), Internet of Things (IoT) in 5G technology and life of elderly for caregiving service, guidelines on developing In Home Care Application for elderly who live live alone, and improving the Health-Tracking/Monitoring experience from primary users to their loved ones.

Chapter 3: Research Methods and Analysis lays out the analysis gained from Semi-Structured Interviews / Surveys for the elderly, family caregivers, and professional experts. The second part is the user-centered approach, which outlines the users' goals and needs.

Chapter 4: Designed Response outlines design opportunities, explains how the design process was conducted, and how individual design decisions are made based on the defined design process. Final prototypes drive the audience through the app and learn target users' needs. Testing comes after prototypes to gain user feedback for the prototypes.

Chapter 5: Evaluation and Reflection of Designed Response help me deconstruct my designs. Having the methods evaluated and reflected help me focus on a specific lens and share what I learn, feel, think, and do throughout the design process.

Chapter 6: Conclusion outlines my research findings, the challenges, and limitations observed from research.

1.5 Summary

My research mainly focuses on researching how the future of smart homes and independent senior living can be developed and improved by integrating the concepts of User-Centered Design (UCD), Artificial Intelligence (AI), and the Internet of Things (IoT). It is essential to consider human nature, which has a wide variety of uses, from home protection to home treatment, and the ultimate goal of rendering smart homes autonomous. The enhancement of senior services is also one of the most critical fields for technological evolution. As a result, the caregiver will recognise what is happening by observing their loved one's everyday life, and the safety of the elderly can be maximized and ensured.

Chapter 2. Literature Review

Chapter Introduction

This chapter provides an overview of technology used for improving the health status of the elderly. The chapter has three sections, part one deals with technologies applied to complement traditional health systems for the elderly, including Human-Body Detection technology. The second part deals with the Internet of Things (IoT) and 5G technology that help monitor the elderly remotely. This part also deals with ways of maintaining data security and privacy while monitoring the elderly. The third parts discuss application areas of these technologies for In Home care.

Human-Body Detection technologies are Artificial Intelligence (AI) systems that study people's movements and analyze daily habits at different times, they generate alarms or notifications for any deviations detected by the system. These technologies include sensor-based systems that analyze a person's day-to-day activities.

The chapter discusses several Human-Body Recognition technologies that assist the elderly in their living. The first technology is a Linear Figure Mode (LFM) where movement is detected, monitored, and described through a sequence of images frames. The technology used is microphones and vision sensors to provide caregivers with 24/7 live stream monitoring (Ted, 2019).

The second Human-Body technology is Real Body View Mode (RBVM). This technology enables caregivers to switch between the RBVM to the LFM. However, LFM is preferred mostly in bedrooms and bathrooms. The third technology is AI-powered performance sensory monitoring (Ted, 2019). This technology monitors physical behavior and gives responses for unusual daily activities from a regular observed routine (e.g. falling).

The fourth technology is AI-powered performance monitoring and analytics. This technology monitors the location of an older person at every given time and also monitors the behavior. Generally, the location of a person indicates particular conduct (Perspectives on Behavior Science, 2020). For example, frequent visits to the bathroom during the night or sleeping during the day could reveal illness. The last Human-

Chapter 2. Literature Review

Body Detection technology is image processing, this technology uses digital computing to process images. This system helps in providing video-based monitoring and recognition technique that helps in differentiating a fall from normal states. It also helps in monitoring positions and movements within the home environment.

The second technology covered in this chapter is to assist in IoT enabled by 5G technology. This technology has enabled virtual and physical equipment for improving elderly monitoring, for example, sensor technologies provide detailed mobility status.

The second also evaluates data privacy concerning Human-Body technology and the IoT. Data usage and privacy via devices should respect all legal requirements. Therefore, healthcare practitioners should differentiate between data protection and privacy, between warranties and opacity, to protect human rights. Real-Time Human Data Transmission (RTHDT) should also ensure that signal transmissions are reliable to secure the data privacy of the elderly.

Data management stresses that information collected from sensors should be stored while ensuring the privacy of the user. Data Security Breaches (DSB) are another concern in data privacy. Protection against unauthorized access, such as hacking, is critical.

The chapter culminates by discussing the application of Human-Body Detection technology and the IoT In Home care environment technology. The first application is in Advanced Healthcare Technology (AHT). These technologies have increased the shift from hospital to home care in many industrialized countries, soon more advanced healthcare equipment will be in this environment. The second application is in ageing in place. When people age, they may want to live in an independent, safe environment. People can prepare for this before their retirement to enable them to stay in a stable environment.
The third application explains the importance of assisted living, where we have home treatment and monitoring. The last application is in health warning systems for the elderly and patients to offer health communication signals 24/7. The chapter is essential in understanding the advancement of technology that improves healthcare for the elderly. I begin by discussing the impact of Human-Body Recognition (HBR) technology in improving quality of life provision.

2.1 Ageing in Place

A great number of people choose to stay in their homes as they age, or if needed with family (Copperface, 2020). Independently ageing is key to the concept of “ageing in place”, although its final form may be different for different people. People work without sacrificing quality of living, as long as possible in a single residence. For others, this ensures that changes are to be made to make the household simpler to manage, and sometimes extra facilities, such as In-Home care, are required to make ageing in place feasible. This development has seen a remarkable growth in the In Home senior care franchises industry that is benefiting from the expanding population of ageing baby boomers. Between 2014 and 2019, the population of seniors over 65 years has been growing by 3.6% annually to reach 55 million persons in the United States (IBISWorld, 2019). As individuals live longer an increasing number of elderly persons are keen on staying in their homes and maintaining independence for the longest time possible.

Health technological options are increasing every day, from artificial intelligence advancements to electronic health records (Thornberry Ltd, 2019). Hence, the use and improvement of technology are vital to advanced home healthcare. In order for the home healthcare industry to remain competitive and productive, it must integrate and utilize new technologies such as In Home Healthcare Technology (IHHT). This will ensure that costs are lower, and resources maximized, offering a return on investment (Thornberry Ltd, 2019).

According to Grand View Research (2020), the global home healthcare market is expected to grow at a compound rate of 7.9 percent annually from 2020 to 2027, and the market size by 2019 was valued at USD 281.8 billion. It was also noted that by the year 2050, the number of older persons is projected to be 1.5 billion, double the current figures of aged persons (Grand View Research, 2020). According to Duffin (2020), thirty-nine years is the expected median age of the global workforce, and that over three million people will be above the age of 100 years globally by the year 2050.

In 2019, North America had a forty-two percent share of the home healthcare market, dominating globally. Increased healthcare expenditure, patient awareness, and the implementation of a streamlined regulated framework are factors that drove the market, as noted by Grand View Research (2019). An increase In Home-based patient healthcare services is expected with the rise in the ageing population.

Chapter 2. Literature Review

The use of technology such as IHHT is an evolution in the medical field and one with the potential of facilitating countless and enormous achievements in medical treatments to reduce challenges brought about by the rising aged population. In areas where there is difficulty accessing hospitals or a lack thereof, patients can still access health-related services with the advent and use of In Home Healthcare Technology (IHHT). Moreover, there are substantial cost benefits associated with IHHT, creating an advantage with the ever-rising costs of healthcare. According to Elflein (2020), the annual healthcare costs per capita in the United States were over twelve thousand dollars, a large amount considering that a U.S. citizen's average income is fifty-four thousand dollars. Furthermore, by patient data being stored continuously and automatically updated regularly in a centralized database, there is a reduction of falsification of results. As more medical practitioners embrace technology use in the medical field, it is essential that the information is protected and reaches the intended end-point without being distorted (Filkins et al., 2016). More so, the right technology must be employed to accommodate the aged and ageing population's needs.

It might be appropriate to downsize to more simple style houses for optimum convenience and comfort. Bungalows do not have stairs, thus making them convenient for elderly citizens (Curry, 2016).
Senior life neighborhoods offering help and services are an alternative choice. Ageing in place does not necessarily involve staying in the same house even though it does help to adjust needs, cope with restricted access. The aim is to live in a welcoming household that offers a high quality of life. While, well-developed strategies might not eliminate all complications, they will this enable elderly to stay in a stable community and continue living at home after retirement.

However, there are some obstacles. Preparing for ageing might not eliminate all the issues. The deterioration of certain mental and physical capacities is irreversible, even with a healthy diet and fitness. According to Kadariya, Gautam, and Aro (2019), the ageing process is characterized by a gradual decline in physical and mental capacity, heightened risk of death and finally death. More than 20% of adults above 60 years suffer from a mental or neurological disorder and 6.6% of all cases of disability among this population are associated with mental and neurological disorders (World Health Organization, 2017). Stressors stand as the most significant risk factor for mental health challenges among the elderly population, and are caused by substantial loss in capacities, coupled with a reduction in functional ability. Moreover, recent research indicates that there is a strong relation between poor mental health and lower life satisfaction at old age (Puvill, Lindenberg, Craen, Slaets, & Westendorp, 2016). Therefore, these

aspects are to be considered to make appropriate arrangements for them. However, not all changes occurring with age are negative. Wisdom and maturity both come with age and even more opportunity arrives with retirement to fulfill one's goals.

Preparing for ageing in place requires thinking about the design of one's home. The need for appropriate planning is informed by the fact the number of falls among individuals aged 65 years and above, particularly injurious or fatal ones, have been on the rise in recent years (Overman, 2019). Statistics indicate that an estimated one in four US citizens 65 years and above fall every year (Overman, 2019). 25% of these falls lead to serious injuries entailing traumatic brain injuries and fractures (Moncada & Mire, 2017). As a result, over 3 million senior citizens in the US receive treatment in emergency departments for fall injuries annually (Overman, 2019). Reducing the risk of falls requires proper planning, which may involve constructing ramps for better entry, installing equipment and instruments for safe usage by persons with impaired vision and coordination and likely implementing a medical warning system in the event of an accident or other emergency. Other measures to reduce the risk of falls include installing brighter lighting, installing railings on stairways, removing throw rugs and installing grab bars by the toilet and outside the shower (National Council on Ageing, n.d.; Overman, 2019).

Preparations could be rendered in order to safely mature. In the sense of pension plans, the emphasis should be on making sure that life does not shift dramatically. Research findings of a study carried out in China indicated that pension enrollment and income from China's New Rural Pension Scheme (NRPS) enhanced the quality of life of senior citizens, which is reflected through improved physical health, enhanced cognitive function, and psychological well-being (Cheng, Liu, Zhang, & Zhao, 2016). This is in tandem with the outcome of an investigation conducted by Mugomeri, Chatanga, Khetheng, and Dhemba (2017), which established that income is a major determinant of the quality of life of the elderly population. If an individual is properly prepared, life might be more than relatively stagnant after retirement, but a period of self-actualization. Proper preparation requires investment contributions and early initiation of an investment fund.

2.2 Human-Body Detection (HBD) Technology

The past decade has seen a rapid increase in statistics around ageing and the elderly across the globe (British Medical Journal. 1999). Notably, uncommon alterations in their daily routine of mobility at home can indicate emerging problems in their health status. However, sensor technologies have been applied in complementing traditional systems of health to cater for the elderly by providing more detailed views on the daily status of mobility. Data collected from diverse low-cost sensors e.g., occupancy and presence, has been employed to analyze the daily mobility habits of elderly people that are independent or live alone. Such a system, based on AI, learns a person's room-to-room movements and daily habits at different times of the day and generates alarms or push notifications after deviations are detected. This research project focuses on monitoring and analyzing unusual behavioral patterns amongst elderly people in their homes, which is fundamentally founded on the concept of assisted living amongst the elderly. Consequently, this literature review evaluates academic work that appraise the impact of AI on assisted living for older adults.

The concerns over recognizing unusual alterations in the lives and daily behavior of older adults has raised multiple problems and is evaluated in different literature. Typical solutions to the problem include sensor-based systems that need non-wearable and wearable sensors to monitor the daily conduct of people and provide regular responses upon detecting deviations. However, most of these solutions need to be activated by a resident user. For example, Maskeliūnas, Damaševičius, and Segal (2019) assert that these solutions are only viable when the resident presses a button located on a wristwatch or pendant or when the resident is monitored via camera-based sensors that are fitted at diverse locations within the home environment.

Notably, previous research on such interventions and procedures conducted by Diraco, Leone, and Siciliano (2017) depicts that camera-based and wearable sensors are not trusted by people since they raise issues of privacy, are computationally complicated, and are inconvenient. Most importantly, elderly people do not feel comfortable when wearing sensors for a majority of the time (British Medical Journal 1999). Others believe that they lose their privacy when they wear these sensors or when they have camera-based systems in their homes. As such, the usefulness of such wearable sensors in continuously observing and monitoring the behavior of elderly people is reduced. Research studies conducted by Chen, Ma, Song, Lai, and Hu (2016) and Reeder and David (2016) propose that

these sensors should be embedded in people's clothes or that smartwatches should be embedded with such sensors. However, such a proposition is limited and cannot be affordable for everyone. Besides, the battery energy of the wearable devices quickly wears out, making them less effective.

Furthermore, most of the systems in place to aid the elderly through assisted living also entail explicitly annotating or labeling different processes offline. On top of that, it necessitates physical configuration to monitor the person's characteristic behavior before the system is used, which increases the needed installation time for the systems and inhibits its adaptability in small shifts or seasonal changes that do not necessarily imply unusual behavior. In my graduate thesis research work, the process of detecting these changes is imperative in the regular mobility behavior of elderly people that live independently at home without immediate support from relatives or caregivers. This objective is achieved through monitoring their day to day navigations between different rooms utilizing AI.

Notably, such an AI-based information technology and computing system could significantly benefit families that act as caregivers for their parents. The system is expected to learn the daily transitions from one room to the other and the conduct in every room, at each specific instance of the day and in turn, generate push or alarm notifications when deviation is detected. Moreover, an algorithm is employed in processing the sensor data streams and in computing the sensor-driven features as part of the established IT system to aid in monitoring conduct and behavior.

The system has a high-enough capacity to attain a low detection delay as time progresses and showcase the detection of diverse and ordinarily abnormal circumstances. The AI technological system is called Human-Body Detection (HBD). The data from such a behavioral monitoring system detects numerous changes in mobility that are symptoms for common problems (David, 2016). From the system's architecture, a different method of monitoring elderly adults has been tested. Additionally, the new system is capable of detecting crashes or actions that suggest a safety risk and sound anomaly recognition, which offers useful information into how seniors navigate their schedules. Therefore, family members can get real-time push notifications if there are any concerning unusual behaviors.

2.2.1 Linear Figure Mode (LFM)

According to Zhang, Guo, Huang, and Han (2018), the real-time understanding of human behavior in video streams is a trending research area in AI and computer vision. The process of understanding human conduct fosters research in automatically detecing, monitoring, and description of human activities through a sequence of image frames. In this case, the Human-Body Detection technology is augmented by microphones and video sensors in monitoring and detecting the older person's movements, which provides caregivers with 24/7 live stream monitoring. The system gives caregivers an advantage of checking in anytime with the elderly. Furthermore, it detects and sends alerts to caregivers when something is not right with the elderly. Consequently, the Human-Body Detection (HBD) technology works like a smart home technology recording the patterns and movements of elderly.

In addition, the system is less creepy than it sounds. Notably, while the cameras identify people by their postures, gait, clothing colour, limbs length, and their faces, all that viewers on the other end get to see for most of the time is a stick figure, which maintains a delicate privacy level for the elderly person. This approach is referred to as the Linear Figure Mode (LFM). The model attached in Figure 5 showcases an example of the LFM.

Figure 5. The Linear Figure Mode, LFM (Image by Dariusz, Jarzabek).

2.2.2 Real Body View Mode (RBVM)

Depending on the personal needs of the elderly, caregivers have the ability to switch between the Linear Figure Mode (LFM) and Real Body View Mode (RBVM). While most seniors might prefer to have the LFM in their bedrooms and bathrooms, the RBVM is mostly applied when they are in their main living area. Each of the sensors, however, has the ability to switch between either modes. Figure 6 below demonstrates what the caregiver sees whenever the live feed is switched from the private LFM to the RBVM.

Figure 6. Real Body View Mode, RBVM (Image by u/TheElectrozoid)

2.2.3 Artificial Intelligence (AI)-Powered Performance Sensory Tracking

Sensory tracking and the monitoring of human behavior are not trivial tasks. As such, there is no individual method that might cover all features when monitoring conduct. However, the introduction of communication and sensing equipment has resulted in numerous innovative approaches and AI leads the behavioral monitoring systems in Ambient Assisted Living (AAL) for the elderly in smart home settings. Current AI-powered performance sensory tracking documents the activities carried out by the elderly within the home environment and assesses the health status of the older individual. As such, an elderly person is noted to be in normal health for as long as they maintain their usual daily activities with no substantial nonconformities from their regular routine. Any departure from the daily routine is registered as an unusual behavior as shown in the Figure 7 below.

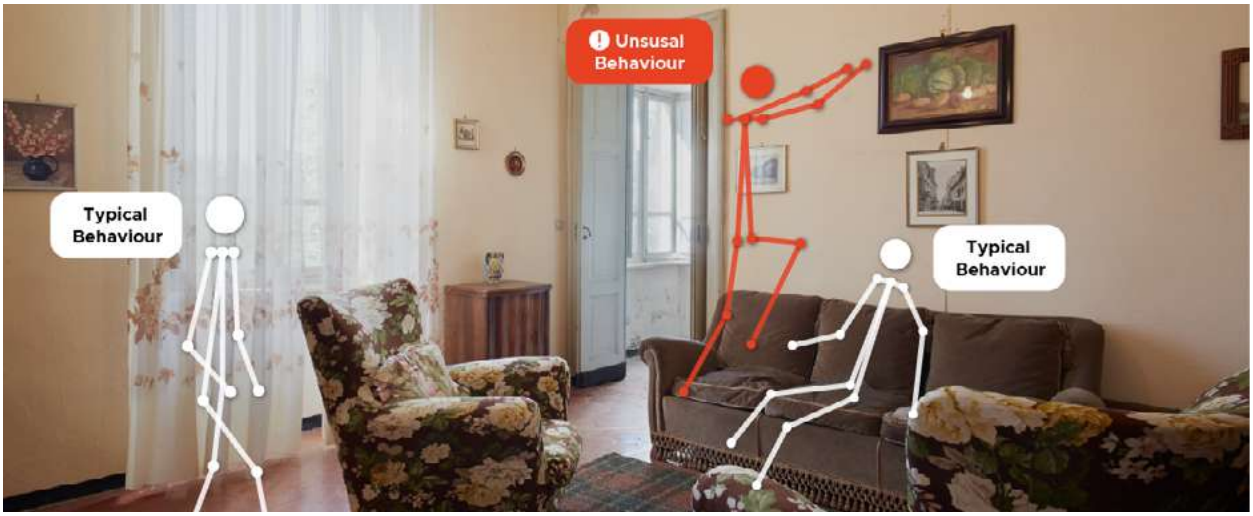


Figure 7. Unusual behavior detected by the algorithm behind the behavioral monitoring system (Image by andersphoto)

Monitoring Elderly People's Daily Living Activities

As Antonio (2016) notes, daily life activities for the elderly person can be grouped into two categories, i.e., the essential and the instrumental activities. Notably, essential activities include functional mobility, dressing, eating, personal hygiene, and bathing. The instrumental daily activities include doing house chores and cooking. By monitoring the day-to-day activities of elderly people, healthcare personnel can continually monitor their functional status, increasing their capacity to live self-sufficiently, and allows

the possible discovery of diverse ailments, such as dementia and Alzheimer's disease. The AI-powered performance sensory trackers have the ability to also monitor movement patterns in the home, e.g., sleeping habits, walking, and falling, as shown in Figures 8 and 9.

Figure 8. Sensory trackers detecting body movement (Image by Andersphoto, Jarzabek).

Figure 9. Sensory trackers detecting a fall by the elderly (Image by Andersphoto)

Sensing Technologies

Generally, there are two kinds of sensors that are employed to monitor human behavior. i.e., wearable sensory tools and non-wearables (Zhang, Fu, Ye, & Fischer, 2017). Most wearable sensors are used in recognizing diverse activities and they differ to the type of application they are to be employed in monitoring. Most are placed on the Human-Body Recognition or people's clothes. Accelerometers are the most common worn sensors and are engaged in monitoring a person's movement and differentiates their motions, e.g., cycling, walking, and running. They also detect when elderly people fall and are used in recognizing user's behavioral rhythms and improving long-term recognition of use activites.

As Botros notes, smartphones are also classified as wearable sensors. They have numerous sensors providing data for varied applications (Sensors 2019), (e.g., accelerometers, gyroscopes, magnetic compasses,microphones, camera, etc). However, to prevent the limitations of wearable sensors, AI-powered performance sensory trackers employ Infrared (IR) sensors in detecting presence,

locating people in their homes, and their motion. Other sensors used in AI-powered sensory tracking include low-resolution thermal sensors, video-based sensors, vibration sensors, pressure sensors, and ultrasonic sensors such as Passive Infrared (PIR) sensors. PIR sensors allow users to sense motion, and detect whether a human has moved in or out of the sensor range. They are small, inexpensive, low-power, easy to use and do not wear out. Table 1 shows a comparison between properties amongst diverse sensors, showing why PIR sensors are preferable in low-cost assisted living technology in the Human-Body Detection model.

Property	PIR	Camera	Smart phone	Smartwatch
Location Detection	Low	High	High	High
Presence Detection	Medium	High	High	High
Tracking	Single User	Muti-users	Muti-users	Muti-users
Resolution	Single Bit (On/Off)	High	High	High
Cost	Low	High	High	High
Privacy Concern	Low	High	High	High
Battery Life	High	NA	Medium	Low
Require Data Processing	Medium	High	High	High
Localization	Low (room-level)	High	High	High

Table 1. Comparing Properties of Sensing Technologies.

Classifying Activities

Numerous machine learning and data mining algorithms are employed in classifying daily activities. These algorithms include neural networks, Bayesian methods, fuzzy logic, decision trees, and random forest. Notably, most of these deep learning and data mining algorithms assume that the data input to classify activities is identically and independently distributed (IID), which is not applicable in human behavior recognition and modelling. What an individual does at a particular time depends on what they were doing a few moments before that instance. As such, more innovative models are needed in handling cases where the IID assumption fails. According to Debes et al. (2016), there are two different models

that might consider dependency assumptions, i.e., discriminative approaches (e.g., the conditional random field) and the generative approaches (e.g., the hidden Markov model). Overall, many algorithms from these two categories have been employed in classifying daily activities and behavioral modeling. However, an intensive and supervised training session is needed in estimating their scope, which might lead to bias by people when annotating and labelling the activities.

2.2.4 Artificial Intelligence (AI)-Powered Performance Monitoring and Analysis

Monitoring Locations

According to Eisa and Moreira (2017), a person's location presents interesting data on their activity, which plays a crucial role in assessing their overall behavior. In this case, the location of an elderly person in question is indoors. Notably, the indoor location of elderly people gives insightful information in building their behavioral models for their daily lives. Their movements correlate with their everyday physical activities and how they perform them. For example, frequent bathroom visits during night time, meant for sleeping, might indicate a disease or a sleeping disorder.

Monitoring Behavior

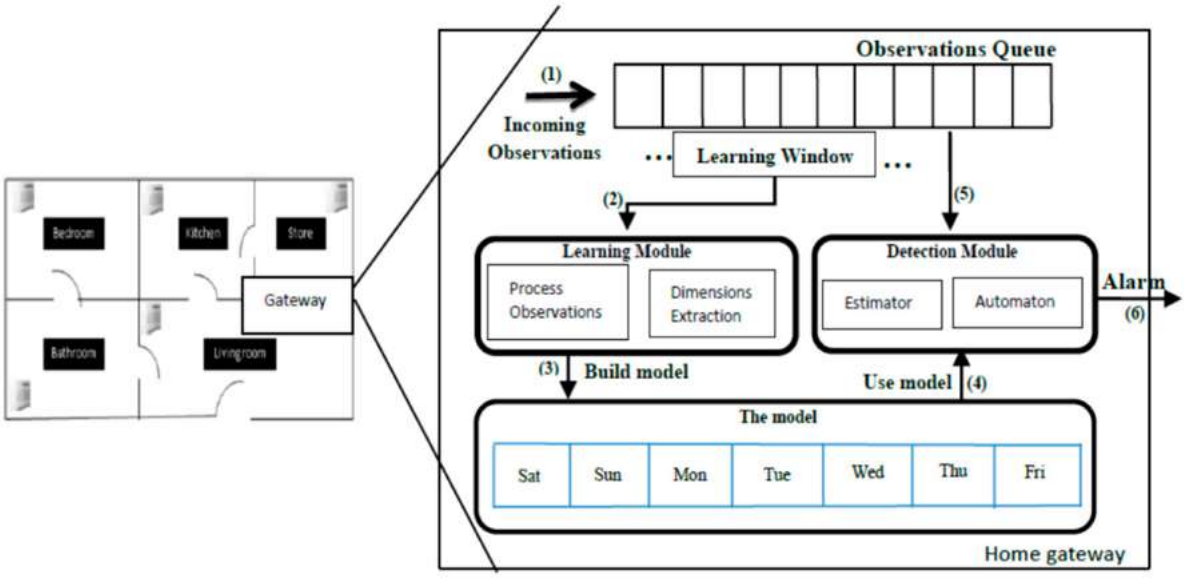


Figure 10. The architecture of a behavioral monitoring system (Image by Samih Eisa and Adriano Moreira 2017)

The architecture above depicts the general design of a behavioral monitoring system, in which a set of sensors are placed at diverse locations within the home environment, intending to collect elderly people's daily routine. The data obtained from the sensory devices will then be progressed to a gateway installed within the home responsible for interpreting and processing the data locally. It also learns the person's routine (learning module) and provides an alarm or push notifications when there are unusual deviations from the regular pattern (the detection module). The learning module in the system is charged with continually processing incoming observations from diverse sensors and builds a realistic model that can be employed in summarizing the monitored person's behavior within the home at various times in the day. It is imperative to build a state transition model, which showcases interlinked rooms and can be used to trace the movement of the elderly person being monitored. An example of a classic state transition diagram appears below.

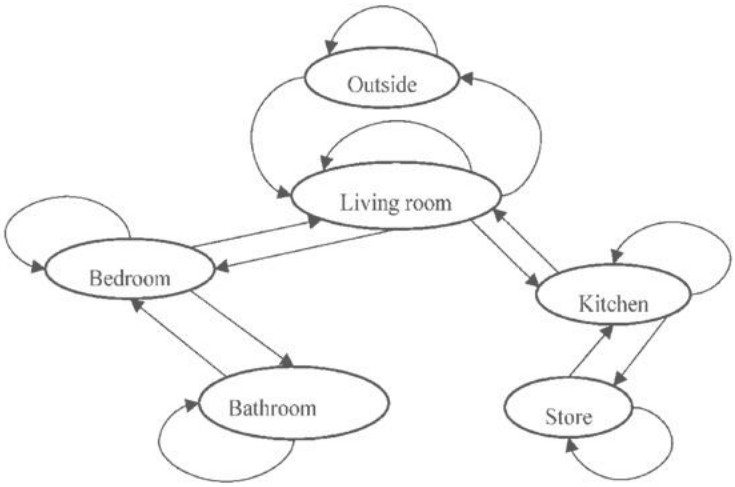


Figure 11. State transition model from one room to the other (Image by Samih Eisa and Adriano Moreira 2017)

As Eisa and Moreira (2017) note, the detection module, refers to a distinct process, which is executed in real-time and is asynchronous to the learning module. Notably, the detection module is responsible for producing outputs at higher and regular intervals, e.g., sixty seconds. This module comprises of the automation part and the estimator, as shown in Figure 12. The estimator is charged with computing the likely location for the perceived motion of the elderly person being observed and providing a state of confidential binary abnormality.

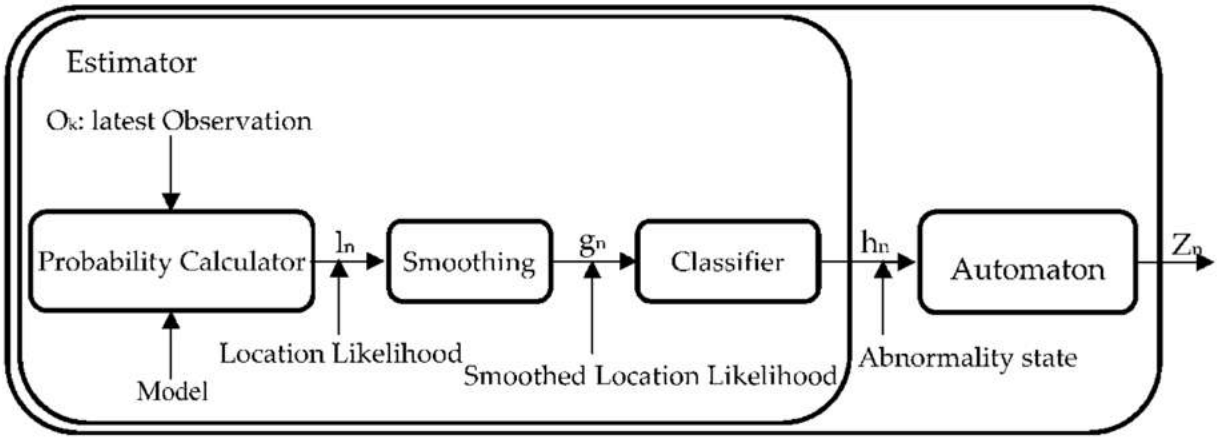


Figure 12. The detection module's internal structure (Image by Samih Eisa and Adriano Moreira 2017)

The estimator is expected to generate the required binary classifications (1 for abnormal and 0 for normal), based on an enquiry of the recognised location for the observed individual. However, such outputs in binary form do not offer enlightening feedback to depict the actual subject's state. In addition, they are at times misleading and unrealistic, which makes it more convenient to describe the detection module's final output terms that offers a more detailed and descriptive explanation of the decisions made by the AI-powered performance monitoring and analytics system. In this case, automation can be described using three states, i.e., normal, abnormal, and potential abnormal. The automation state is updated regularly as required by the estimator's output shown in the Figure 13 (Eisa, S.; Moreira, A, Sensors, 2017).

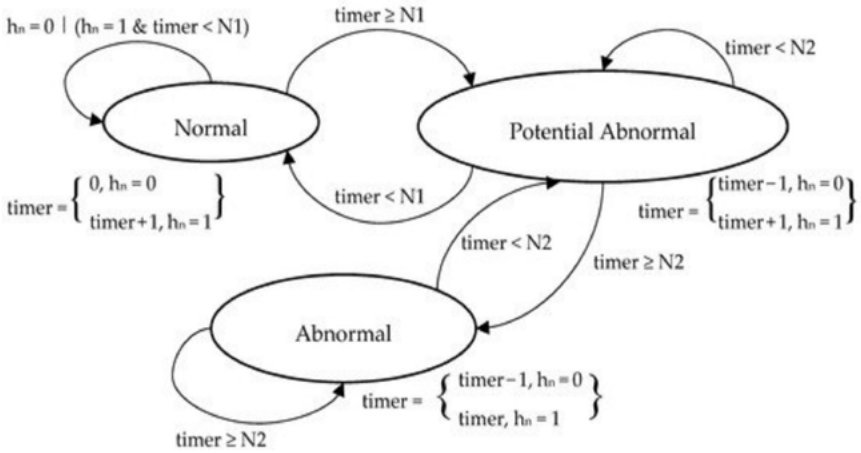


Figure 13. The detection module's automation (Image by Samih Eisa and Adriano Moreira 2017)

Furthermore, an elderly person might have diverse abnormal or unusual behaviors when they are performing different activities within the home environment. As such, most of the literature on the concept limits itself to a finite set of unusual conduct that can be detected by the Human-Body Detection technology. In the detection module, it is imperative to add an additional step that classifies the detected unusual conduct, which makes it easier for healthcare providers and caregivers to understand and react upon it. As such, a rule-based classifier is introduced, as shown in the Figure 14, to incorporate the automation output with behavioral models' dimensions that classify differently detected unusual conduct (Eisa, S.; Moreira, A, Sensors, 2017).

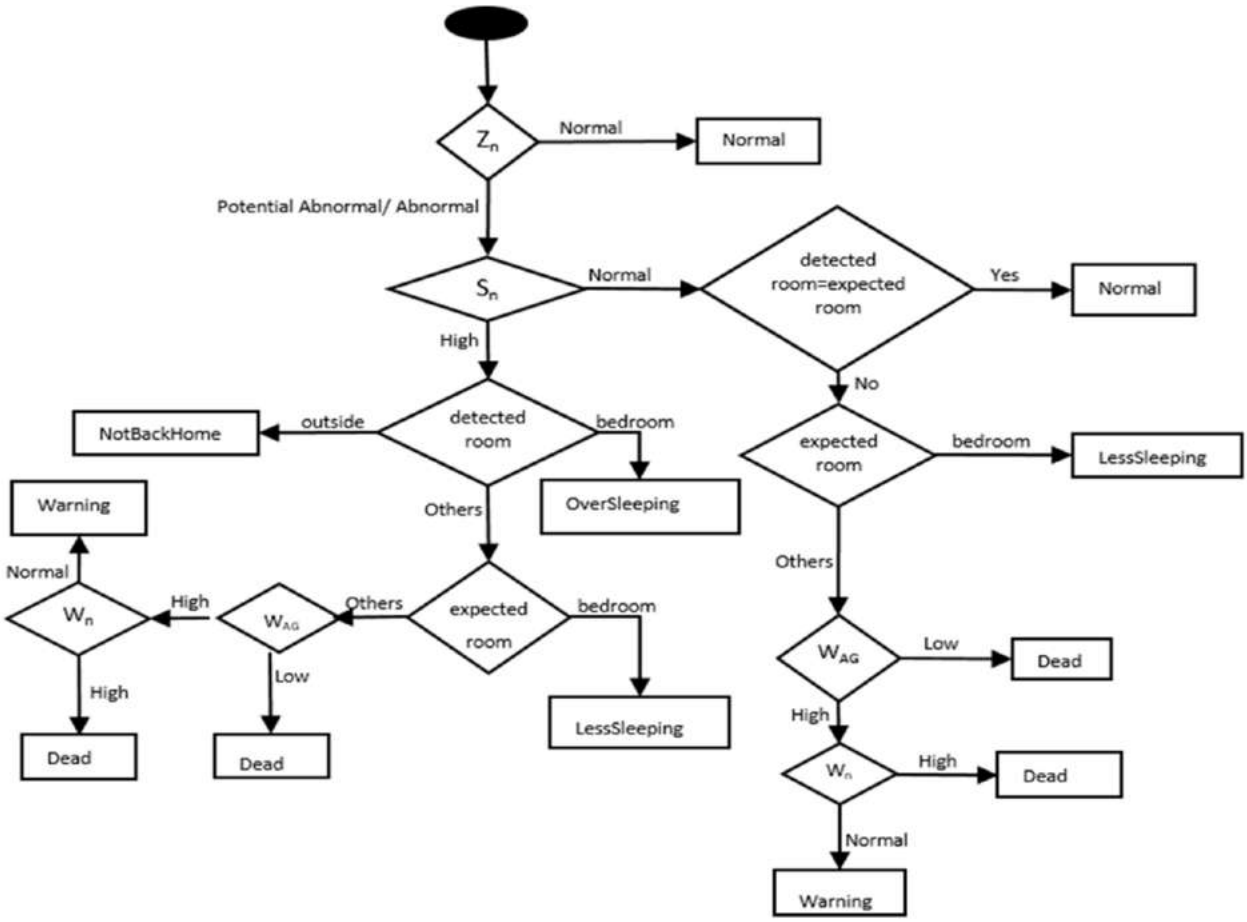


Figure 14. Anomaly classification flowchart based on different rules (Image by Samih Eisa and Adriano Moreira 2017)

2.2.5 Image Processing

Image processing refers to the use of digital computing to process images via different algorithms. Notably, image processing is a subfield of digital signal processing and aids to enhance pictures and in extracting meaningful information from them. According to Htun, Zin, and Tin (2020) on the application of AI in monitoring elderly people, advances in image processing continue to provide more clear views for AI systems in healthcare and medical management. Notably, image processing technology has presented a considerable leap for video-vision-based monitoring and recognition systems. Image processing systems have become useful aids in differentiating falls from the normal states of elderly movement and positions within the home environment. Moreover, vision-based systems used in monitoring conduct amongst the elderly present greater potential in intelligence monitoring in the indoor environment. Consequently, image processing techniques have been extensively employed in detecting fall events or abnormal occurrences, such as those intended for this project.

2.3 Internet of Things (IoT) in 5G Technology

The proportion of the population that is elderly has significantly increased in recent decades due to improvement in their life expectancy. Notably, Azimi et al. (2017) highlight that dynamic susceptibility to different diseases, and the frailty of old age are some of the issues elderly have to deal with, arising multiple challenges in their care. However, these past few years have witnessed an increased demand to develop care services for the elderly, employing novel technologies to improve independent living standards. Consequently, Azimi et al. (2017) note that the IoT has come into play as an advanced paradigm on which virtual and physical equipment are connected to improve remote elderly monitoring. Sensor technologies have been employed in efforts to complement other traditional health systems by providing in-depth and detailed views on the daily mobility status of older people as they conduct various tasks within the home environment. This literature review evaluates academic work documenting an integration between Human-Body Detection technology and the IoT, data privacy, management, informatics, and encryption technology for security purposes.

According to Apex (2020), personal support workers and home health aides have traditionally provided care, with assistance from family caregivers. However, as the baby boomer generation matures, there is not enough personal support workers to meet demand. Traditional home-care models are unsustainable in the long run, and there is an urgent need to rethink the present approach to senior-care in order to relieve the burden on healthcare institutions and respond to rising demand-supply gaps. This is when some of our current existing technologies comes into play such as Internet of Things (IoT) and 5G. These technologies can offer effective, economical in-home care, allowing limited healthcare resources to be directed more effectively to a growing elder population.

Today's world increasingly relies on ambient intelligence, and the IoT serves as a gateway. The data collected from different low-cost sensors, e.g., presence and room occupancy, can be employed in analyzing the daily mobility habits for elderly, especially those pursuing independent lives. Such systems heavily depend on AI, automatically learning the room-to-room mobility of an elderly person and developing patterns for different time frames during the day. As such, it is possible to generate push notifications to relatives whenever deviations from ordinary behavior are noted.

The IoT refers to a rapidly expanding device collection charged with collecting, transmitting, and sharing

data over the internet. According to Verizon (2018), roughly 8.4 billion devices make up the IoT universe, from wearable technology to appliances and cars, representing a 31% increase since 2016. Verizon (2018) also forecasts that by 2025, the number of predicted devices to connect to the IoT universe could exceed 55 billion. Figure 15 depicts the connection between various devices that makes up the IoT universe.

Figure 15. The Internet of Things (Khoshafian, 2017)

Ambient Assisted Living (AAL)

Given that the traditional family setup that used to ensure care and safety for the elderly has changed due to our present societal setup and work culture, caring for the elderly consumes both monetary and time resources. As such, Ambient Assisted Living (AAL) comes into play as a boon that improves the quality of living by monitoring daily mobility, routines, and activities and providing services in healthcare if and when they are needed. AAL refers to an emergent field intending to advance daily living standards. AAL implements an ecosystem through different sensors, computing devices, and dynamic applications that are installed to evaluate the individual ageing person's health. Notably, Vijayalakshmi and Jose (2020) showcase that AAL is equipped with various services and products that are enabled through high-end technological abilities, which are both user-friendly and economical. Most importantly, Vijayalakshmi

and Jose (2020) assert that the IoT executes a crucial part in how emerging technologies are intertwined to foster the concept of Ambient Assisted Living (AAL) among the elderly. In this case, it is evident that the adoption of IoT technologies has opened up healthcare and medical domains to substantial improvements, particularly in the diagnosis, prevention, and care for elderly patients to ensure comfort.

5G Technology

5G technology is an key facet to the efficacy of the IoT since sensory devices need a faster network bearing a higher capacity to serve the necessities in connectivity. Breakthroughs in sensor technology, analytics, and software are poised to disrupt several industries. Thus, the key to ensuring that these connections remain robust is to establish a network with the capacity to handle intense speeds in data transmission, data loads, and battery life required by the devices. Consequently, for IoT to actualize its potential in AAL, Verizon (2018) notes that 5G technology is crucial. Notably, the 5G network spectrum, shown in the Figure 16, expands the necessary frequencies that are to be used by digital cellular technologies in transmitting data.

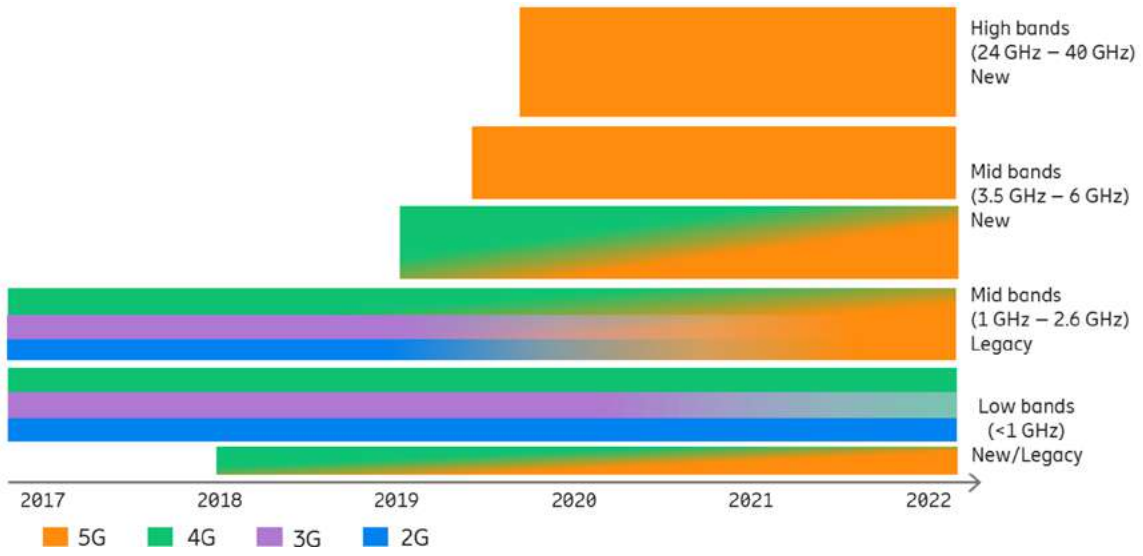


Figure 16. The 5G spectrum (Tuhlin, 2018)

2.3.1 Home Automation

Numerous technologies contribute to the assisted living concept and its eventual vision. In this case, Mora, Matrella, and Ciampolini (2018) believe that telemedicine technologies and home automation devices have led to remarkable achievements in assisted living. Many AAL systems depend on "smarthome" technologies, with distributed sensors within the home environment to aid in inferring behavioral patterns amongst the elderly. Uddin, Khaksar, and Torresen (2018) posit that such reliable and cost-effective technologies are needed in caring for the elderly within the home environment. Similarly, in a systematic literature review, Sapci and Sapci (2019) note that the adoption of smart and in-house automated monitoring technologies could increase the independence of the elderly. Current Human-Body Detection could benefit from integration with home automation devices. Figure 17 shows IoT-based home automation sensors that can be integrated to foster assisted living, particularly video sensors. Notably, Mora et al. (2018) believe that the power of sensor technologies could be tapped to extract useful data to monitor health and wellbeing. For example, Mora et al. (2018) note that simple sensors could be used in tracking sleeping habits, which goes a long way to provide an indirect yet expressive health-related measure of an elderly person's wellness.

Figure 17. Home automation sensors (Image from allteksystemsla.com)

Given the present advancements in technology, it is evident that home automation devices could be used to complement assisted living in Human-Body Detection. Mora et al. (2018) note that environmental sensors with data inherently carry behavioral information that could be used to offer health-related insights and infer wellness knowledge indirectly. To exploit the features presented by home automation devices, there is a need to introduce powerful analytics that converts raw sensor output data into accessible and meaningful insights. However, the home sensors and back-end services based on cloud technologies provided by home automation raise multiple concerns over data usage and privacy of interconnected devices. Other technologies used to monitor behavior amongst the elderly are documented in Figure 18. Furthermore, other technologies specific to the home environment that are employed in behavioral monitoring for the elderly are demonstrated in Figure 19.

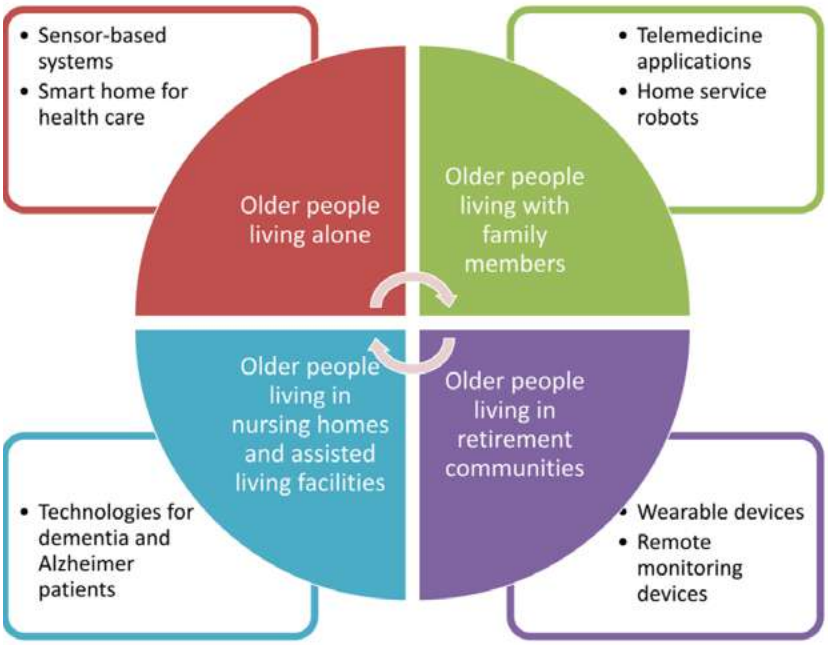


Figure 18. Other technologies applied to older adults (Sapci & Sapci, 2019)

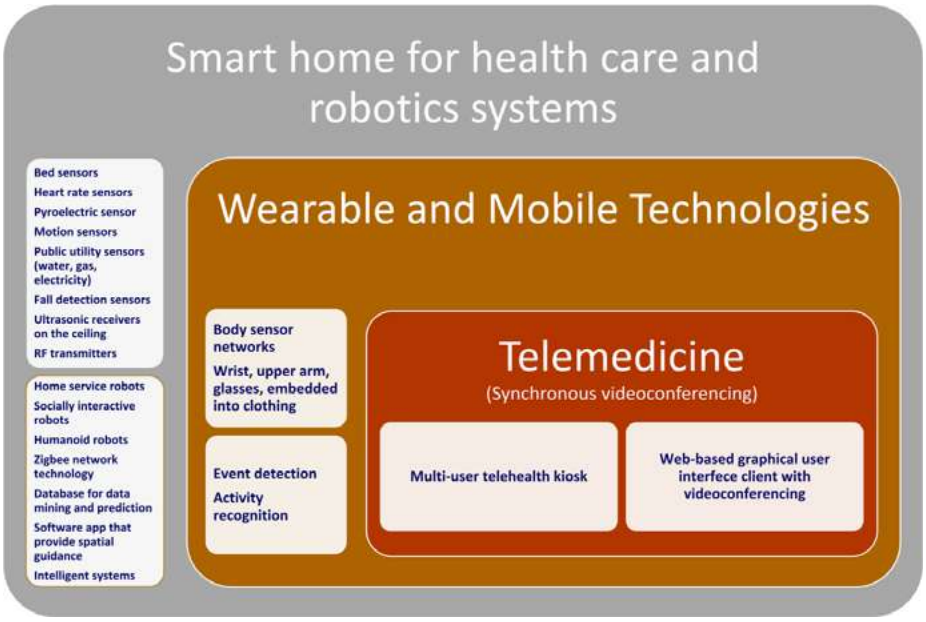


Figure 19. Smart home technologies used to monitor elderly behavior (Sapci & Sapci, 2019)

2.3.2 Data Usage & Privacy via Devices

According to Regina Connolly and Grace Fox, (2017), systems used to monitor behavior amongst the elderly should respect the legal requirements and the rights of the person holding on to the data. However, it is inevitable that dataveillance amongst the elderly through home automation sensors results in various risks. Dataveillance refers to the systematic utility of personal data when monitoring and investigating the behavior of peope. As such, it is imperative for healthcare practitioners involved in monitoring the behavioral conduct of the elderly to distinguish between privacy and data protection, between transparency and opacity.

While technology brings multiple threats that might harm human rights to privacy and protection of data, as Michael Nadeau notes, (GDPR, 2020), the Data Protection Act in Europe provides guidelines on the data usage and privacy through devices meant to foster quality of life and healthcare. Notably, the Data Protection Act obliges data controllers In Home automation systems dealing with the elderly to obtain and process the individual data with a high degree of fairness (Regina and Grace, 2017), to store the data for explicit purposes, to process the data only when the intention lines up with the initial objective for which it was recorded, and to ensure that personal information is kept securely and safely. Also, the Data Protection Act obliges data controllers to ensure that behavioral monitoring data is updated and stored in an accurate yet complete manner, ensure that the stored information is not excessive, is relevant, and is adequate for the earlier intended purposes (GDPR, 2020). Moreover, data controllers might not retain the stored data for a extended period than what is necessary to achieve the initial goal of the behavioral system and should provide a copy of their data upon request.

2.3.3 Real-Time Human Data Transmission

Al-Shaqi, Mourshed, and Rezgui (2016) note that signals obtained from the monitoring sensors and devices within the home environment are illustrated as continuous or binary values to the system used in monitoring activities. The real-time transmission of such data to the database occurs in numerous ways. Notably, Al-Shaqi, Mourshed, and Rezgui (2016) showcase that once the devices are triggered, the signal is transmitted for purposes of local storage, e.g., to a personal computer, through wireless or wired communication. In this case, the signals refer to the raw data, which is, at times, annotated with data such as the location of devices used in monitoring and the time they were activated. However, for reliable system performance, it is imperative to have structured communication between computers, sensors,

and devices within the home environment. Other plug and play models of wireless communication can be employed to provide alternative means in communication. Overall, the integration of sensors with the local databases could be attained through structured cabling.

2.3.4 Data Informatics

The developers of AAL depend on the real-time transmission of crucial signs in the behavior of the elderly to introduce personalized care options. In this case, Al-Shaqi, Mourshed, and Rezgui (2016) note that vital sign availability determines the kind of personalized care that the elderly receive. Thus, the critical signs of the elderly population should be continuously monitored. For example, a fall detection system is embedded inside Human-Body Detection to monitor the daily activities to provide support in case of emergencies. In another case, a triaxial accelerometer device can be employed to measure motion and classify the subject's orientation (Al-Shaqi et al., 2016). Any change in basic body orientation should trigger a response. According to insights from Al-Shaqi et al. (2016), it is also possible to introduce motion sensors to detect and form a pattern of daily activities for the elderly using an activity learning system. Although body attached motion sensors can be employed, they were not preferred for this system in realizing various gestures from an ageing population.

2.3.5 Data Management

According to Almeida et al. (2017), a considerable amount of data is obtained from the sensors in the behavioral monitoring system. Notably, the type of data collected includes user motility (the user's ability to move body parts in executing different roles), user localization (user's position within the house), and his or her environmental interaction. Such information or data needs to be stored while assuring the privacy of the user and ascertaining that their personally identifiable data could only be accessed by approved personnel. The information could be normalized to ensure that third parties and healthcare stakeholders properly consume it. Overall, the data could be securely gathered, stored using robust technologies, and normalized through a semantic structure. Moreover, the information should be shared flexibly with stakeholders. As such, Almeida et al. (2017) propose a personal data management system for the collected data that employs the conventional interfaces bearing a Linked Open Data framework to provide a shared and common repository as shown in the Figure 20.

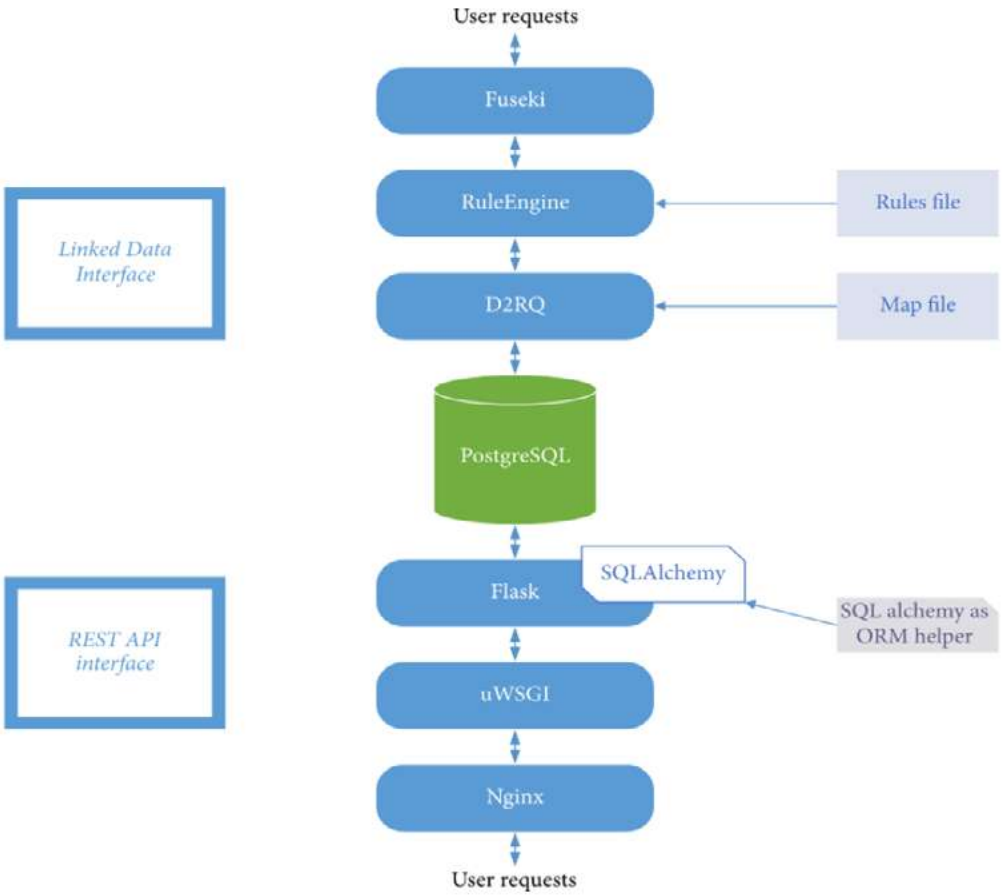


Figure 20. The structure of the data management system (Almeida et al., 2017)

2.3.6 Data Security Breaches or Methods of Protection (MoP)

Overall, increased adoption of distributed sensing devices fosters assisted living systems amongst the elderly in collecting data and in proposing customized services in healthcare. However, constrained resources in developing the behavioural monitoring system might lead to an exchange of private data over wireless networks. To avert these kinds of breaches, it is essential to enforce several cybersecurity measures. For example, the three-level network model presented by Mbarek and Jabeur (2019) is very efficient in protecting the patient's data against breaches and hacking to obtain unauthorized access.

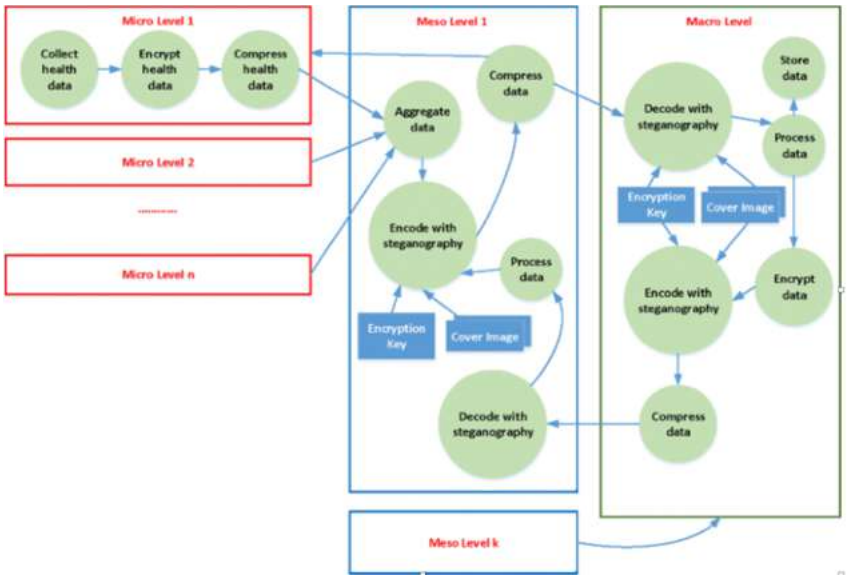


Figure 21. The three-level network or hiding steganography method (Mbarek & Jabeur, 2019)

In this case, Mbarek and Jabeur (2019) propose a model where the medical data is exchanged securely from micro-level (sensor nodes) between peers through the macro-level (the health management server), and the Meso-level (general cluster heads) as shown in Figure 21.

2.3.7 Encryption Technology

Mbarek and Jabeur (2019) propose the Encryption Compression Aggregation Security Scheme (ECASS), which is a novel encryption technology used for assisted living systems. Notably, the ECASS system is founded on practical approaches that employ systemic cryptography keys, steganography, and compressed sensing to ensure that healthcare data is privately safeguarded. Mbarek and Jabeur (2019) opine that ECASS is more robust compared to the IBE-Lite security scheme that was previously adopted by former systems in assisted living. In this case, ECASS exhibits NS2 simulations to lower the consumption of energy and also reduces existing overheads in communication by about forty or fifty percent, which makes ECASS an effective encrypting technology to be adopted in assisted living systems.

In the current project, it becomes imperative to compare ECASS with other addition schemes in security, e.g., MACE encryption, and also evaluate the impact of interchanging the phases involved in encrypting, compressing, and aggregating the performance of the security scheme through using aggregation encryption compression and compression encryption aggregation. Overall, while focusing on medical health systems and assisted living, ECASS encryption offers secure data exchanges for wireless networking while attaining low communication overhead and low consumption of energy, which makes it a productive technique for adoption with the behavioral monitoring system for the elderly.

2.4 In Home Care for the Elderly Who Want to Age in Place

2.4.1 Advanced Healthcare Technology (AHT)

The amount of In Home Healthcare Technologies (IHHT) used has grown significantly in the last 5-10 years (Technological Advancement In Home Healthcare 2021). Data on usage patterns and realistic interactions are critical in order to monitor their use and to maintain consistency and protection. In this section, the literary study of the trends, habits, styles, patterns and viewpoints of In Home technology is given (The Human Factors, 2011).

According to Hollestelle, Hilbers, van Tienhoven, and Geavanceerde (2005), cost savings and clinical changes are anticipated due to demographic growth of elderly people, which indicates an increased shift from hospital to out-patient care during the next 5–10 years in most industrialised countries (Bilthoven; 2005, Geneva; 2008). Therefore, it is necessary to move advanced healthcare equipment into home environments and more development could be predicted in the near future.

If the amount of home-based healthcare equipment used is ‘growing’, there is little proof of the extent and volume of the technologies in question. The industrial market presently comprises of nearly 500,000 distinct models and grades of healthcare equipments (Geneva; 2016). Reports on healthcare equipment laws and regulations are issued by the European Commission (EC), but the detailed figures of ambulatory healthcare infrastructures are not fully known (Council of the European Union). The United States National Center for Statistics on Health (NCSH) claims advances have spread from hospitals to the household, but the results are also not evident scientifically (NCSH Health, United States, 2009). Searching for information on the overall number of healthcare technology used In Home settings was difficult with little systemic data sets globally available.

The preservation of quality treatment and patient safety is a critical precondition for the use of In Home Healthcare programmes within the residential population (Den Haag; 2008). From a historical context medical technologies were built for hospital environments (Home Healthcare Nurse. 2006, Technol. 2010). Therefore, it is important to consider the specific factors pertaining to home deployment and use (Bilthoven; 2009). Medical technology threats are typically rated according to (1) environmental conditions; (2) human factors; and (3) technological factors (Welz. en Sport; 2011). However, human

factors remain very important to patient well-being both in hospitals and at home (Bilthoven; 2005). For one, a major risk factor is the number of users and changes in the care chain. A limited range of diverse users of healthcare equipment are involved at home, often in varying levels of experience, readiness or education. Although user ownership affects the role of the patient and/or relatives, a major user group is competent nursing workers. Understanding users' views and background on traumatic accidents and near-incidents are critical factors in building awareness about the use of home treatment. The sharing of this knowledge assists in the function of patients and clinicians and specifically nurses which will contribute to patient safety and quality treatment.

Therefore, the types of technologies used at home could be addressed first; secondly, how often they are used and thirdly, trends can be observed. Further analysis on what scientific data is available on actual overall UX; training, instruction safety and what can essentially be concluded on the role of nurses in healthcare technology home use.

Usually, In Home Healthcare Technology (IHHT) refers to the usage of structured knowledge and resources through the usage of devices, procedures and methods created to resolve a health concern and enhance the quality of life (Health Technologies Internet. 2007). The World Health Organization (Geneva; 2016) uses the definition of "medical device" as a tool, equipment for avoiding, diagnosing or handling disease and/or recording, measuring, correcting and modifying the structure or act of the body for some kind of health cause."

The environment of IHHT ranges from very basic to rather complicated equipment. Wagner et al. (1988) claimed that 'high-tech addiction' contributes to 'technology-dependence' in the case of a medical aid designed to offset the loss of vital body production and meaningful and continuous nursing services to avoid mortality or further harm. (US Government Printing Office Washington, DC; 1987). These patients' requirements vary from the persistent help of a machine and a professional caregiver to less frequent treatments. It also involves competent nursing (Bell & Howell; 1991) and a considerable amount of strategic decision-making, planning, training, and supervision (Chest; 2007).

2.4.2 Should Assisted Living be Considered or In Home Care?

When we have an elderly parent, we accept the reality that they may be unable to take good care of themselves. When the time comes and we are given a decision between treatment at home or a helpful

life, it is important to consider deciding which would be our beloved's better option.

The first option we should take into consideration is In Home care assistance. In this way, we can periodically employ somebody to support them. This kind of consideration has many advantages including:

a. It provides a degree of independence and the comfort of living in a familiar environment (Howley, 2019);
b. It helps family caregivers to maintain schedules;
c. It helps our aged family member to live independently;

On the other side, some elderly people are not comfortable having visitors in their residences, although there are restricted hours within which an In Home care providers need assistance. In comparison, In Home care can be very costly, with a cost of at least $15 per hour. Supported living can be another choice for our loved one. This is suitable for elderly who need support with everyday activities, but may not need continual medical help. In addition, an assisted living facility includes private and common accommodation, with community areas and group leisure and socialization alternatives.

Usually these groups provide food, lodging, washing and essential healthcare. Supported living communities provide the extra advantage of offering supervision for our loved one 24 hours a day. People may notice, though, that elderly people are hesitant to transfer to an assisted living centre, since it would involve leaving home and giving up their own schedules and everyday activities.

According to an article by the American Association of Retired Persons (AARP), ninety percent of people aged above 65 years prefer to stay in their own houses as they age compared to assisted living facilities or nursing homes (Khalfani-Cox,2017). This shows the importance of ensuring and achieving independence of patients. Hence, as more and more older adults prefer to stay at home, the advancement of home healthcare will be significant in the growth of healthcare services.

2.4.3 How Health Warning System Works and Who Can Take Advantage of Using it?

Behavior tracking is a feature of healthcare alarm systems. The base unit of the health alarm system can

create a beeping noise for the first procedure, which triggers a light flash. If the remote is not pushed, users are alerted by further beeping by the machine. If they fail to click the button after a defined period of time, staff at the control centre are informed that something might be incorrect. The second approach requires that motion detectors, be mounted on doors and in hallways across the elderly's house. Although health warning systems are sometimes conceived as products for the aged, that is not generally the case as citizens of all ages benefit from them. These technologies are beneficial to a range of users, including:

a. Someone recovering from a previous procedure;
b. Elderly people who stay alone or who like to spend a few hours at home by themselves;
c. Patients confined to bed due to a difficult pregnancy;
d. Or severe health problems like recurrent cardiac insufficiency;

In these situations and others, a health alarm device can give people the peace of mind because, when accidents happen, healthcare help could quickly be received 24 hours a day, 7 days per week. The advantage of health alarm devices is that they aid in preventing further injury or death after an emergency health incidence (Norman, 2020). However, it is reported that some health alarm systems experience significant delays when calling 911 centres. In this line, individuals should consider purchasing health alarm systems that relay medical emergencies within the shortest time possible to avoid delays (Byskal, 2019).

2.5 Summary

A rapid increase in the elderly population over the past decade raises the need to complement traditional care systems by providing a detailed evaluation of their daily mobility. Notably, ambient intelligence and data obtained from sensors applied in the IoT can be employed to monitor the daily mobility of elderly living independently. I am focusing on a system, dependent on AI that learns the daily room-to-room movements of elderly living independent lives. The system is based on the assisted living concept and generates push notifications for family caregivers (The primary target users) who care for their loved ones (The secondary target users) when deviations from ordinary activities are detected. The system is beneficial for family caregivers because it can give them the most updated information of their loved ones safety from anywhere they get peace of mind knowing their elderly parents are staying healthy.

The essential activities carried out by the elderly include bathing, personal hygiene, and functional mobility, eating, and dressing, whereas instrumental activities include cooking and house chores. The system depends on a series of image frames in describing, monitoring, and detecting activities carried out by the elderly. The monitoring healthcare workers get to see a virtual skeleton in the Linear Figure Model (LFM), which preserves privacy. However, caregivers can switch to the Real Body View Mode (RBVM) when the elderly are within the living space of the house. Non-wearable sensory technologies, i.e., video-based sensors, are implemented. Image processing, as a subfield in digital signal processing, is applied in detecting all activities through dynamic algorithms.

The Internet of Things (IoT) is an advanced paradigm that connects physical and virtual equipment to be used in monitoring the elderly. IoT has been employed in implementing traditional care systems. In this case, low-cost sensors, e.g., room occupancy and presence, are used to evaluate the daily mobility amongst the elderly pursuing independent lives or staying alone. The full capacity of IoT can be realised through 5G technologies that provide faster networks for devices sharing data. 5G technology promises faster speeds in loading and transmitting data, which should make the Human-Body Detection technology productive in caring for the elderly. Together, home automation and telemedicine technologies also promise remarkable achievements.

The data collected by the Human-Body Detection system should respect all legal requirements. The

system may feature real-time data transmission to local storage via wireless or wired communication to aid in providing personalized care options. Sensors are integrated with local databases via structured cabling. In the monitoring system, a considerable amount of data is obtained on the user's interactive environment, user mobility, and indoors localization or position. The personal data is accessed by authorized personnel to ensure the safety of elderly patients. To prevent breaches in security and provide all-round protection, dynamic cybersecurity measures are to be enforced.

Overall, given the shift in conventional family setups and care for the elderly, the present work cultures and structure of society requires the adoption of assisted living. Consequently, assisted living should be considered for the elderly as it aids to foster independent lives, and caregivers only get involved in demanding situations. Through video-based sensors, the technology alerts caregivers to monitor the elderly whenever abnormal daily activity is recorded. The Human-Body Detection system promises considerable aid to elderly living alone, having mobility disabilities, and those exposed to physical therapy.

Chapter 3. Research Methods and Analysis

Chapter Introduction

According to Kaplan, and Berkman (2019), almost 90% of older people living alone express a keen desire to maintain their independence. Many fear being too dependent on others and, despite possible loneliness, want to continue to live independently. To help them maintain their independence, I have attempted to better understand their daily routines, activities, needs, pains, and behaviours from different perspectives.

This chapter summarizes my research findings from a survey, interviews with older people, adult caregivers, an Artificial Intelligence (AI) expert, a Human-Computer Interaction (HCI) expert, and an expert in Adults/Older Adults. A summary of qualitative analysis from each interview and the survey results helped me better understand people's thoughts, beliefs, needs, pain points, and expectations. Understanding people's behaviours collected through contextual inquiry and other ethnographic approaches obtained from user research guided my final application design.

I also summarize my research outcomes from conducting specific User-Centered Design (UCD) approaches, which provides a chance to look at problems found while researching multiple perspectives. Concepts gained from working with UCD methods should make my design more usable, practical, and better meet my target users' expectations.

3.1 Semi-Structured Interviews / Survey

According to Adams (2015), conducted conversationally with one respondent at a time, the semi-structured interview employs a blend of closed- and open-ended questions, often accompanied by follow-up why or how questions. The benefits that I gained from conducting semi-structured interviews are that I:

a. Learn about the needs, thoughts, demands, behaviours, and activities of ageing people who live independently;
b. Learn about the field of caregiving;
c. Identify the benefits/drawbacks of specific technologies for caregiving;
d. Effetively collect valuable data by using a semi-structured interview method;
e. Explore possible app features that fulfill the needs for caregiving in order to improve and simplify the overall User Experience (UX);

I conducted semi-structured interviews with four elderly participants and two adult caregivers. These interviewees were all Chinese, and I chose to interview them because China is ageing much faster than other low- and middle-income countries. The population that is aged 60 years and over will increase from 12.4% in 2010 to 28% in 2040 (World Health Organization, 2015). I realized that ageing in place has increasingly become a serious social issue. As a result, we need to have effective solutions to help seniors live comfortably. Furthermore, according to John Strauss, a large percentage of the elderly in China, 45% in their sample, live alone or with only a spouse. Thus, the health and safety of the Chinese elderly become a top priority to be facilitated and improved. The chance to learn about my elderly participants deeper, their sons and daughters have logically become the focus of my attention.

I also interviewed three participants working as a product manager in AI and UX design.

Each participant engaged in an interview for approximately 60 minutes through online video calls and was audio recorded via Zoom or Wechat. The relevant portions of the audio from these interviews were then transcribed. My interviewees are divided into three categories, i.e., elderly participants, adult caregivers, and professional experts.

Elderly

These elderly participants live independently without daily support from their family members or caregivers. As a result, they may be more likely to experience a fall and could develop a disability or lose mobility. Illnesses and injuries could happen suddenly at home without timely and proper first aid (Bayshore, 2021). They were asked a wide range of questions about the demands, living conditions and behaviours from their daily activities.

Adult Caregivers (Family Members)

This group of survey respondents has ageing parents who live independently. However, due to a variety of reasons, this makes it more challenging to take care of their parents. Some of them live far from their elderly parents, or their parents like to live independently. Interviewing these family members provided me with knowledge and observation of what concerns them and their challenges looking after ageing parents.

Experts

Three experts participated in my interviews. They include an Artificial Intelligence (AI) expert, a Human-Computer Interaction (HCI) expert, and an Older Adults & Family Caregiving Expert. The AI expert provides technical perspectives on utilizing Human-Body Detection (HBD) technology on my caregiving application and the benefits/drawbacks that this technology could bring to users. The HCI expert provides me with her research process of designing an Internet of Things (IoT) application and its challenges. I also learned about the everyday frustrations of most ageing people, the supports/facilities that the elderly need, how society assists seniors from an Older Adults & Family Caregiving Expert.

The interview analysis included the following steps:

a. Send all the consent forms, invitation forms to each of my participants;
b. Participants have a basic understanding of my project, and receives questions;
c. Acceptance of invitations from my participants;
s. Interview audio/transcripts were reviewed iteratively;
e. Several key points and themes were extracted from each interview and survey;

f. Data translation

3.1.1 Interview Analysis

Through listening and re-listening to documented conversations, reading and re-reading transcripts of each dialogue, the subject of the conversation can be explored. Thematic overview purports to evaluate various topics or categories essential to the research (Bryman, 2012). As stated by Marshall & Rossman (2006), this permits me to classify content from the crude data and create connections between the study issue and the results. The study would have identified related or equivalent patterns in the data being gathered. Data regarding this issue was then grouped into related categories. Denscombe (2010) addressed the commonality of the study, and the results of the analysis would be guided by the prior information reviewed in the literature review. From the interviews, the following key points were established. They were split into five groups of participants including, Adult Caregivers, Elderly, Artificial Intelligence (AI) Expert, Human-Computer Interaction (HCI) Expert, and Older Adults & Family Caregiving Expert.

A. Interview Analysis: Adult Caregivers (Primary Users)

Living Concerns for Ageing Parents

Ageing parents gradually lose the ability to perform daily activities, and most family caregivers have this experience. As a result, adult children usually take the responsibility of helping their ageing parents with everyday life activities, meaning they are frequently in contact with them several times in a day or a week. For instance, one of the family caregiver interviewees, Participant A, states that:

"My elderly mother's need to have help or assistance with daily chores took a gradual course from the time she was unable to pay her bills because of the inability to handle the internet, which was essential in sorting out her related financial issues. She had also lost her mobility, making it a challenge to move around as she was used to, and so, she needed help to run the daily errands. Inabilities associated with ageing piled up with different needs, such as help with doing her grocery shopping, preparing meals, and reminding her to eat, as well as assistance in taking her tablets. She needed support doing her laundry, cleaning her apartment, as well as her personal hygiene."

Interestingly, caregivers feel satisfied when they succeed in meeting the needs of their parents. Participant A is pleased with her capacity to do so as she feels that:

"It was motivating to see my effort of assisting my mother working perfectly because it gave me positive energy and was never an energy loss."

Undeniably, adult children get motivated when they are able to support their parent's daily needs as Participant A claims that:

"I believed that my mother needed to have the best life while staying at home and that really motivated us as a family caregiver."

Another adult caregiver, Participant B, who was interviewed believed that:

"Making parents feel better while ageing was a driving factor that made me meet their needs. Having

known them in my life, I could easily see what they need and realized they were happy and feeling satisfied."

Freedom of Choice

Due to the developed economy and the increasing level of technology, people face more and more pressure in their daily lives in modern society. There are many people who not only have to work every day, but even work late into the night. In other words, modern middle-aged people are so busy working that they do not have time to take care of their families and their elderly parents. Some middle-aged people could lose their freedom if spending time taking care of their ageing parents. That is one reason why many elderly living independently become common and why many people choose to send their ageing parents to nursing homes.

Interviewed family caregivers agreed on making choices regarding the challenges and need to help their elderly parents. Their motivating factor was to perform such tasks voluntarily. For instance, Participant B, who was a caregiver interviewee, thinks that:

"If someone makes me take his/her orders, especially when helping meet essential needs, I would probably tell him/her that I want to make a choice myself. I believe it was my decision and motive to help my elderly parents, and so I should decide the tasks to assist."

Moreover, Participant A added that:

"The decision to help my parent was my own free will because I could have denied or neglected."

Most importantly, family caregivers are required to set boundaries, especially when deciding on the tasks to perform, and Participant A states that:

"It was perfectly fine to help my mother for most of her personal needs, but for example I could not help her in the shower, it was not right for me."

Family send their parents to nursing homes for various reasons. A reoccurring reason was that

they do not have enough time to take good care of their parents, families send their ageing parents to nursing homes so that they can have a better place to live in their old age.

B. Interview Analysis: Elderly (Secondary Users)

The four elderly participants ranged in age from 65 to 72, and all lived alone or lived without family caregivers in their apartments. It quickly became evident that it was essential to better understand why many elderly participants live at home alone in old age. As a result, three primary factors for living alone were identified:

a. Cognitive Resilience;
b. Self and Personal Resilience;
c. Social Networking and Companionship.

Cognitive Resilience

Based on Staudinger and his colleagues (1995), daily competence and cognitive pragmatics were found to be associated with cognitive resilience. Additionally, the themes of relation-focus and family-orientation were also essential cognitive resilience features, as indicated by the study. Accordingly, living alone among the elderly is against normative cultural expectations. However, most elderly interviewees who live alone accepted reality and believed that such experience is transformed into apparent benefits for their families. For instance, Participant E, one of the ageing interviewees, revealed that staying alone away from his married daughter brings freedom to their marriage and avoids unnecessary conflicts with his son-in-law. Participant E states that:

"I have no idea whether my son-in-law will be happy staying with me or not. He may like me today but tomorrow is uncertain. So it is hard to tell because their jobs are not stable and life in uncertain. To be honest, I can accept if they might not like to stay with me."

Most interviewees believed that staying alone was a decision driven by the interest of their extended family because freedom brings happiness, as Participant F says:

"Despite the social expectation to stay with children, I prefer to live alone because I have diverse perceptions and values compared to my children. Living separately may be the only way to keep conflicts away."

Surprisingly, according to Chinese cultural expectations, living with children when one gets old was very important, and so, interview participants had to adapt various strategies to adjust to the reality of living alone. They applied various strategies, such as minimizing essential expectations from the family members while associating more with ageing people who were miserable in their eyes. A 67-year-old interviewee, Participant D, said:

"Now I have minimized my expectations toward my children. However, we have several tea gatherings in a year and I feel happy. They have their life and they are all very busy developing themselves."

Another elderly interview participant, Participant C, revealed that:

"I am happy staying separately away from my children because there are many elderly people who are more unfortunate than me."

Based on the daily competence, interview participants indicated that sometimes they had to complete errands by themselves, including cleaning, household chores, and budgeting, shopping, among others. Comparing to elderly living with family caregivers, the interviewees indicated they practice and enhance their problem-solving skills in everyday life. Therefore, it implies that the art of self-perceived competence is embraced by those elderly participants living with others. Such a feeling was expressed by Participant F, who was proud and confident. He said:

"I run my everyday errands, such as preparing meals, going to market, and doing household challenges. I am happy because I take care of myself and sometimes, hang out with friends to play Mahjong (Mahjong is a game that originated in China, commonly played by four players.) for over ten years."

Interviewees had knowledge of what it means to live alone, and so, they adeveloped a reliable action plan for running daily errands while handling relevant life events. Undeniably, they anticipated a serious life crisis such as physical sickness and prioritized a list of emergency contacts, especially when they run into trouble. These elderly interviewees had an established contingency plan as it was asserted by one,

Guang Lu Zhang, who states that:
"I normally contact social workers from the elderly center for assistance in case I'm in serious health problems. Other tasks like taking medications and visiting the doctor, I do it myself, meaning I run my daily errands."

Self and Personal Resilience

According to Singelis (1994), Chinese culture takes interdependence as a familiar concept. However, interviewees felt that they have the wisdom to transform and have a new perspective of cultural interdependence, Participant D, states that:

"My family members will have less trouble if I take care of myself, because it is a good and necessary idea which makes me feel better."

As a result, these elderly individuals established self-management strategies that prioritized their extended family's interest by setting life goals for them. Therefore, setting their life goals, especially those aligned with their life, was legitimately compared to those closely related to their family, children, and relatives. Seen in this light, Participant C, a 65-year-old interviewee, mentioned that:

"I feel very satisfied because I rarely bother my children with my problems. They have jobs and family, meaning they are independent on their own. I am happy taking care of myself."

Living independently made these elderly interviewees learn and understand how to be sensitive about their emotional experiences. They preferred to stay discreet by avoiding disclosing negative feelings that can lead to a sense of trouble-making. Instead, they maintained a harmonious relationship with their family members. In instances of lonely feelings, sadness, or depression, the interviewees would control their emotions and relieve their negative moods. Participant F expresses that:

"I normally reschedule my daytime social engagements whenever I feel lonely and go out for a walk. For instance, I go out to navigate on the internet, visit the elderly center, and socialize with people, singing Cantonese opera, and listening to Cantonese opera, among others."

Another participant, Participant E, states that:

"I normally visit the nearby flower market whenever I feel lonely, or do some window shopping in a nearby mall. I can bring myself into laughing by watching films and TV series because they make me feel relaxed."

An open and accommodating personality was the most crucial trait portrayed by the interviewees. It took time to schedule their daily lives because they were fully aware of the limitations of living alone and a challenge to nurture new talents and hobbies. The form of social interaction and effective communication determined the lifestyle direction. For example, they will go for organized road trips with peer groups and local elderly centers. Such activities were essential in passing the time and enabling the elderly to share their burdens and experience meaningful social engagement while embracing a particular social identity within the community.

Social Networking and Companionship

In Chinese culture, there is a difference in social relationships between kin and non-kin. According to Bond (1996), Chinese social culture indicates that an individual needs to establish and maintain a social network with non-kin through their socialization process despite the family being the core network source. In the context of elderly staying alone, life circumstances prompted them to have dual efforts and to have a peaceful relationship with people outside of their family and keep harmonious interactions with the family members as well (Bond, 1996). The experience was essential in creating a good relationship with everyone, including the extended family members, social workers at the elderly center, and exercise peers, among other groups. During social contact, the interviewees reinforced positive experiences as they kept frequent contact with other people. Thus, Participant F, points out that:

"I have three peers whom we meet almost every day, doing regular morning exercise while chatting and sharing during the day. There is a tea gathering group that I can join after the morning exercise and this often brings a lot of joy."

While interacting with people from different networks, interviewees were aware of the boundaries,

especially on what to talk about, when, and how it was a life-long wisdom accumulation that is important in the late-life developmental stage. Notably, the concept of communication was essential in maintaining the social circle while avoiding bringing shame to family members. As participant C expresses:

"You share some of your personal information, but there are some parts that cannot be shared. For instance, it is hard to share family matters with outsiders because it is rare people understand you, and rumors will spread."

Therefore, the general observation of Chinese life indicates that this communication pattern is not unique. Since living alone could not translate into a fully family-oriented life, interview participants' actively maintained social engagement with people from different backgrounds such as social workers at the elderly center, exercise peers, neighbours, and peers playing majiang together. With accumulated wisdom, they could not disclose their family issues by keeping a certain distance. The elderly Chinese individuals kept their families' reputation because it was necessary even though they lived alone.

While living alone, older adults had to adjust their lifestyle in disadvantaged circumstances by using culturally divined resilience in the pursuit of achieving psychological well-being. The idea of resilience involved joining other social networks for mutual support and help while accepting that living alone is for other family members' benefit and well-being and enhancing their self-management behaviour. Culturally, living alone is potentially disadvantageous and unfavourable, and as a result, social workers in community centres should always consider and reframe cultural-pre-interpretation with living alone. The family's well-being can be enhanced, mostly when elderly adults stay in the same geographical location or city with their children. Emotional awareness, setting life goals, priority, and management are essential motivating factors that enhance active self-management. Previous studies on Chinese elderly show that they suffered from mental distress because of the negative feelings caused by management and self-suppression (Kung, 2003). Furthermore, help-seeking motivation can be driven by caring for and assisting family members (Abe-Kim, Takeuchi, & Hwang, 2002). It is also recommended that elderly who live alone should be encouraged to consider their preferences when establishing development networks (Andersson, 1998; Lin & Wang, 2011). More importantly, multiple networks are necessary to avoid adverse social relationship effects (Stafford et al., 2011). Therefore, benefits from relationship networks can be realised through engagement in multiple circles of relationships. In brief, coping is achieved

whenever individuals cannot meet traditional and cultural expectations by understanding resilience through a relation-focused approach.

C. Interview Analysis: Older Adults & Family Caregiving Expert

The elderly work hard to keep their independence and to live meaningful lives. Now, these expectations can be achieved with the support of Artificial Intelligence (AI) assistive technologies. Meantime, family caregivers who provide love and support attain peace of mind knowing that they are not only happy but safe and secure.

The inducement to be concerned came out as critical discoveries for this research. Dr. Liu, the Older Adults & Family Caregiving Expert and professor who studies governing technologies, described how caretakers' inspiration to look after a family member influenced their understanding of caring. She is also a former Professor in the School of Public Health and Health Systems of the University of Waterloo. I interviewed Dr. Liu because her research examines ways technologies can help older adults and their family caregivers.

Love and Responsibility of a Member of the Family

The parent-child connection, coupled with husband-wife, came into view as a caretakers' determinant of experience. These connections seem to be an inspiration for care. When asked to describe their drive for caring, people who took care of a child stated that there was not an alternative. There was no inquiry as to if they were willing to do it, it was an essential part of their parenting responsibility and thus, offering care was unavoidable. As Dr. Liu expressed:

"Giving birth to my kids, they are mine. No inquiry ever came up if I was taking care of them or not. To admit that these kids require greater attention relative to the rest of the kids does not add up to anything. They are my kids; I will care for their well being because it is part of their requirement. Or, a guardian can become ill for decades, the time their kids were little, and the guardian did not for one time have to tell their kids to give them a helping hand. That's where the burden comes to the photo. You have a spiritual duty not to lose trust in the people of your family, to help them out in times of trouble and to love them in everything that you have to give."

Parents were also convinced of the need to care of their child. In this event, parents had confidence in raising their children instead of enrolling them in a daycare facility, gave the child a chance to bloom, not

only physically but personally, by establishing connections with the rest of the members of the family and friends.

The outcomes indicated a unique statistical relationship between the drive to be concerned and the carer's experience. This result is compatible with many authors' perspectives that practical care occurrences are subject to affirmative inducements (Lyonette & Yardley, 2003; Romero-Morena et al., 2010; Smebye & Kirkevold, 2013).

Compensation

Impressively in these incidences, caring is seen as an appreciation for whatever the one being taken care of has done for the caretaker long-ago. Dr. Liu reveals that:

"Joy, for without it a family would not have been viable in the first place. And accountability, because without that, the family wouldn't remain that way. At various stages of life, our affection for our families will be checked, which I can promise from my own personal experience. For example, giving birth to my kids, they are mine. I will take care of their well being because nevertheless it is part of their requirement. Or, a guardian can become ill for decades, the time their kids were little, and the guardian did not for one time have to tell their kids to give them a helping hand. That's where the burden comes to the photo."

Elements like the quality and nature of the caregiver's connection and their recipient played as drivers in administering care. According to parents, taking care of a youngster was incorporated into their duties, while in the view of couples, it was part of their marriage agreement. Research shows that the kind of motivator was taken as pleasant by the partakers and was likewise to Camden et al. (2011) who discovered that motivators like these were pleasant because that mean the caretaker has a good understanding about caring. Nevertheless, Lyonette and Yardley (2003) confirmed that offering close attentiveness due to responsibility, commitment, or charge was paralleled with advanced levels of the carer's distress and negative knowledge of paying close attention. Romero-Moreno et al. (2010) correspondingly discovered that Alzheimer's caregivers who talked about willingness and obligations were at a particular danger for negative caregiving results. As Kietzman et al. (2013) declared, caregivers inspired by relatives' connections coupled with specific needs of the recipient of their services are more

inclined to hold their responsibility in high regard.

Unwilling Caregivers

Dr. Liu noted that care, specifically taking care of elderly relatives, is often practiced out of having no choice. The expense of convalescent homes has indicated that often people turn out to be unwilling caregivers.

"Seeing additional individuals becoming caregivers, with no option; there are no more families residing adjacent, maybe they are the remaining family and the elderly individual is not willing to enroll in a convalescent home, or it is not affordable."

Smebye & Kirkevold (2013), Lyonette & Yardley (2003), and Camden et al. (2011), maintain the civilization norms and what society expects of you was significant to unwilling caregivers, and as such, offering care out of duty, guilt, and commitment was expected.

Participation in Social Life

Dr. Liu noted that in different living circumstances, the duty of close attentiveness had also affected socializing routines, mostly for those taking care of the elderly. Most commented on how they lacked a social life. Dr. Liu notes that even when they were relieved of their caring job or got to socialize, their duties were very demanding and they were still concerned for who they cared for. Dr. Liu explains one of her partakers and states that:

"The socialization ability of my participant vanished totally, she is unable to abandon her elderly mother in the hands of anyone. As they could not find a caregiver to take care of her, they had to let her mother move to care home or some places in which their mother can receive care."

Caregiving, for family members, consumes much of their time, and a total of their decision-making are stretched on the person they take care of. Compassion and commitment peak in family caregivers' sentiment that their lives have been overtaken. This is in accordance with the observations of Stoltz et al. (2003), who reveal how as compassion gets intense, this may lead to emotions of annoyance and

self giving inhome caretakers, plenty of them go through a lack of independence, and they have feelings of losing their own lives.

D. Interview Analysis: Artificial Intelligence (AI) Expert

Human Processes in Decision-Making

The Artificial Intelligence (AI) expert, Yichao Jin, who was interviewed is a digital interface product and tech leader across multiple startup companies within app/web-development, Human-Body Recognition, computer vision, smart construction, chatbot, data collection, as well as sports technology. I interviewed Yichao because many of his projects involve Artifical Intelligence.

Yichao indicated that humans have an advantage over machines through morals, instinct, ethics, and intuition in terms of decision-making, noting:

"Human beings have a competitive advantage in decision-making compared to machines. The choices made by a machine cannot be accepted by a human even if the decision is optimal."

Yichao claims that:

"The computer may not be influenced by its actions, however the choices it creates will have an effect on humans. I believe that humans are likely to accept decisions made by members of society, meaning they are not ready to follow the decisions made by a machine. Machine learning is a machine undertaking that lacks supervision and debate owing to the assumption that the machine doesn't have a person involved and people are not equipped to comprehend it entirely, rendering it less credible than human-led decision-making. In fact, this is the reason why humans question how the machine makes a decision. Undeniably, the algorithm of decision-making is questionable. Since humans are still accountable for the choices they make, they still have an essential role to play in decision-making."

Yichao differentiates between the creator of the mission and the person who carries it out. He mentions that:

"The decision owner describes the rules of engagement and directs a decision maker, which can be a machine or humans in a concept called rule-based decision-making because execution is done according to the rules. For instance, the human is always in charge since rules are defined by knowledge elicited by

an information analyst."

Providing the last word in decision-making should be a responsibility given to humans due to many reasons. Reproducing the reasoning of their designers makes machines follow a particular rational process in making decisions. As a result, humans are better decision makers because they can apply intuition in addition to following rational processes while referring to their automatism and emotions derived from decisionmaking experience (Kahneman, 2003, p. 698). Also, people can make choices using thought patterns that machines cannot reach (Dejoux & Léon, 2018, p. 206).

Human beings will remain dominant in decision-making because it is challenging to transform the traits associated with intuition into code to be applied by machines, especially in the rule-based decision-making process. Importantly, intuition is the primary reason why humans will remain owners of decisions. Humans have unique capabilities to determine in which ways AI should follow their orders, such as critical thinking and common sense, making them establish decisions that are possible to implement. They also apply AI decisions to reality because their knowledge of morals and ethics may prevent decisions that are not acceptable in society even though they might have optimal solutions. It also implies that AI does not have a legitimate advantage over humans in decision-making, according to the AI interviewee. It is worth pointing out that individuals will often decline decisions made by machines and accept those from their peers.

Autonomous Artificial Intelligence (AI) in Decision-Making

The Artificial Intelligence (AI) expert, Yichao, claims that:

"We cannot accept the process of decision-making to be fully given to machines, but maybe to a certain extent because there is no global view on machines. Machines do not integrate a synthesis function since they are designed and directed to handle a precise problem. Looking at the overall picture makes human beings better because they consider an evaluation of several factors in the process of decisionmaking. Some of the factors, such as feelings and ethics cannot be evaluated by a machine before making a decision. The capacity and ability to analyze and evaluate a huge amount of data through Machine Learning Artificial Intelligence (AI) has a consistent advantage. Undeniably, a precise model can be achieved when human beings mandate a machine to evaluate and analyze huge number of cases since we can be limited to our experiences and memories, shifting the precision of decision-

making."

Yichao also notes that:

"Decision-making and company laws require a completely integrated decision-making service focused on the rules laid down. In particular, the concept would entail the combination of a number of sub-models of algorithms to build a powerful AI, where each model has a specialisation in decision-making for a specific mission. All the outputs will be synthesized because each model will give their decisions to a single algorithm model which will take the final decision."

There are various skills and abilities where AI outperforms humans in decision-making. Unfortunately, the worry is whether AI can make decisions autonomously. At a limited scale, I noted that AI takes decisions autonomously through my results analysis. However, such decisions are thankless and repetitive for humans, making it necessary to be fully automated because machines are better than humans in terms of capabilities, for instance, dealing with a considerable amount of data that require an objective conclusion. Accordingly, enterprises utilize AI to address routine operational decision-making that are well structured (Parry, 2016, p. 573).

In most of high-frequency caregiving management, there exists automated decisions. The interviewee agrees that AI's decisions and reasoning remain within humans' boundaries even though the decision-making process is automated. The limits established by humans are the laws of algorithms that are generally regarded as rule-guided decision-making. The idea means that machines are programmed and mandated to make specific decisions, implying that developers can provide the same solutions to a given task since they know the decisions that will be made by the machine. As a result, the machine's decision is the designer's choice (Pomerol, 1997, p. 19). In the modern era, weak AI is restricted to making autonomous decisions. Yichao emphasizes that:

"The ability to have a global outlook allows humans to play critical roles in the process of decision-making while controlling the actions of AI in the final decision. If the machine fails, the designer will unplug it. There is less trust in the power of machines because current AI is prone to mistakes without human control."

Partnership between Humans and Artificial Intelligence (AI) in Decision-Making Process

Artificial Intelligence (AI) expert, Yichao, expresses his thoughts that:

"With time we will be forced to change our opinion about Artificial Intelligence (AI) because machines will gain legitimacy and become independent in decision-making. The importance of partnership is to enable us humans to know who is in charge of the decision-making process."

Furthermore, Yichao's view of humans/machines collaboration is that:

"I believe that after the rules are extensively evaluated and validated, human beings can now be responsible of directing machines. In either way, humans will have to know and understand the decision made by a machine. To follow the right methodology, humans will have to ensure provision of right data statistics to have a correct pattern."

According to Yichao,

"Understanding all the data patterns result from the explanation to the last detail because there will be no black boxes. Through the process of collaboration, the important task will be asking the machine correct questions."

Yichao outlines that:

"Due to expected changes in various circumstances, AI needs to adjust by having continuous tweaks. These circumstances include the market as well as rules and regulations, and in future, humans will be replaced by AI in repetitive and non-rewarding tasks."

Combined efforts can be stronger when compared to working separately, and so, the partnership between Artificial Intelligence (AI) and humans is beneficial, stemming from both human and machine intelligence. Organizations have been facing challenges on how to combine the intelligence of AI and humans. Within a hybrid decision-making system, humans should take the intuition role, and machines could assume rationality. Based on Jarrahi's (2018) research, there is a need to utilize machines' superior capabilities

through a human/machine symbiosis. It can work correctly when a machine is asked a question, in which it provides suggestions, and humans select the response. There are various challenges, but the entire process begins with the owner who selects and mandates the machine to execute the decision. Using its advanced computer power, the machine analyses the situation. The decision owner, a human, examines the suggested solutions from the machine who can decide to implement the solution directly, ask for a new solution by declining the first one, or adapt it before implementation (Pomerol, 1997, p.22). Since, in either case, humans have the last word, it is easier to gauge the suggestions of AI, implying that it is a tool for humans who have augmented decisions.

E. Interview Analysis: Human-Computer Interaction (HCI)-Expert

Lee Bing has more than four years of experience working in UX Design in healthcare technology, and the travel industries. She graduated with a major in Human-Computer Interaction-Design in graduate school at the University of Washington-Seattle. I interviewed her because the majority of her User Experience (UX) projects are service-driven, focusing on improving social services for people.

According to Silvia Pericu (2019), increased life expectancy increases pressure for a society where more older adults will lead an assisted and independent life. The provision of user-friendly products and services with lower social costs has prompted researchers to establish innovative strategies and solutions aided by caregiving science and research in design. However, it a dynamic process to design products for service design. Since it is not a single process, it involves a flow that begins from market opportunity identification, the definition of the issue, and the establishment of possible strategies to address such problems. Lee describes what makes a great product. She states that:

"We have to avoid the assumption that everyone has a similar definition and understanding of the term 'product' because it is pretty vague. The experience human beings gain on a daily basis in not thought in terms of products. For instance, clients booking a holiday flight are thought to be interacting with our digital touch point and do not think about our products. The mental models of individuals are essential in creating the experience that can be used to design features of a product. Since companies need to appeal to several slices of the business, you cannot only rely on products but also on the key needs. A single slice will provide revenue for the organization but is unlikely to satisfy the core needs or overall experience. Therefore, actors in the ecosystem are important when taking a holistic view of their experience to avoid situations that do not satisfy their core needs. These can be achieved by establishing efficient and intuitive tools that can successfully help to serve the user."

Product designers can incorporate the ideas and methods used in HCI to better understand the design process and design thinking. The design process can incorporate individuals' points of view to address their needs. It is significant to understand that design thinking utilizes the available resources from the toolkit of designers to seek innovative insights to address the current needs while creating solutions to everyday problems. Through the concept of service design, innovation can be used to identify and provide solutions strategically. For instance, Lee Bing claims that:

"Service design aims to connect interactions between people or systems using touchpoints. As a result, the concept creates a two-way understanding of the systems and people involved in business process and their interactions."

Descriptively, it is essential to begin from a human-centred approach by focusing on people's interests and needs. For the elderly population's current case, they differ significantly because of a different lifestyle, experience, and upbringing. Perceiving and generalizing ageing is a continuous challenge because it relates to the past of an individual. Additionally, it is challenging to perceive ageing because people respond differently to minor and chronic conditions in the quest to lead a quality life.

3.2 User-Centered Design (UCD) Approaches

As Sergey Gladkiy (2018) notes, User-Centered Design (UCD) is an approach to design responses focused on users. It starts with human beings and ends with the answers tailored to their individual needs. When we better understand people, we are trying to reach and then design from their perspective. Then we come up with better answers.

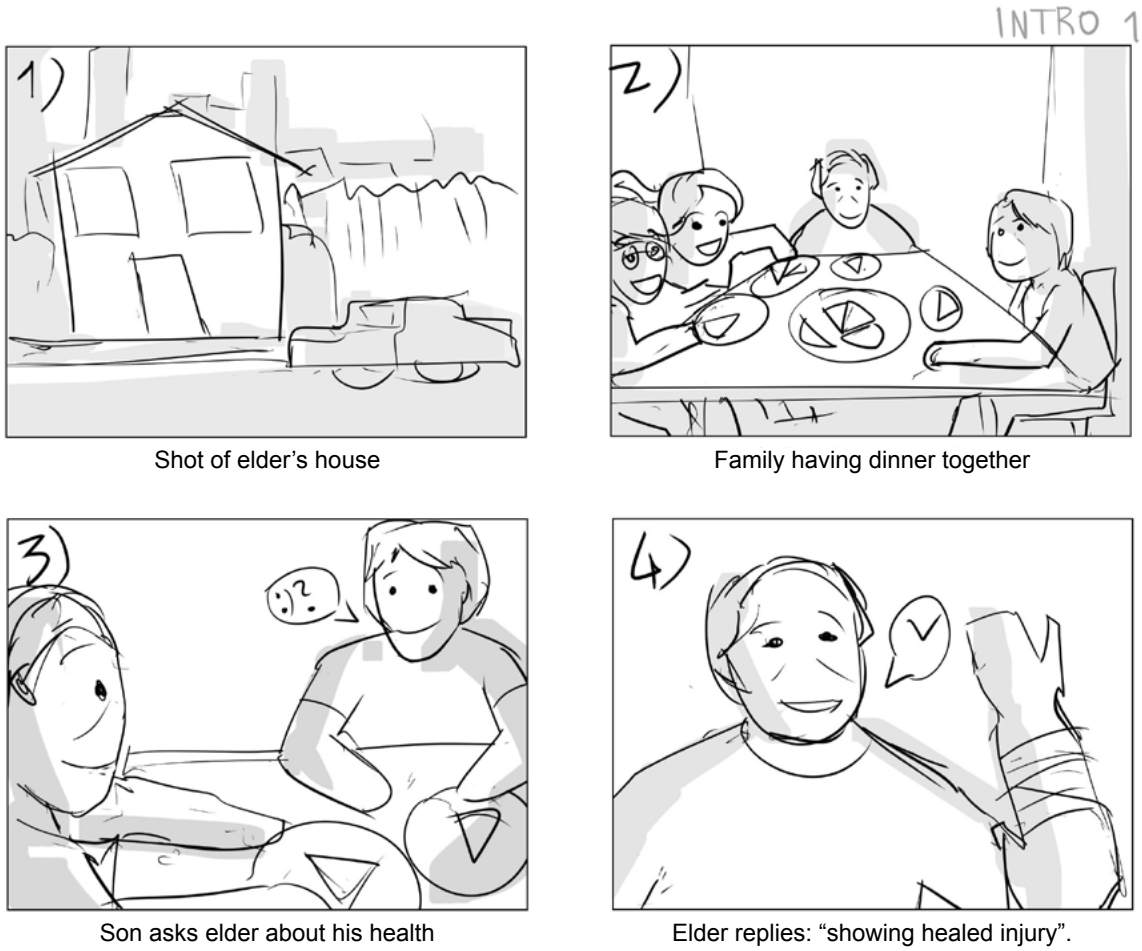
UCD is both how we are thinking and what we are doing. It is about building empathy with the individuals we are designing for. As an essential step of creating a human system, I incorporated numerous UCD approaches into this project, including the use of:

a. Storyboard;
b. User Personas;
c. User Journey Map;
d. User Empathy Map and Analysis;
e. Competitor App Analysis.

These approaches help me to better understand the users, tasks, and environments, consider the overall User Experience (UX) and involve the users within the design process. The definition of each UCD approach follows.

3.2.1 Storyboard

I completed a User Experience (UX) storyboard to envision and prospect a User Interface (UI) of the caregiving product for elderly living independently. A storyboard is a linear sequence of illustrations, arrayed together to visualize a story. UX designers use it to understand the flow of experiences between target users and the system over time, allowing designers a better picture of what is significant to users. Through the storyboard, you are able to identify and recognize the background story of my primary and secondary users need to use the caregiving app, and how their family members take measures to deal with the problems of their loved ones.



Shot of elder's house

Family having dinner together

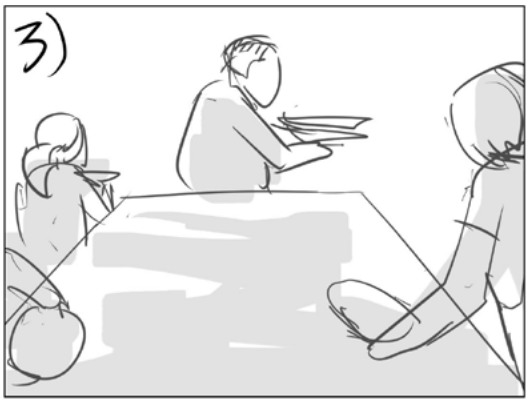
Son asks elder about his health

Elder replies: "showing healed injury".

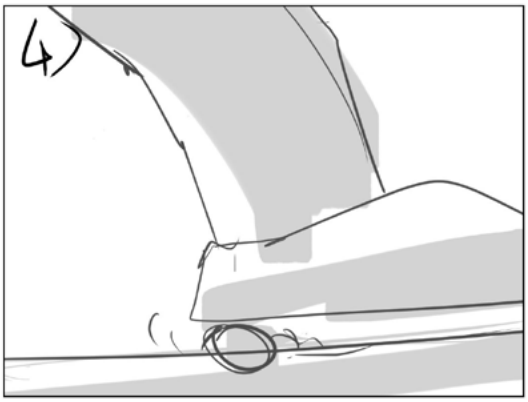
Figure 22: Illustration of Storyboard

Kids ask elder to come live with them in the city

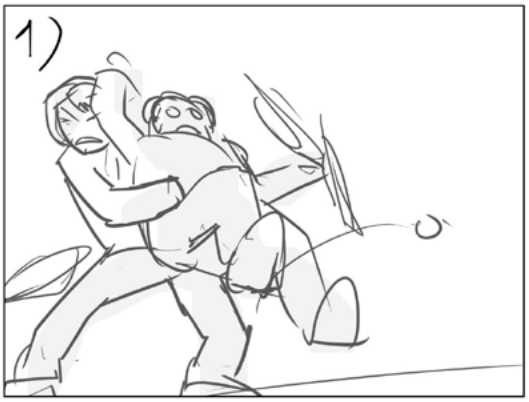
Elder kindly declines, prefers to live independently



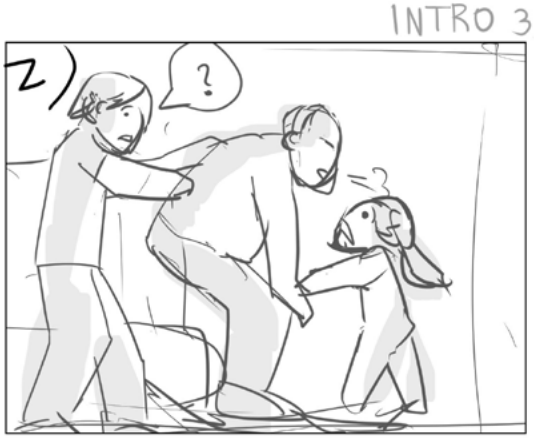
Family gets up to put away the dishes



Shot of elder stepping on a rolling object

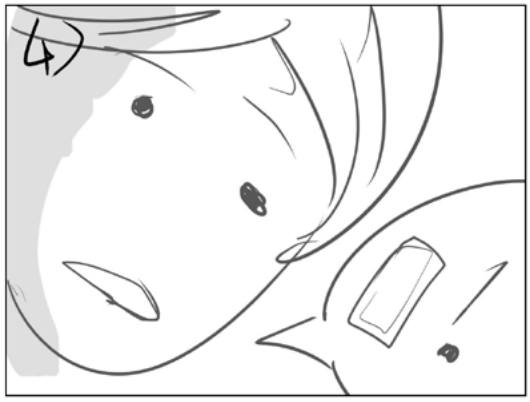


Elder slips and falls, son catches him



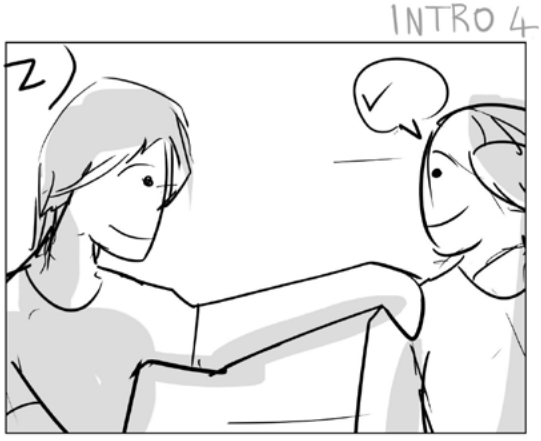
They sit down and make sure he is okay

Worried son asks again if elder wants to stay alone in the house

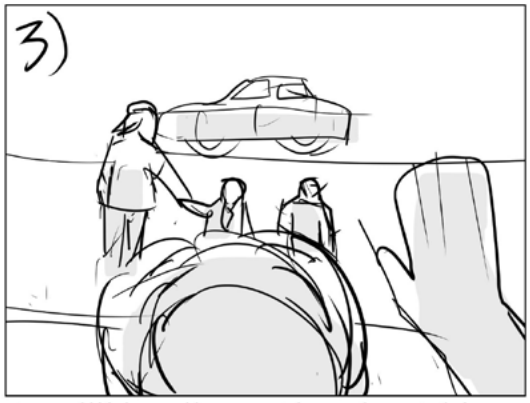


Son gets an idea, remembers this app he heared about

Son checks out app on his phone



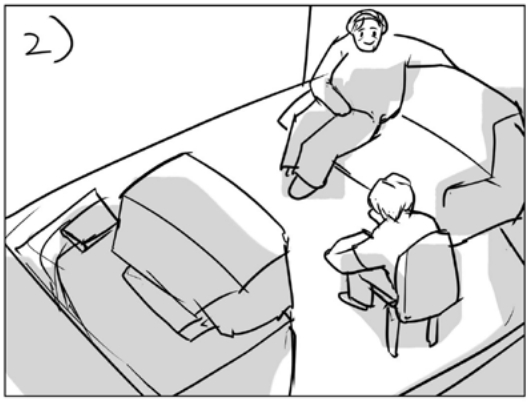
Son tells elder he will be back soon with a solution



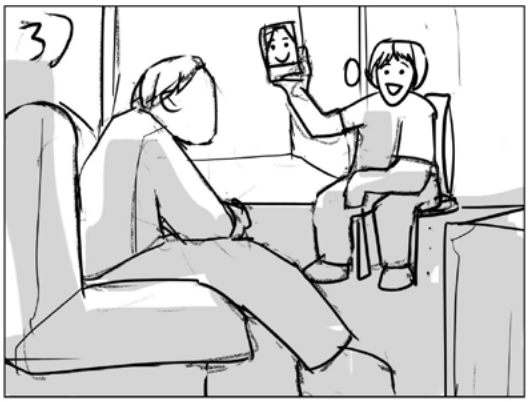
Son and kids leave, elder waves at them as they go to their car

Closing shot of elder being pensive about the solution

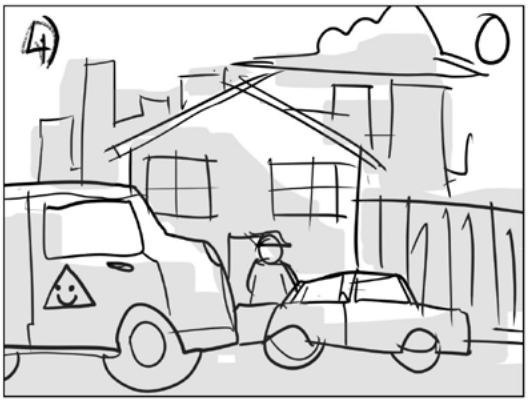
Shot of the elder's house, son parked in front, background of big city



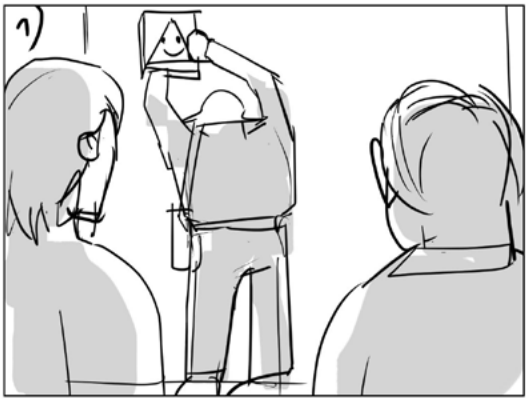
Elder and son having a conversation in the living room



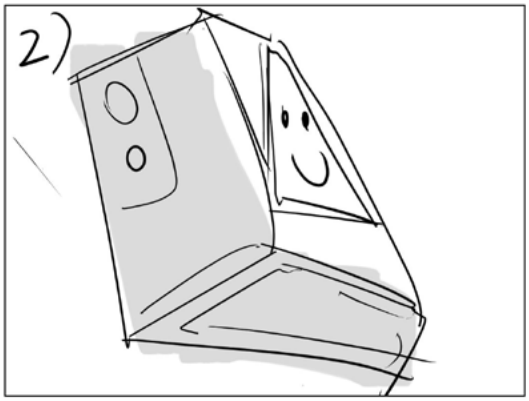
Son shows application from his phone



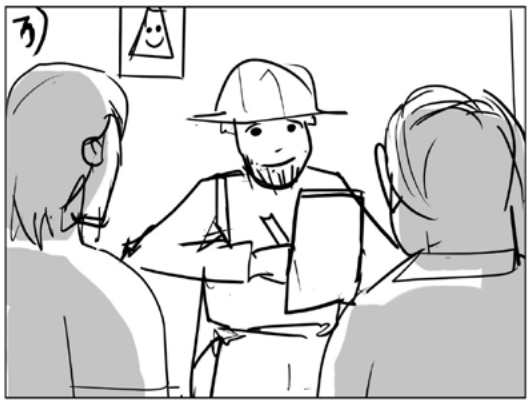
Car parks in front of the house, has the app logo



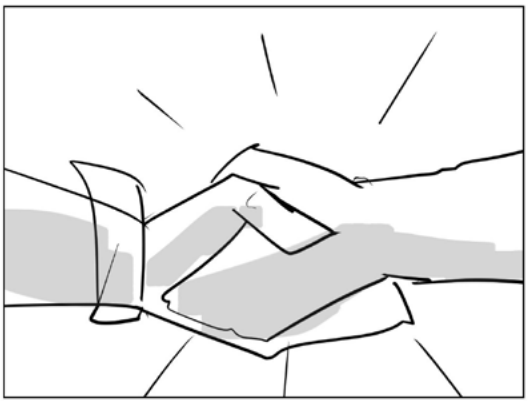
Technician comes in and places the device. Normally, only one device will be installed per room.



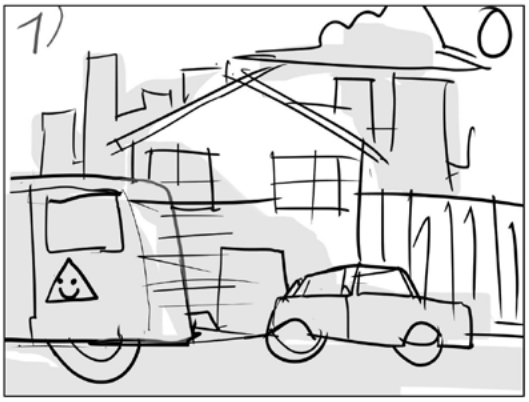
Close up shot of the device



Technician fills out some paperwork with his clients



Agreement is made, handshake closeup shot

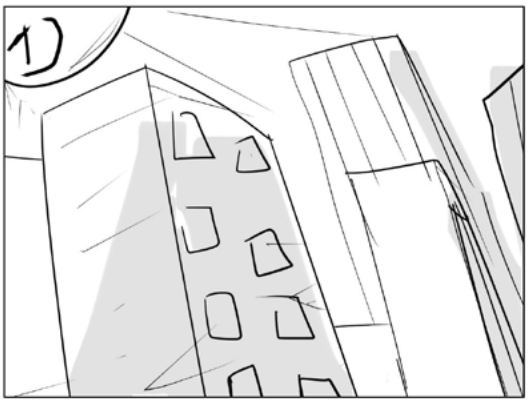


Technician leaves the house

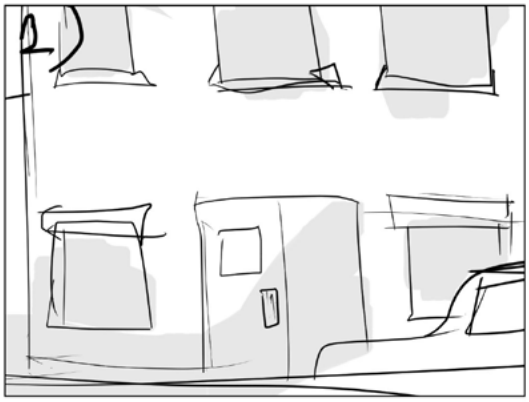
Son and elder hug each other

Son leaves, won't return for a while probably

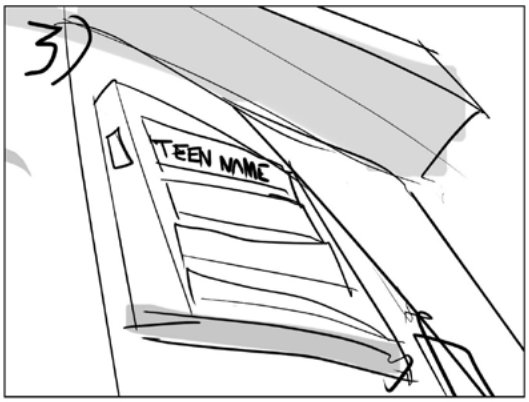
Closing shot of the house, no car parked, city background



Shot of big city with the sun up



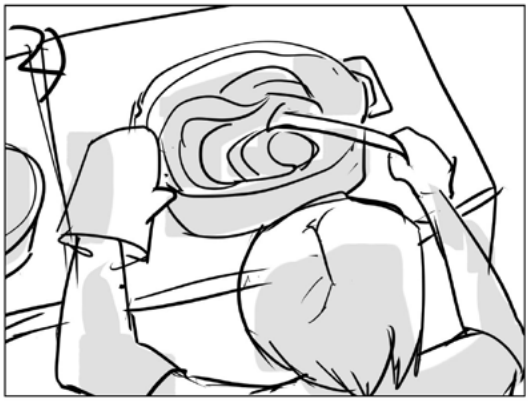
Shot of entrance of big building with door phone, son's car out of frame



Shot up close of the door phone with focus on son's name

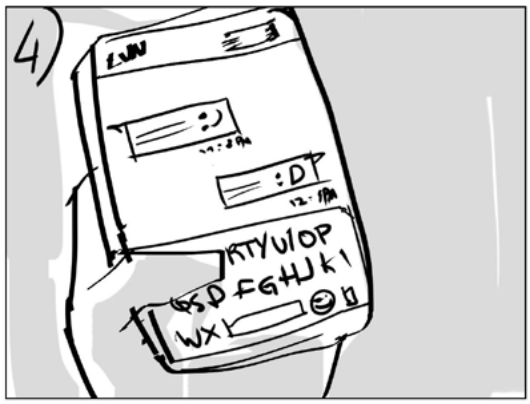
Closing shot of the house, no car parked, city background

Kids running around the room, son does not pay attention to the clock on the wall



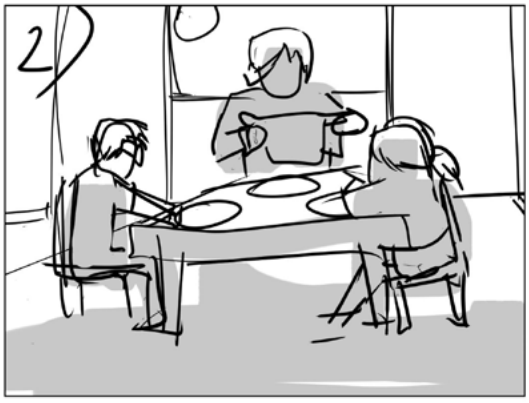
Son is cooking pasta for his kids.

Uses left hand to look at his phone, right hand is still stiring

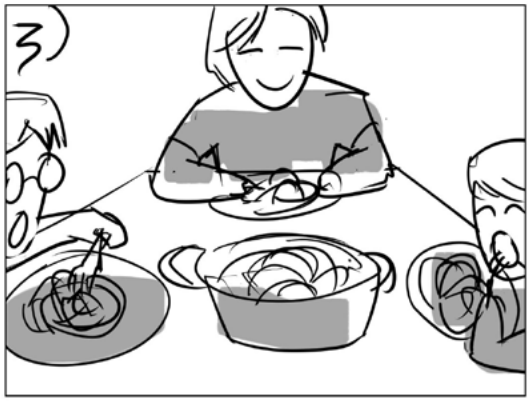


Close up shot on the text convo with elder

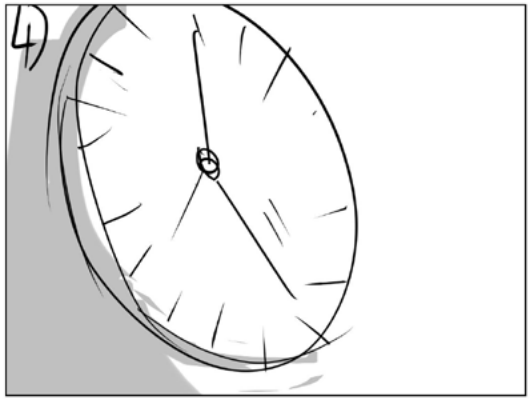
Son smiling at his phone, kids playing in the background



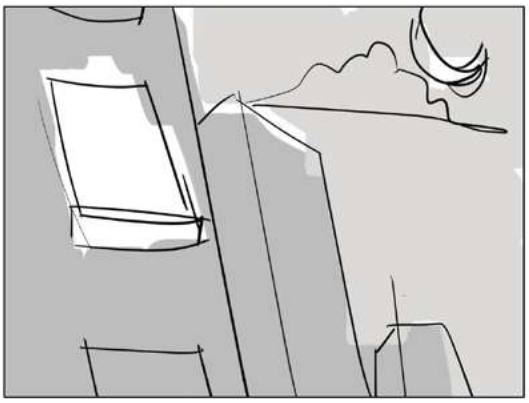
Son puts meal on table, kids sat with plates out



Family eating peacefully in the living room



Close up shot of time passing

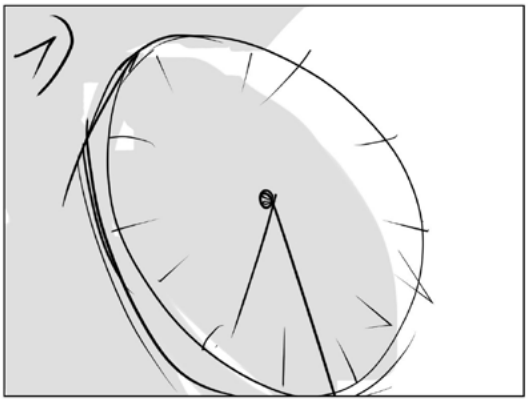


Window of appartment at night

Kids doing homework, son comes to say it is time to go to bed

Kids brushing their teeth, son texting the phone

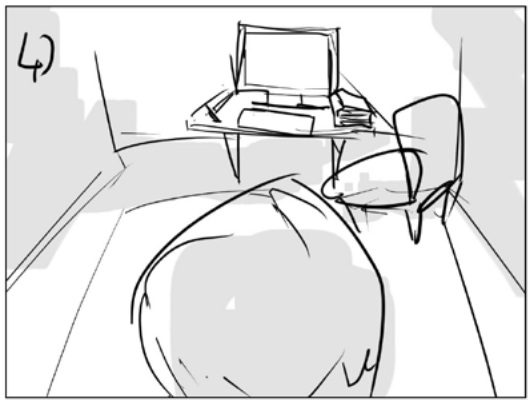
Close up shot of texting with elder



Shot showing it is 9 pm

Son leaves kids room, they are sleeping in a twin bed

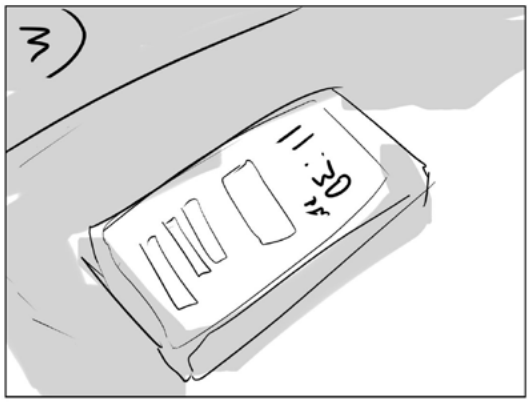
He takes a moment after closing the door



stares at desk full of work

Son working late at night

Notification pops up while he is working



Close up shot of phone screen with notifications

Picks up his phone again

Son looks at phone, smiles

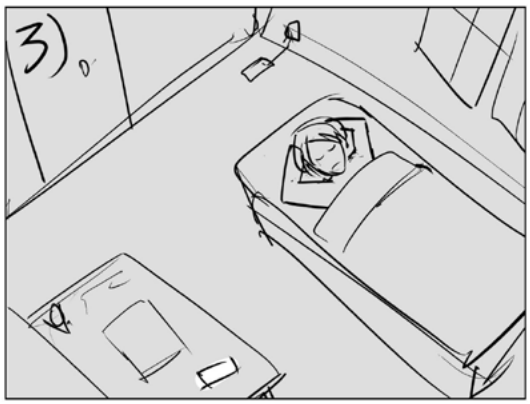
Elder is asking how he is doing, they chat a bit

The son continues to text. The clock is ticking...

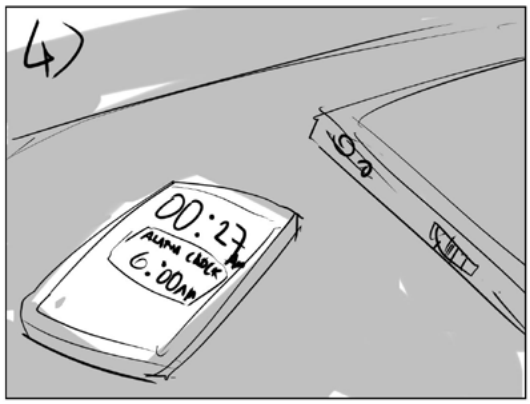
Son lays back for a section, notices the time

Leaves work from desk

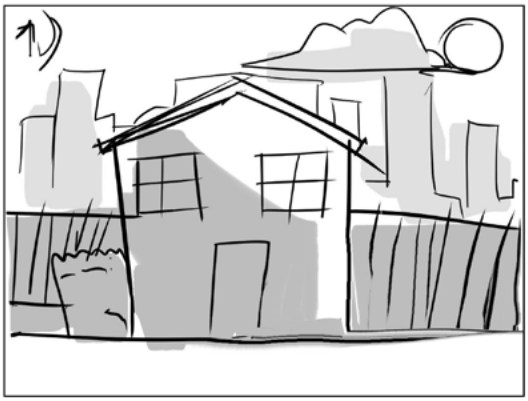
Shot of son in the bathroom brushing his teeth



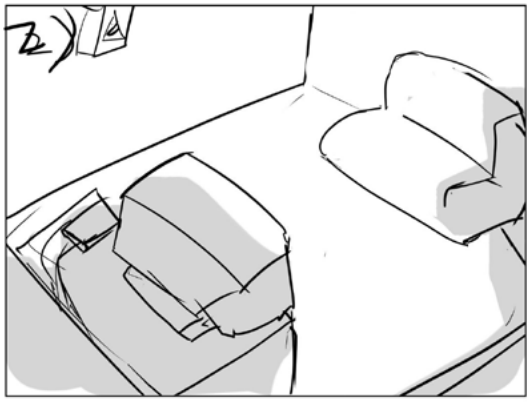
Son is resting in his bed, dark room, only light being his phone



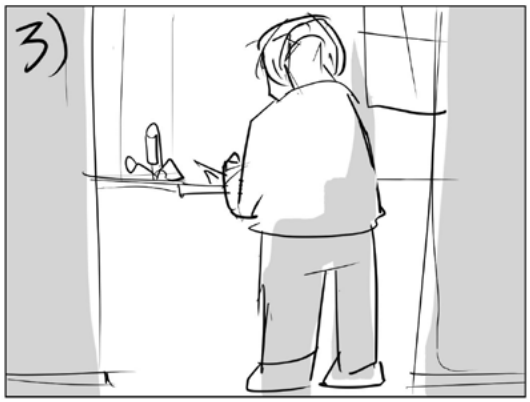
Shot of desk, phone has alarm set to 6 am



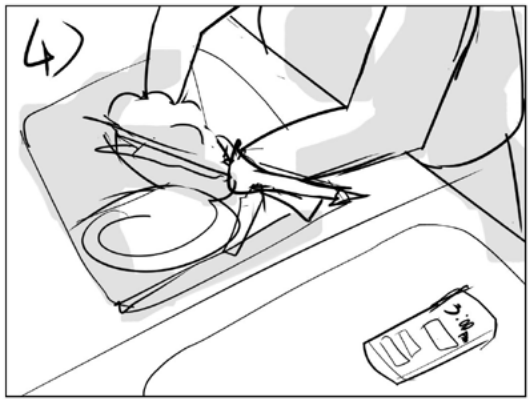
Shot of elder's house



Shot of empty living room, noise coming from the right



Shot of elder doing his dishes

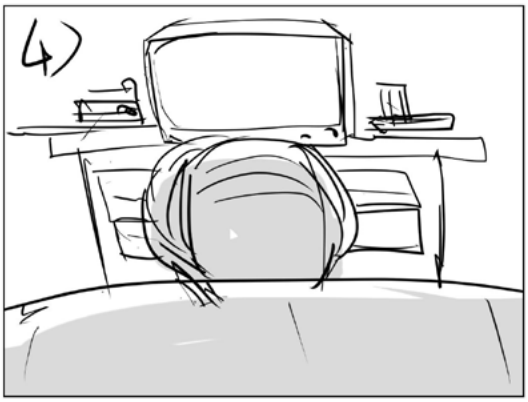


Close up of him doing his dishes, phone next to him

Elder exits kitchen with phone left on table

Enter the living room, walking towards the couch

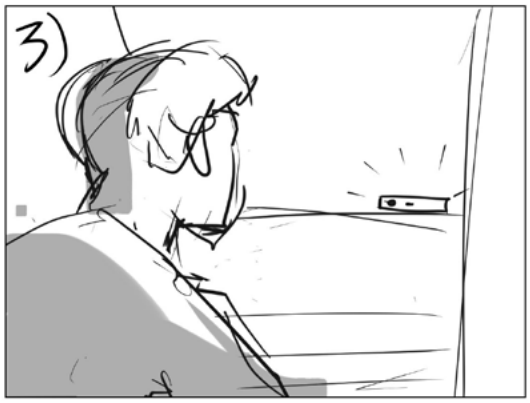
Sits on the couch and starts the TV



Starts watching TV

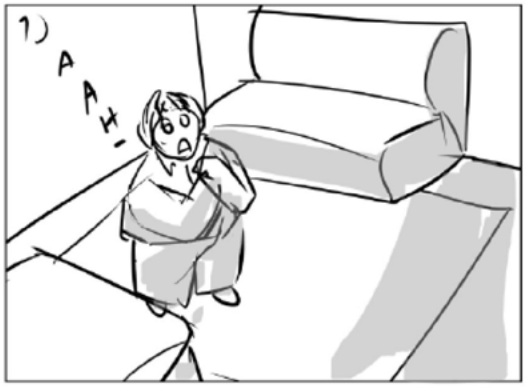
Elder notices a pain in his chest

The pain intensifies, he is confused



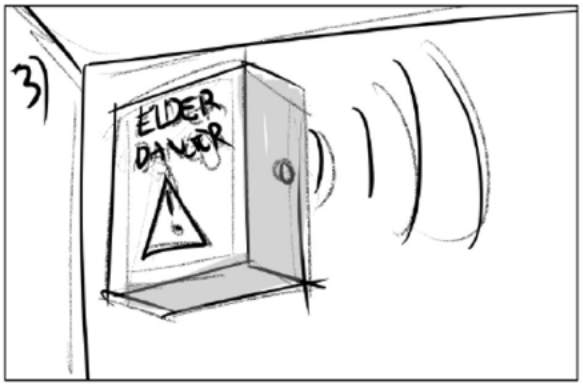
He looks at his phone on the kitchen counter

Shot of the phone, elder in the background



Elder gets up to his phone but the pain is intense now

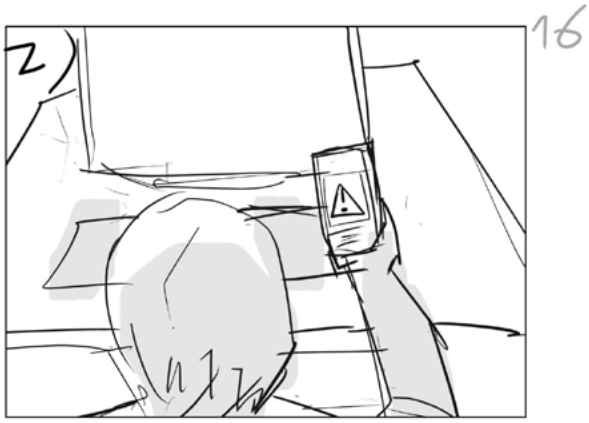
Elder falls to the ground, system goes off in the background



Shot of the system screen, bips signifying that it is operating

Son works at his desk receives a notification

Son looks at his phone

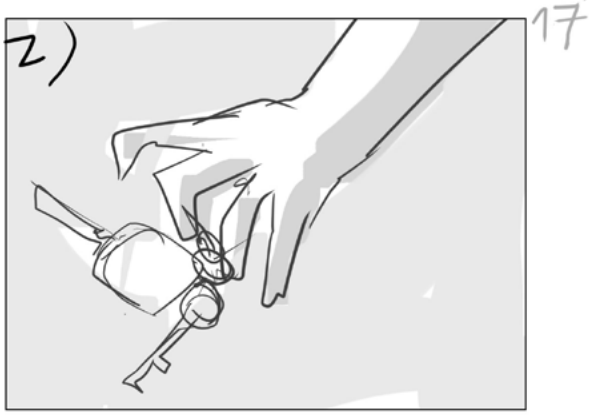


Son picks up his phone and sees the notification

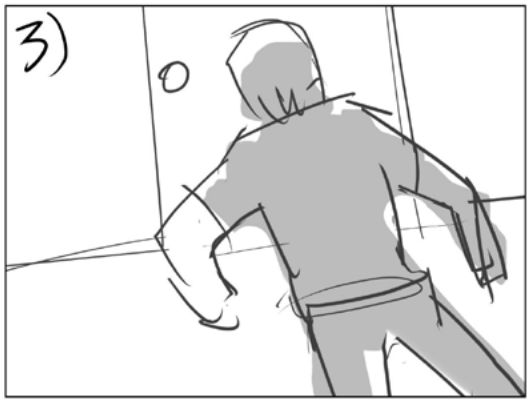
Face shot of shock

He frantically calls 911

Son tells the emergency to 911



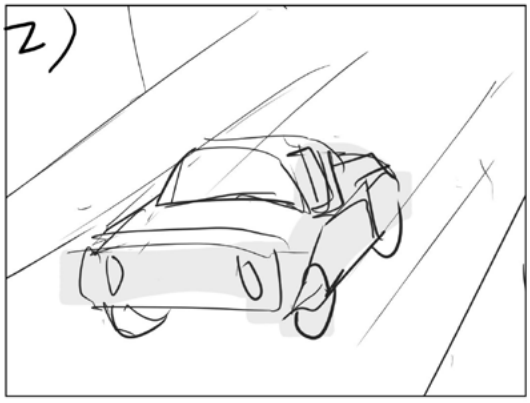
He picks up his keys



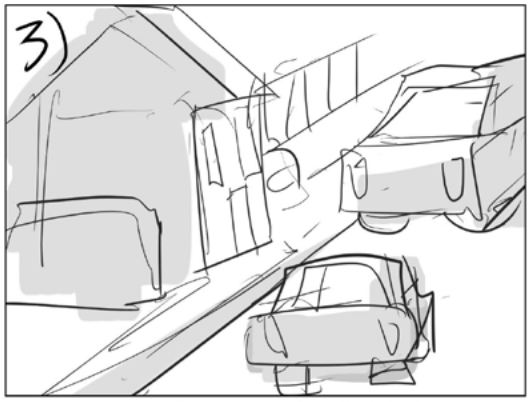
Runs out of his appartment

Shot of him running outside of the building

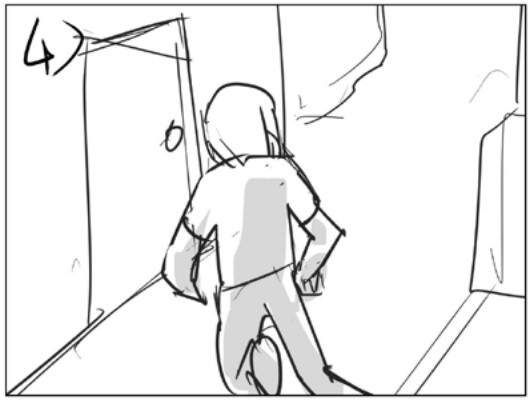
Son gets in his car



He drives away



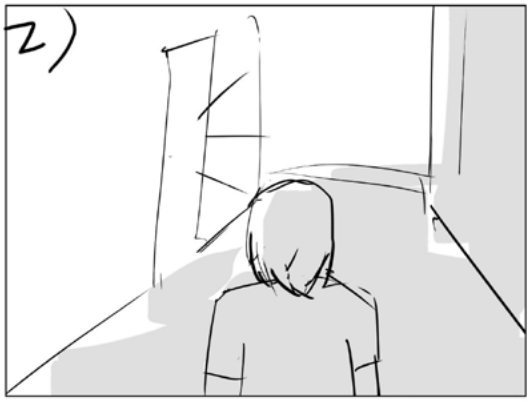
Son arrives at the elder's home, a 911 vehicle is alread there



Son runs towards home's frontdoor

Son opens door of the house

19



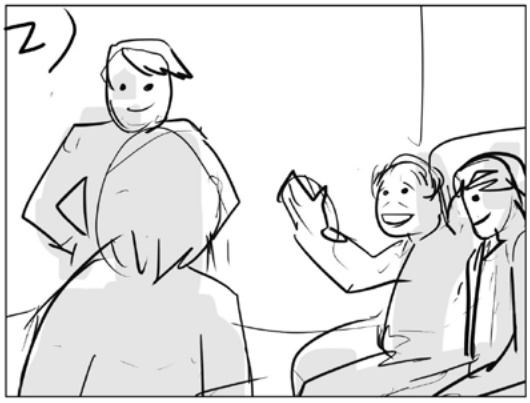
He notices noise coming from the living room

Son peeks into the room

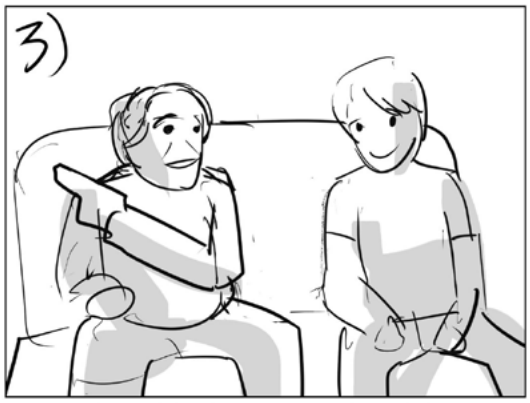
Shot of son's surprised face

20

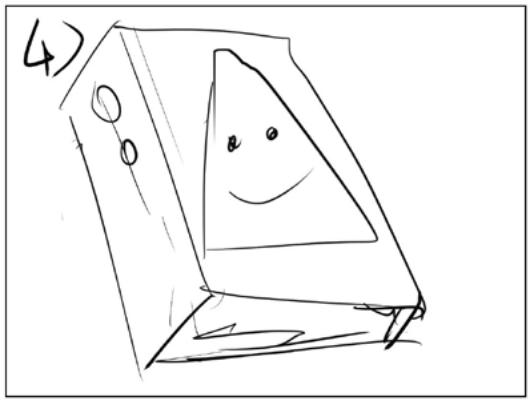
Son finds elder in the living room with carers



Elder greets the son, carers move out of the way

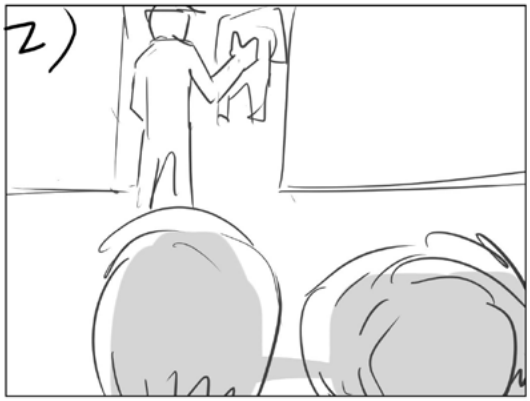


Elder explains what happened, points to device

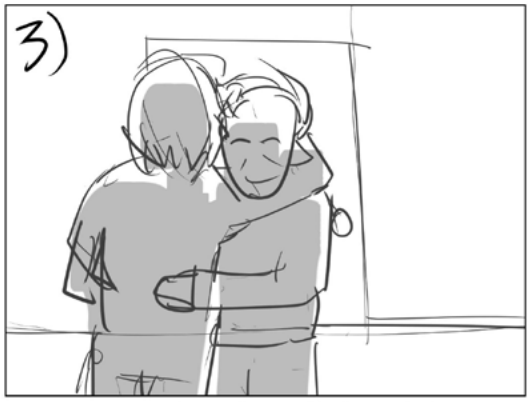


Shot of device back in safe status

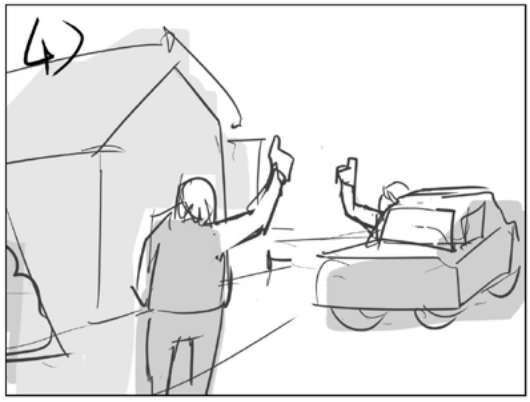
Son thanks the 911 team



They leave as son and elder watch



Son has to leave, him and elder hug each other



Final shot, son leaving in his car, as he waves at elder

3.2.2 User Personas

It is crucial to better understand the existing frameworks before stepping forward toward the project behind the story:

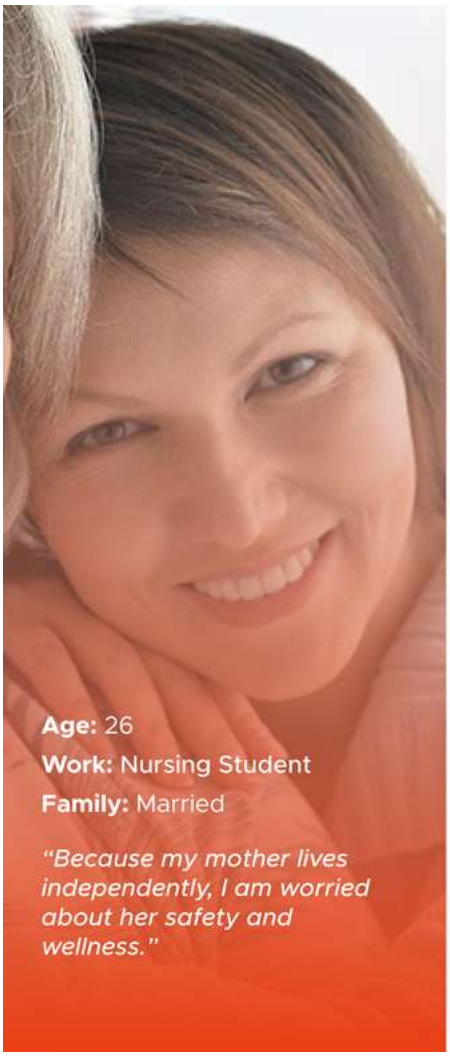
a. Who are the target users?
b. In general, what is the case with caregiving alert systems?
c. Do any caregiving alarm services support their subscribers successfully?

As one of the crucial parts of the User Experience (UX) Design process, I developed two user personas who use the Usafe app. The primary persona would be the family caregivers who use the Usafe app to monitor the health and safety of their elderly parents. The secondary persona would be the elderly people who live alone at home without family caregivers around.

Rikke Friis Dam and Teo Yu Siang (2021) noted that personas are fictional characters, which you create based upon your research to represent the different user types that might use your service, product, site, or brand in a similar way. According to Raven L. Veal, Ph.D. (2019), user personas are one tool designers use to gather user research and create more human-friendly products and experiences. As UX designers, we should design to understand the user's needs and expectations. The design process generally starts with user research. Designers try to learn what the issues are and how their users think, feel, and behave to design the solutions that will fit human behavior.

Developing user personas tends to be a particular strategy that, while limited, helps the designer envision their users. By creating user personas, first, I ask myself who the users are. Once target users are defined, I can design with one person in mind, which allows me to focus on delivering and meeting the needs and expectations of that person.

Primary Persona



Anna

Background

Anna is 26 years old. She works from Monday to Friday, and she attends nursing school at night. She knows how to take care of the elderly because she works as a caregiver on the side to help pay for school and get experience.

From nursing and fostering stray animals as a child to volunteering at her local hospital in her teens, Anna always knew she wanted to be in the healthcare profession. She enjoys being with and caring for older adults.

Wants and Needs

> Wish her mother to live with her together
> Support her mother as she needs
> Wish her mother to stay safe and healthy
> Stay in contact with her mother on a daily basis
> Be able to remind small things that happened in her mother's life

Fears and Frustrations

> Not be able to take care of her mother daily because she is too busy at school work
> Worry about her mother who may forget things that cause dangers
> Worry her mother's safety, wellness, and health
> Unfamiliar with caregiving technology because she never tried any ones before

Figure 23. Family Caregiver Anna-Primary Persona (Image by Kyla Roma by Benita)

Secondary Persona

Erica

Background

Erica was recently diagnosed with dementia two months ago. She is feeling a little anxious and uncertain for her futuree, but she is still feeling optimistic about life. She pretends to be strong because she does not want others to worry about her too much. However, the truth is dementia has brought unsafe factors to her life physically and mentally.

She lost her husband 3 years ago. She loves when her family can visit her home, but she also prides herself on being independent and hopes to delay co-dependent life as soon as possible.

Wants and Needs

> Stay independent for as long as possible
> Stay in contact with her family daily
> Be able to be reminded of small things that happened in life and who her family members are
> Stay safe at home and reassure her family she is safe
> Manage her daily routine without forgetting
> Be entertained and exercise her mind with small activities

Fears and Frustrations

> Fears her memory will deteriorate quickly
> Doesn't want to be a burden on her family
> Fears losing the life she loves
> Being uncertain what her future will look like

Figure 24. Ageing Parent Erica-Secondary Persona (Image by Kyla Roma by Benita)

Designated Story for the Primary and Secondary Persona

Anna 26 years old, is as a smart phone user, her mother Erica 62 years old lives in a different city and they see each other only at weekends. Anna is worried about her mother being lonely and without help in case of an emergency. Anna would like to see her mom more often, but she lives far away. Erica is active and autonomous but tends to forget things. Anna would love to be sure nothing happens when her mom cooks or roams around the house. Erica loves her daily walk and Anna wants her to continue this, but she suffers from a heart condition. What if an emergency happened? Her mother doesn't measure her blood pressure or forgets to log the result. When Anna visits her mother she brings the Usafe sensory caregiving system which could be placed anywhere or installed on the wall in their house, that could help Erica stay independent, the sensors can be programmed and learn Erica's routine at home. Anna can set up numerous boxes in Erica's home, but only one box can be installed per room. The box can detect falls or injuries when Erica stays alone at home using body detection technology. If any unusual behaviors happen, Anna will receive push notification alerts on her phone, so she could call for help. However, there are some limilations of the system. For example, If the elderly dies peacefully in their sleep, the box couldn't be able to recognize immediately because it is difficult for the back-end system to decide whether or not the person who is being monitored still has any vital signs. If the elderly still has no any movements after 24 hours has passed, the system will report to the family. On the other hand, the monitoring professional staff will get synchronized push notifications and warnings as well whether there is a fall or other related unusual activities from seniors. This ensures that medical support occurs more efficiently than other senior care options.

3.2.3 User Journey Map

After developing who the target users are, I illustrated the needs and expectations by conducting a User Journey Map. User Journey Map is used to map the relationship between a user and an organization over time and across the channels on which they interact with the business. Design teams utilize User Journey Map to see how user experiences meet their expectations and find areas where they need to improve designs (What are Customer Journey Maps?, 2021).

By completing a User Journey Map, it helps me define a time-based journey period. Second, another component is building scenarios. The sequence and context of activities/events are observed, which users could achieve a goal (e.g, a user wants to buy a ticket on the phone). Third, finding touchpoints can define what users do while interacting and how they do it throughout the digital system, information system, or a service that we design. Fourth, there are several channels in which actions of users are performed. And finally, developing a User Journey Map provides insight into what the users think and feel at each touchpoint (What are Customer Journey Maps?, 2021). In Tables 2 and 3 in the following pages, the User Journey Map is designated in terms of Anna and Erica's story in section 3.2.2 User Personas.

Primary Persona

Anna

Scenario	Goals and Expectations	Fears and Frustrations
Anna always knew she wanted to work in healthcare. She interns every day, and she attends nursing school at night. She enjoys being with and caring for elderly people. She also takes care of her mother Erica.	> Wish her mother to live with her > Support her mother with help as needed > Wish her mother to stay safe and healthy > Stay in contact with her mother daily > Be able to remind small things that happened in her mother' life	> Not able to take care of her mom on a daily basis > Worry about her mom who may forget things that cause dangers > Worry her mom's safety, wellness and health > Unfamiliar with caregiving technology because she never tried any before

	Morning	Workday	Afternoon	Evening
Doing	 Get up, make coffee, make the bed, take a shower, get dressed, eat breakfast, prepare going to work.	 Working during the business hours, taking care of elderly during internship, eat lunch.	 Working during the business hours, taking care of elderly during internship, prepare to finish today's work, eat dinner.	 Call Erica to follow up her health condition in the day, walking dog, prepare for bed.
Thinking	> Call my mom tonight. > Manage my routine for today. > I have to concentrate on work today. > I need to take care of my kids, sending them to school.	> Learn new healthcare technologies from work, and probably could be used for my mom. > Learn how to communicate with elderly.	> Learn new healthcare technologies from work, and probably could be used for my mom. > Learn how to communicate with elderly.	> I need to take care of my kids. Pick them up from school. > If my mom's health is okay? > Guilty for not spending more time with my mom because I live far away from my mom.
Feeling	> Had a great sleep for better working performance. > Worried about my mom's health condition.	> Worried about my mother. > Worried about my work will be interrupted. > It's stressful to keep monitor of everything at work.	> Worried about my mother. > Stressed. > Tired.	> Worried about if my mother wouldn't pick up her call tonight? > Worried about my mother's body condition. > Looking forward to going to bed.

Table 2. Journey Map of Primary Persona

Secondary Persona

Erica

Scenario	Goals and Expectations	Fears and Frustrations
Erica was recently diagnosed with dementia. She pretends to be strong because she does not want others to worry about her too much. Dementia has brought unsafe factors to her life physically.	> Stay independent for as long as possible > Stay in contact with her family on a daily basis > Be able to be reminded of small things that happened in life and who her family members are > Stay safe at home and reassure her family she is safe > Manage her daily routine without forgetting > Be entertained and exercise her mind with small activities	> Fears her memory is deteriorating rapidly > Doesn't want to be a burden on her family > Fears losing the life she loves > In uncertain what her future will look like

	Morning	Workday	Afternoon	Evening
Doing	Get up, let the dog out, make the coffee, take pills, make the bed, take a shower, get dressed, eat breakfast, exercise.	Go for a walk, talk with other people, sometime stay alone at home to read newspaper, watch tv and garden.	Prepare lunch and eat, do a puzzle, take a walk, shop, garden, visit a friend, go on an outing, volunteer.	Having conversation with daughter on phone, personal care-bath, brush teeth, prepare for bed, read books.
Thinking	> Call my daughter tonight. > Did I forget anything? > Want to learn something new and be active. > Manage today's routine. > Body is in good condition.	> Stay at home if there are no activities to do in the day. > Routine is kept on monitor without forgetting anything. > Body is in good condition.	> Want more feeling exchanged when talking with others. > Able to go out for shopping without helps from others such as caregivers or family members.	> Have to finish all the daily routine before daughter calls in tonight. > Plan on manageing routine for the next day.
Feeling	> Had a great sleep last night, which is important for manageing my routine for today. > Will my daughter call me today? > Worried about my health condition that enables my ability of moving around.	> Not sure if the routine has too much or too little activity. > Not sure which type of activities worked the best. > Worry if the time of the day is not the best for senior function.	> Feel no longer being needed. > Worried that someone thinks of me getting older. > Worried about body health condition. > Being postive and active.	> Feel excited to talk to my daughter tonight. > Looking forward to going to bed. > Tired. > Brain runs slow.

Table 3. Journey Map of Secondary Persona

3.2.4 User Empathy Map

I also explored data on alert service systems for caregiving. According to Medical Alert Device Consumer Usage Report 2020, the data shows:

73% of seniors believe they do not need a medical alert device and **just 8% do**. The rest are unsure.

Each year, one-in-four seniors age 65 and up will fall, often leading to serious injuries. Roughly 23 percent of respondents experienced a fall within the past six months.

Caregivers list a medical alert device as the senior safety product they'd most recommend with a third of caregivers believing the senior they care for should have one.

More than **8** in 10 seniors who have never had a fall said they had no need for medical alert devices.

Table 4. Research key findings from Medical Alert Device Consumer Usage Report 2020 by Tobby

This knowledge forced me to further explore with the users to learn what kinds of thoughts and reactions are correlated with their history with utilising caregiving alarm systems. I have acquired the following details regarding my target users from interviews with my elderly and relative family participants secondary persona, and User Journey Map:

In case of emergency:

Primary users likes to assume their loved one is seeking support and are notified instantly.

Secondary users want to feel protected, to get assistance when they need it, and to provide a means for their families to be informed of their emergency.

As for how they felt about caregiving alert systems:

For primary users: They want to be secure that their loved one is doing well, that they feel concerned and guilty about being physically far away, and that they want to check-in with their loved one without being overbearing.

For secondary users: When using it, they feel old, the pendant is unnatural and humiliating to use in their everyday lives, they want to feel empowered and independent, and they feel like a strain on their families.

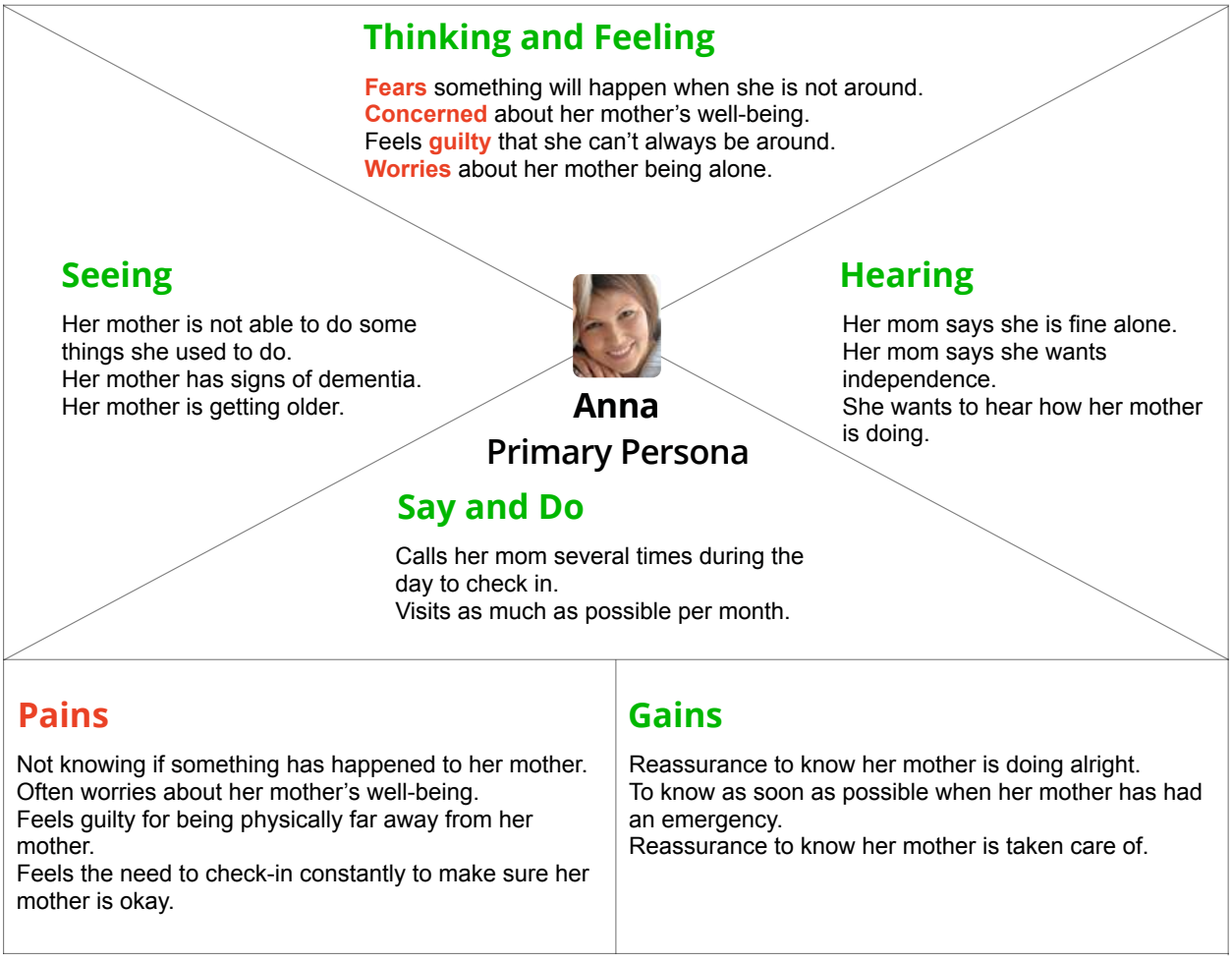


Table 5. Empathy Maps created using the data collected from interviews and academic research articles

Thinking and Feeling

How will my kids know if something happens?
Worry!
Will someone get here in time? What happens if I fall?
I don't want to feel like a **burden**.
I want to feel **independent**.

Seeing

I don't want to be seen as old.
The pendant looks **embarrassing.**
Awkward!

Hearing

I want to know if my family is notified when I'm in an emergency.

Erica

Secondary Persona

Say and Do

I am fine living on my own.
I want to hang out with my friends.
I want to talk to my daughter occasionally.

Pains

Getting help when needed.
Fear of not being able to get help if alone.
Not feeling independent.
Language barrier.
Worry about family being informed.
Feels like a burden to my daughter.

Gains

Reassurance that her loved ones will be notified if she can't call them herself.
Security, knowing she can get reliable help.
Freedom to live how she wants.

Table 6. Empathy Maps created using the data collected from interviews and academic research articles

3.2.5 Competitor App Analysis

After evaluating the users wishes, desires, and pain points, I found that elderly adults want to live comfortably and independently and need the knowledge that trustworthy support is accessible as required.

According to Steven Douglas (2020), getting to grips with the ins and outs of a User Experience (UX) competitor review will help designers better appreciate the business, product, and priorities. Designers are also going to better understand the market, get actionable insights, and improve the brand. With an almost infinite number of players out there all competing for attention, the pressure is on learning just what they're doing right (or wrong) to build an efficient User Interface (UI) and a product that users enjoy using.

I analyzed two existing In Home caregiving/monitoring mobile applications whose main functionality and usability are similar with the app I design in my thesis research project. This helps me better understand the information I am looking for. The benefits of conducitng an UX competitor review are listed below (Steven Douglas, 2020):

a. To help you reresolve usability problems;
b. To understand where your product or service stands in the market;
c. To inform the design process;
d. To know the strengths and weaknesses of your competition;
e. To have reliable evidence when making product changes;
f. To focus your efforts in a target market.

Benefits and Drawbacks of the Applications

1st Competitor App: Painscale Application

This application was designed to improve the patient's management of chronic pain. It provides insights into the patients' health condition and increases the quality of the information shared between the patients and the doctors to maintain standards of excellence in pain management (PainScale, n.d.). The application monitors patent information such as sleep, heart rate, glucose, and physical activity. Like

the heart rate trackers integrated into most exercise wearables, a smartwatch linked with the Painscale app on users' wrists monitor their heart rate by sensing shifts in blood flow below the skin's surface. The app records this blood flow by using the flash of their phone's camera to highlight the skin to produce a reflection.

The advantages of the application include the provision of trusted content, instant reports, and the delivery of tips and insights. The Painscale application provides medically accurate information that has been reviewed by physicians. The patient can log in, track, and manage their symptoms and treatments, all consolidated in a single application. By using the application, patients can also learn treatments that work for them and other people with the same condition. The application generated instant reports that improve communication with the doctor in finding new treatments faster (PainScale, n.d.). The reports give patients options concerning treatments for their conditions and symptoms, allows them to track their pain, mood, activity, sleep, medications, and treatments. The application also allows patients to spot trends and patterns to understand what helps and triggers their pain. The visualization helps them learn and communicate what impacts their pain.

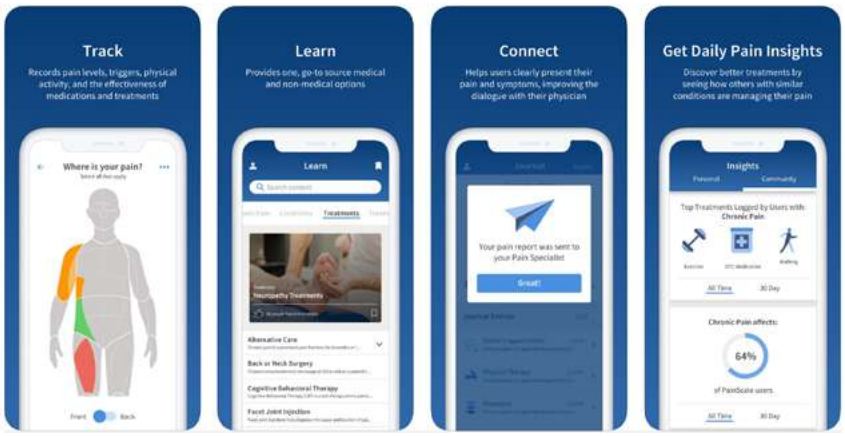


Figure 25: Painscale App (Image by Boston Scientific)

2nd Competitor App: eCare21

eCare21 is a virtual care platform which has the ability to engage patients in their homes or remotely. Patients are allowed to share their data within their community of care with their family members. Their caregivers connect their data to a clinical documentation back-end. What that helps patients to do is enabling medical assistants to be part of the circle of care. Such a clinical documentation system can

engage in reimbursement codes in the United States. The Centers for Medicare and Medicaid provide payments allowing physicians to get reimbursed for work that they're already doing as a matter of good practice.

What eCare21 provides is an easy way to document caregivers' encounters, and keep track of them to bill appropriately. eCare21 can generate a clean and compliant bill with Medicare patients. For other countries other than the United States, eCare21 acts as a virtual care platform for patients. For example, they might invite their caregivers for a personal reason. For a clinical sense, caregivers might want to engage with their patients remotely. All of the data is connected to the cloud securely and shared. So, the patient will control access to their data from a mobile app for the most part. The clinician will retain access to the data via roles that they assign within the clinical practice.

The advantages of eCare21 include remote monitoring capabilities, simplicity, low cost, security, robustness, and self-management. The application is easy to get started and use with a simple setup and ease of installation. The application has a secure online portal where users can access their data. The data is encrypted from outside intrusion, complying with the HIPAA provisions. Also, new clients receive free training before using the platform. The application is robust because it allows users to track a wide range of specific conditions. It is a low-cost platform because it combines predictive analysis, cloud, IoT, and mobile (eCare21, 2020). It provides a circle of monitoring by health professions, helping to reduce patients' hospitalizations, as shown in Figure 26.

Figure 26: eCare21 (Image by eCare21.com)

Disadvantages of the two Applications

The User Interface (UI) of the applications and security issues pose problems to the users. The inability of the clinicians to gain access to graphical pain data visualization impact clinical utility of mobile applications despite the high demand (Zhao, Yoo, Lancey & Varghese, 2019). The applications are subject to abuse and misuse. As Pichierri (2018) noted, the platforms rely on the internet, cloud services, and the Internet of Things (IoT), which allow for possible attacks from people with malicious intent. The applications also lack rigorous scientific evaluation concerning the information and content availed to the patients. The absence questions the efficacy of the information in the management of chronic pain (Thurnheer, Gravestock, Pichierri, Steurer & Burgstaller, 2018). Moreover, there has been a growing issue of users' privacy. The applications share patients' health-related data with social media. According to Davis, (2020), healthcare is the most-hacked industry in the United States. These data breaches expose data to outsiders who may deteriorate the patients' conditions because of the stress involved.

3.3 Summary

By analyzing the research results from my participants and learning relevant caregiving fields from multiple perspectives in Chapter 3, this research has provided me with an expanded understanding in caring for the elderly. By using Artificial Intelligence (AI) and User Experience (UX), it is possible that families can continue to interact with their loved ones to improve the quality of life at home for the elderly. As a result, I can envision a caregiving application with a better design based on the observations and a situational organization from the qualitative analysis of interviews/surveys and user-centric design approaches including Storyboard, User Personas, User Journey Map, User Empathy Map and Analysis; and Competitor App Analysis.

Chapter 4. Designed Response

Chapter Introduction

This chapter outlines the design process for Usafe, an Artificial Intelligence (AI) and Internet of Things (IoT) based monitoring mobile app service designed for family caregivers who need monitoring and analyzing of their elderly loved ones. From the elderly's side, the Usafe platform could enable them to live independently for a longer period of time at home to stay healthy and safe. This chapter discusses the design opportunities established in the review of the semi-structured interviews, as discussed in Chapter 3. The goal of the design outcome is to improve the User Experience (UX) and service communication for both family caregivers and elderly adults, centred on designing the caregiving app, the recommendations for the usage of applicable technology, and the user context developed from the literature review. The design process is divided into five stages, which supports designing a user-friendly caregiving system. Design decisions and final prototypes are also shown in this chapter to convey how the system works in a real-world story. The short film scenario shows how the app is used by different groups of users in the real world and what infrastructures support behind the scenes. Of course, the app is not fully resolved, this is a conceptual prototype. Thus, it needs improvement. The feedback gained from usability testing at the end of this chapter provides valuable reference about how the product could better serve users in the future.

4.1 Design Opportunities

The design opportunities listed as following are identified from the analysis of the semi-structured interviews and results of User-Centered Design (UCD) research from Chapter 3.

A. Preparation and Fast Response Increase Chances of Living Longer for Ageing People

Family members should pay attention to self-help and first aid for their loved ones' health and safety. Because of disease incidence, the rate of disability and death is higher in old age, and disease's early symptoms are not completely obvious. Often by the time the signs are discovered, the disease has become dangerous. Therefore, elderly and their families should have some measures to prevent emergencies and improve first aid efficiency before emergencies happen, especially for sudden illnesses and accidents for the elderly, to learn self-rescue, first aid, and gain valuable time for first responders. This is especially true for family caregivers to take their responsibility on knowing what their ageing parents need, as I mentioned in the interview analysis of adult caregivers in Chapter 3.

B. Safety is a Priority for an Ageing Individual Living Independently

The interview analysis of Chapter 3 states that elderly in Chinese culture tend to select and prioritise life goals toward their own "family," and live for the sake of their extended family, in spite of the fact that interdependence is popular in the Chinese community (Singelis, 1994). As elderly take good care of themselves, they know that they'll be able to place themselves in a healthier role for their family members, so they can feel better, and realise that it is important to take good care of themselves. However, when it comes to the elderly living independently, health and safety should be considered a priority, resulting in opportunities that support people to achieve their goals. It invariably creates value in preventing safety hazards and helping people to eliminate concerns about them. Family caregivers could do better to minimize injury and distress suffered by their elderly loved ones when they train themselves on what to anticipate and do. There are also reasonably easy, rational safety steps that people could take to help keep their elderly parents and other loved ones healthy and safe.

C. Negative Impacts Caused by Social Isolation for the Elderly

The onset of ageing can undermine the self-confidence of the elderly and reduce their motivation. Secondly, changing lifestyles and social roles can bring feelings of loss and isolation. Without new content to fill, it is likely to affect their health. Some elderly adults cannot adapt to their new roles because they worry about their financial situation after retirement, which results in anxiety, depression, or low self-esteem. Some older adults who live alone suffer from social disconnection, and this can reduce their access to the outside world and hurt their health and safety. The application designed for this thesis aims to help address the safety risks associated with social isolation due to mental, physical, or emotional health issues.

D. Eliminating Anxiety and Releasing More Free Time for Family Caregivers

Family caregivers should continue to plan care of their ageing parents by providing proper caregiving measures. This is because most ageing parents worry that relying on their children can be embarrassing. They don't want to be burdensome, as the interview analysis for the elderly states in Chapter 3. Such emotions can cause negative feelings, which could potentially harm the elderly's safety and health. This could reflect on the fact that older adults cannot always adapt to the idleness of retirement. They might believe that they have become a burden to their families and society, they have lost the value of their existence, and they have a low opinion of themselves. Therefore, sometimes family members should respect how their ageing parents decide to live to reduce their emotional turmoil. This could also give the family a chance to rethink how they care for their elderly parents. For those families who live far away from their parents or do not have time to take care of their parents due to work or school, family caregivers spending too much time taking care of ageing parents could prevent themselves from participating in social life, as mentioned in Chapter 3. Therefore, utilizing technology to resolve ageing problems in place as a third-hand helps lower family caregivers' life pressure and could help them engage society.

E. Systematic Data Management Enables Uniformity of Artificial Intelligence (AI) Infrastructure Development (e.g., Human-Body Recognition)

Artificial Intelligence (AI) technology has a wide array of uses in the caregiving service sector. These

uses include health monitoring, imageing, and data informatics, among others. Human-Body Recognition (HBR) provides the technological supports that involve an algorithm to monitor seniors' daily activities. The algorithm helps in the automatic identification of the features or patterns of data stored in the database. It uses the established practices to judge and provide results about the Human-Body Recognition or objects that need to be identified. Caregiving informatics is likely to benefit the most from AI technology. The caregiving sector generates a massive volume of data every minute that can play a crucial role in providing better care. However, human beings and the existing technologies have a limitation in the amount of data they can analyze for decision-making because the capacity for automated decisions to make high frequency caregiving is now well-known. However, AI is independent in the act of making choices, but these decisions are still controlled by the human makers of the laws, as mentioned in the interview analysis of the AI expert in Chapter 3.

The integration of AI technology in caregiving informatics ensures that information related to diagnosis is available in real-time without a human being's intervention once decisions are defined by humans. When used in the healthcare sector, AI technology provides complicated software and algorithms to emulate human cognition as far as the analysis of complex medical data is concerned. Using AI technology, patients can get information from a database about what is ailing them and a possible treatment modality for their condition.

Additionally, the use of AI in body detection and sensory monitoring saves human power and money. At the same time, AI ensures faster decision-making. The technology provides an opportunity to collect accurate information that enables decision-makers to act as soon as possible.

F. Service Design Innovates Senior Care

The Human-Computer Interaction (HCI) expert in the interview analysis of Chapter 3 noted that service design seeks to consider the end-to-end trajectory of the individuals and processes engaged in a business operation and how they communicate with each other. It is an extra phase of emphasis on the relationships between people and processes. According to Michela Cozza (2019), many suggest the idea of social innovation as a means of improving design for older people. Social innovation relies on interactive modes of working and refers to new ideas (products, services and models) that simultaneously

meet social needs and create new social relationships or collaboration. Developing solutions to problems through products that make it simpler – no matter the intended users' age. Although seniors definitely will profit from creating well-planned products, technology embedded into service design will enable improved caregiving management through mobile applications to assist the elderly who live independently.

4.2 Design Process

User Experience (UX) design is a crucial stage in ensuring that a product works well for its end-user. UX gives a clear sense of what users are dedicated to, and as a result, it is possible to figure out how to satisfy the needs users have. In the UX process, designers evaluate a design based on defined requirements. This can help designers formulate strategies that they can rely on to fulfill their strategic objectives. It is also essential to ensure that what is on the screen has the most necessary and desirable features for the current and probable users (Wroblewski 2019). As Wroblewski notes, this implies that designers have to be aware of what is most needed to be able to create a multichannel design of numerous experiences (2019). My UX process is divided into stages in terms of the suggestion of 5 stage process in the Design Thinking Process provided by Rikke Frils Dam and Teo Yu Siang as shown in Figure 27.

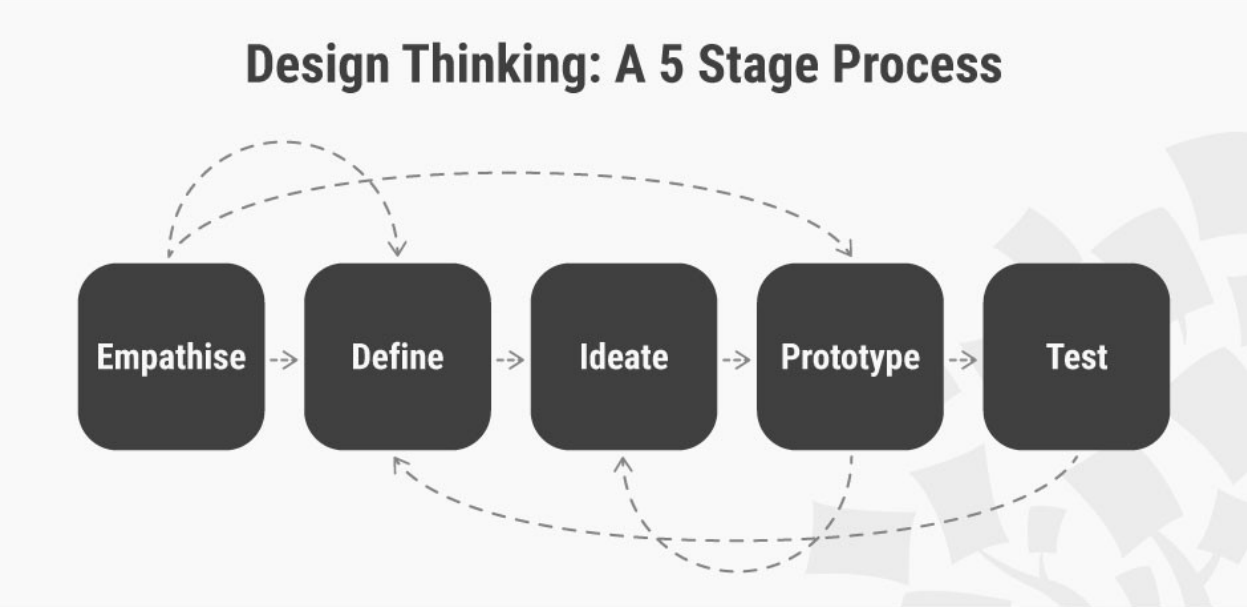


Figure 27. 5 stages in the Design Thinking Process (Image by by Rikke Friis Dam and Teo Yu Siang)

A. Empathise

Following the context of Chapter 3, the raw data gained from interviews and deep learning for my target users from the results of user-centric approaches provides me with a better empathic understanding of the problem. This enhances me to learn more about the field of concern through studying, communicating, and empathizing with target individuals and to consider their perspectives, needs, and expectations.

B. Define (The Problem)

The stage of Define helps me gain valuable information and ideas to establish features, functions, and other elements, which enables me to address the problem in a meaningful and useable way. During the define stage, I bring together the knowledge I have obtained during the Empathise stage. This is where I evaluate and analyze the raw data gained from the research process in Chapter 3 to identify the main challenges. To illustrate, the problem I defined is , “I need to design something for helping family caregivers take care of their elderly loved ones who live independently, which enables ageing parents to live longer safely and in good health.”

C. Ideate

I start generating ideas during the third stage. At this moment, my target users and their desires at the Empathise level have already been defined. Also, during the Define stage, their backgrounds have been analyzed as well. With this context, this is the time when I start “thinking outside the box” and design innovative solutions to the issue statement I’ve made. After ideating, I decided to create a virtual mobile application for family caregivers to remotely monitor their ageing parents’ daily activities and behaviours for keeping themselves a quick-responsive reaction if their loved ones suffer any emergencies at home when living alone.

D. Prototype

After going through the research, the next step is the User Interface (UI) design implementation. Since UX design itself is planning the future product, the UI brings this to life. The prototyping plan is divided into

three phases. The first step is to determine the look and feel of the product. Step 2: Sketching low-fidelity wireframes to define some main features and functions. Step 3: Designing a high-fidelity prototype (The design is improved based on wireframes). According to Steve Krug's succinct definition in *Don't make me think!* (New Riders, 2014), the best UX is the most intuitive one. As a UI/UX designer, I need to think about how to accurately communicate the target users' needs to the interface design in a direct and simplified way. As described above, the process needs to focus on usability and aesthetics and make full use of a designer's creativity to make the product an effective and pleasant experience.

E. Test

During this phase, I conducted an initial user testing for the final design. This is an excellent way to garner feedback as reference for improving the app. Sometimes, we are unsure if the designed solution can adequately meet the user's needs because many of the requirements and design solutions are just the designer's ideas. Usability testing is a great way to better understand how real users interact with the product and whether they can do the assigned tasks, how long it takes them to complete the assigned tasks, and how satisfied they are with the product. Identify changes needed to improve usability issues, qualitatively analyze usability, and see if it meets goals, and so on. However, due to the fact that the time was limited in my graduate thesis research project, my testing was only in the initial phase as yet. More testing would be followed as I further develop the app.

4.3 Design Decisions

For making appropriate design decisions, my plan is divided into two parts: First, I wrote a design specification of the product according to the users' needs, which have already been defined in the previous chapters. This is also a brief description of the app. From this, readers can learn the background of the application, the target users, what kind of problems the users have in their lives, how the app changes the way they behave, etc. Second: I present the visual design and interaction design through two separate roles (primary and secondary users). The visual design includes things like layout, fonts, and how visual branding is expressed. Information Architecture explains the flow of user interacting the app in each step.

4.3.1 The Usafe System (A Remote Health / Safety Monitoring Interface for the Elderly)

Usafe is a user-friendly solution equipped with:

A Mobile App: The app is installed on family caregivers' phones to help them monitor any unusual physical behaviours (eg. a fall, heart attack, sudden chronic pain etc,) of the elderly at home. An alert push notification is sent to family caregivers' phone when unusual behaviours or emergencies are detected.

Physical Sensory Boxes: Multiple sensory physical boxes were installed in the rooms (One box in each room) with sensory function monitoring unusual behaviours of the elderly living independently at home. When any unusual behaviours or an emergency are detected, the sensory box collects data, the data should be sent to the system/processor, and then decisions are made. Finally, family caregivers will receive their alert notifications generated by the decisions through their phones, which inform them that their parents are in a possibly dangerous state.

Data Processor: The cameras provide data to a central processor. This processor can store and analyze all data locally to maximize the turnaround time for responsiveness and additional anonymity. Cameras and the processor connect through a Wi-Fi connection. If users need to be alerted or use an interface to view a live stream, the processor will only communicate to the server. The app can provide a daily summary of the actions of the seniors it is supporting, which can sustain elderly care facilities.

Chapter 4: Designed Response

When ageing people who live independently have unusual physical behaviours, this system will analyze the situation and automatically warn their family members of a possible concern or emergency.

Relevant data are compiled in the dashboard to help medical staff decide if changes in treatment or patient re-admission may be necessary. Staff, along with a customized regular summary of activities, can screen images of “anomalies” such as falling, crying, or other non-typical behaviours..

The ageing people’s family members and monitoring staff will receive synchronized push notifications and warnings on their phones whether there is a fall or other unusual activities. This ensures that medical support occurs more efficiently than other senior care options.

The camera set up on the physical sensory box of Usafe has a 165-degree field of view and an infrared night vision display. There is also a motion monitor, an accelerometer, a compass, and an altimeter in each camera to better understand and observe the physical locations.

The cameras provide data to a central processor. This processor will store and analyze all data locally to maximize the turnaround time for responsiveness and additional anonymity. Cameras and the processor connect through a Wi-Fi connection. If users need to be alerted or use an interface to view a live stream from space, the processor will only communicate to the server. The app can provide a daily summary of the actions of the seniors it is supporting.

Usafe is also supported by a sensor attached to a key chain, which can detect falls or injuries when away from the home. Users can press a button to contact their family members, who then contact emergency personnel to aid the user. The Usafe app offers a quick way for loved ones to be notified of the emergency.

Thus, in my master thesis research project, I was challenged to research and develop the Usafe app with particular features to help family members who wish to monitor their ageing independent living parents’ health and safety.

4.3.2 Moodboard

As shown in Figure 28, the Moodboard is created based on research results. The Moodboard contains an accumulation of images, colours, fonts, and words that inspire me and set the mood I want in the design. I use the Moodboard to learn what feelings I evoke in my audience for designing the caregiving solution. From the images, seniors are portrayed as helpless and in need of assistance because they need it in their lives. It's a great way to keep track of where I want to go while designing. I also use it to retain some aspects as the project progresses. The Moodboard can also inspire me when I run into trouble during the design.

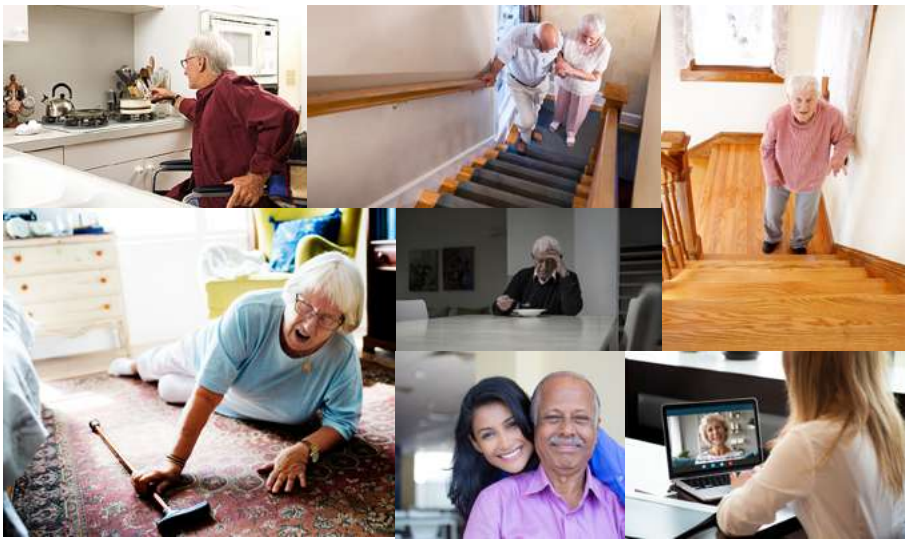


Figure 28. Moodboard (Images by Thinkstock, GETTY IMAGES, intentionalcaregiver.com, Photographee. eu, Rawpixel.com, fizkes and AshTproductions)

4.3.3 Design Guidelines

The purpose of a design guideline is to maintain visual and functional consistency in interface design. Functional consistency makes the app more predictable so that users can understand how elements could behave to make them feel safe and comfortable when they land on the User Interface (UI). Visual consistency includes branding logos, UI colours, fonts, size, location, and other visual aspects that help users identify and categorize UI elements. UI components can also use User Experience (UX) features that combine functionality and visual consistency. Component-based design specifications allow for visual and functional consistency in applications, helping users feel at home and direct to complete their desired interactions with the product.

A. Style – Visual Identity, Icons, Colours

Visual identity is how you shape perception and create an impression through your brand's visible elements (Jamahl, 2020). The name "Usafe" (Figure 29) divides into two parts for interpretation. The first part is the capital letter "U," which means that you are critical and taking care of your health is my priority. The second part is the word "safe," which means that the brand's principle and goal are to ensure people's safety and health. The colour's name for the identity is called Niagara. It feels soft and gentle. It can bring a feeling of spiritual healing, a sense of reassurance, and security to the family caregivers, which fits my project's intention.

I sketched out three conceptual ideas for the Usafe brand identity, which sets the foundation for branding across the mobile application design. I chose the first concept because it does not include any graphical visual elements but just letters. This is beneficial for people to recognize easily what the application is all about. Additionally, using letters as the only visual element on identity could emphasize the most important feature of the application through brand identity. As Marina Yalanska mentioned in 2019, brand keywords present the set of words people will use to find your app. Basically, letter 'U 'means 'You', the word 'Safe' means keeping families' loved ones safe.

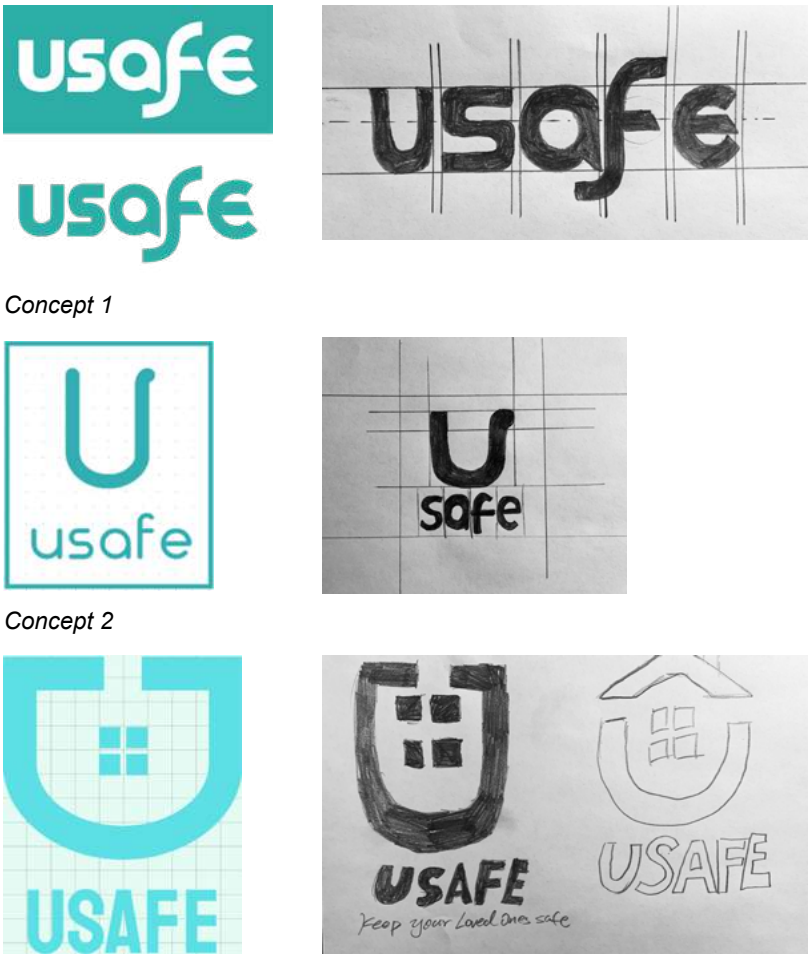


Figure 29. Visual Identity

According to Manuela Langella *(Designing For User Interfaces: Icons As Visual Elements For Screen Design)*, an icon is a simplified image serving as an intuitive symbol used to help users navigate the system. Icons below are used for building the Usafe app. Each of them represents a specific meaning or activity.

Setting Up Sensory Boxes / Adding Loved Ones Into the Usafe System

The number of monitored people: This icon shows while the user (family caregiver) is adding their loved ones to the Usafe system for monitoring the elderly's safety and health.

Manage account: This icon shows in the top right corner within the navigation header of the user dashboard. When hit, users get to manage their added loved ones and connected devices.

Successful: This icon confirms the users as they have successfully added a monitored person to the system and connected a monitoring box with the Usafe app.

Events / Activites Detected

Call 911: This icon shows in the top right corner within the user dashboard's navigation header. When an emergency happens for the elderly, the family caregiver hits the icon to call 911 for first-aid.

Unusual activities: This icon only shows when unusual activity happens for the monitored elderly. The exclamation mark is used for highlighting the event. It will disappear when the unusual activity stops.

Emergency: This icon only shows when an emergency is detected from unusual activity for the monitored elderly. The ambulance graphic is used to highlight the event. It will disappear when the activity stops.

Summaries

Night summaries: This icon represents the monitored person's daily report that the caregiver receives at the end of the day.

Colours for Interfaces

Primary	Secondary	Secondary	Secondary	Secondary
#2CAEA6	*#000000*	*#9B9B9B*	*#FBFBFB*	*#FFFFFF*

Status Accents

Normal Status	Typical Behaviour	Unsusal Behaviour	Emergency Alarm
#00B700	*#FEFEFE*	*#EA3F13*	*#C33ACE*

B. Typography – Font Variations

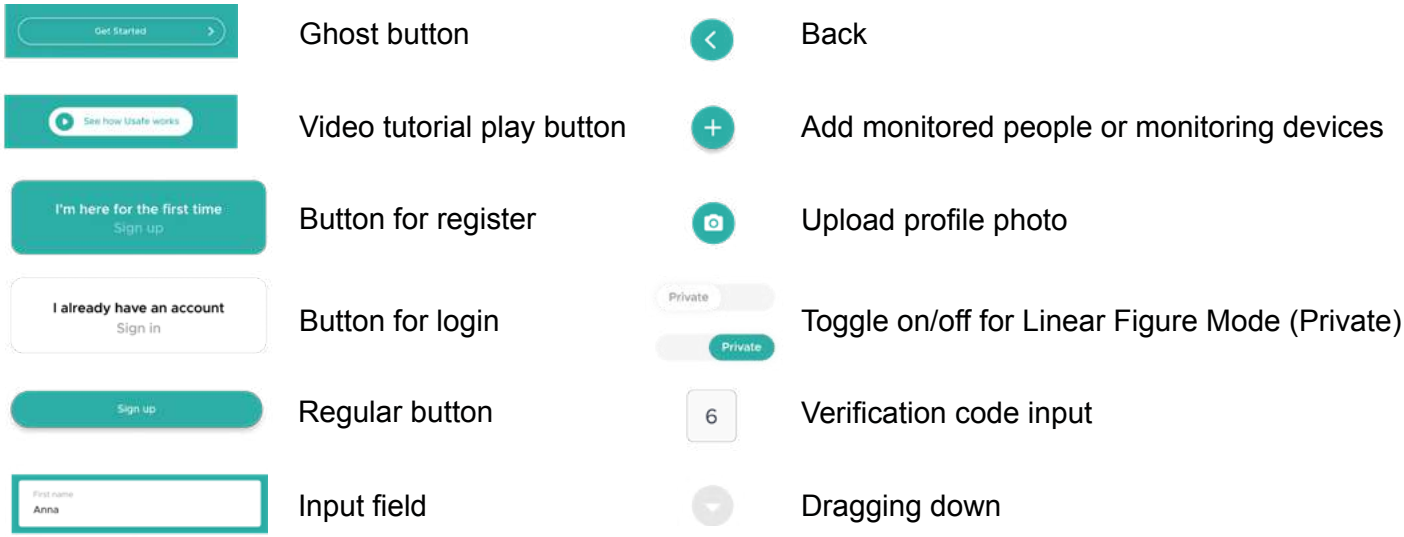
Chris Simpson makes the Metropolis Font Family. I choose Metropolis as the typeface for my mobile app to design a modern and geometric feel because the app involves various types of technologies. Metropolis is a minimalistic design that is readable at small font sizes, while still legible on big displays. (Metropolis font, 2021)

Metropolis

Extra Light	Regular	Medium	Semibold	Bold	ExtraBold
14 pt	20 pt	25 pt	20 pt	34 pt	30 pt
	15 pt	17 pt	18 pt	25 pt	
	14 pt	16 pt	17 pt	20 pt	
	11 pt	15 pt	16 pt	17 pt	
		14 pt	15 pt	16 pt	
		12 pt	12 pt	15 pt	
				14 pt	

C. User Interface (UI) Controls

Employing User Interface (UI) controls intelligently can guide users through your product as you intend, by making it feel familiar and learnable. In my design, the UI controls known as clickable elements are kept consistent with their colour, shape and feel etc.



4.3.4 Information Architecture

According to Robert Sens (2019), Information Architecture defines how content will be structured and presented to a user when interacting with design. Figures 30 and 31 show the Information Architecture laying out every individual screen. Driven by the target users, I developed the primary user for the family caregiver, and the secondary user for the elderly. The main user of the app is the primary user who utilizes the Usafe platform to monitor their loved ones' safety and health.

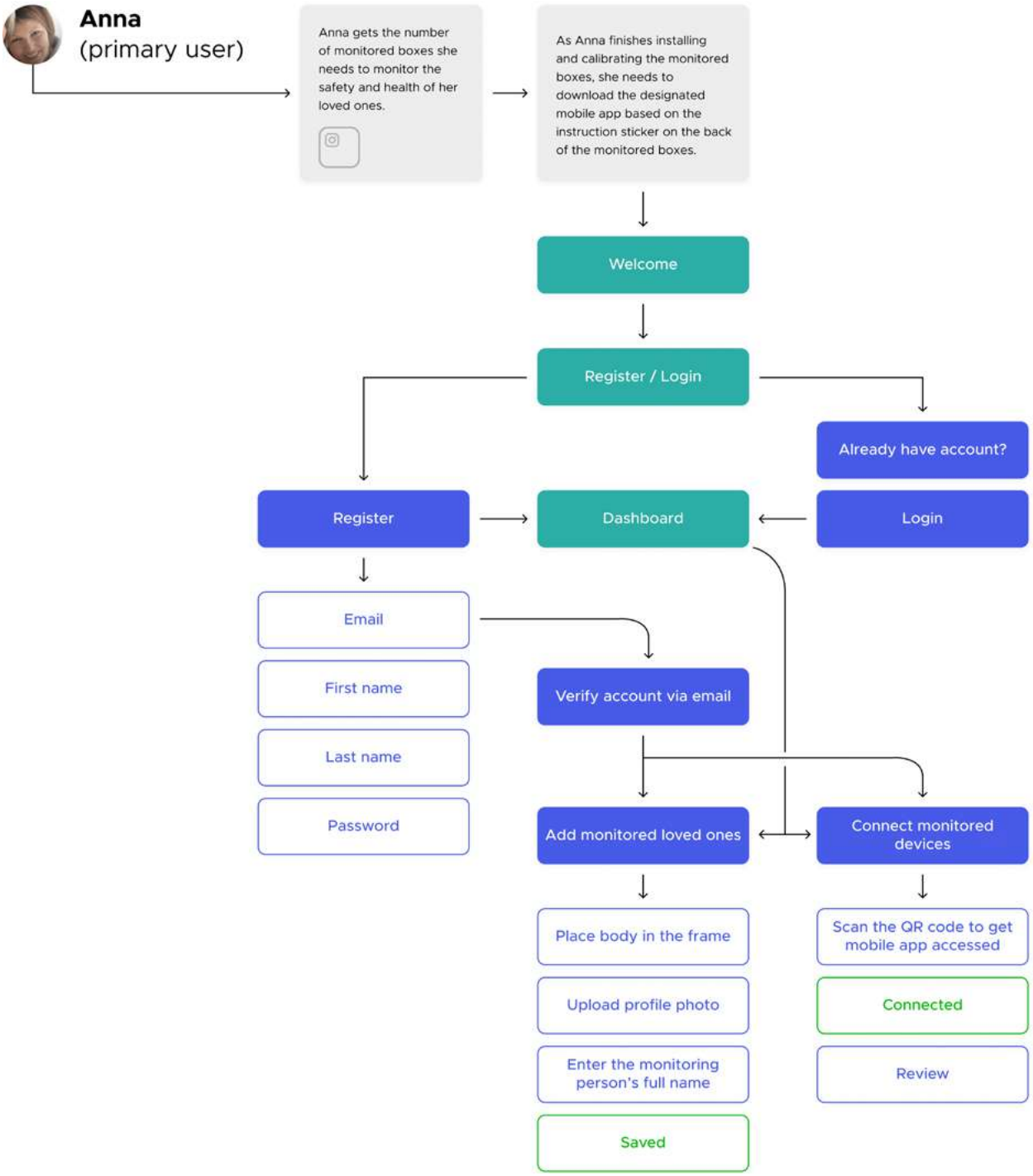


Figure 30. First part of Information Architecture for the Usafe app

Below is the Information Architecture explaining how the secondary user, Erica, is supported by the technology. The physical sensory box detects her sudden chronic pain when Erica stays at home alone. The system sends an emergency alert push notification to the primary user, family caregiver Anna's phone.

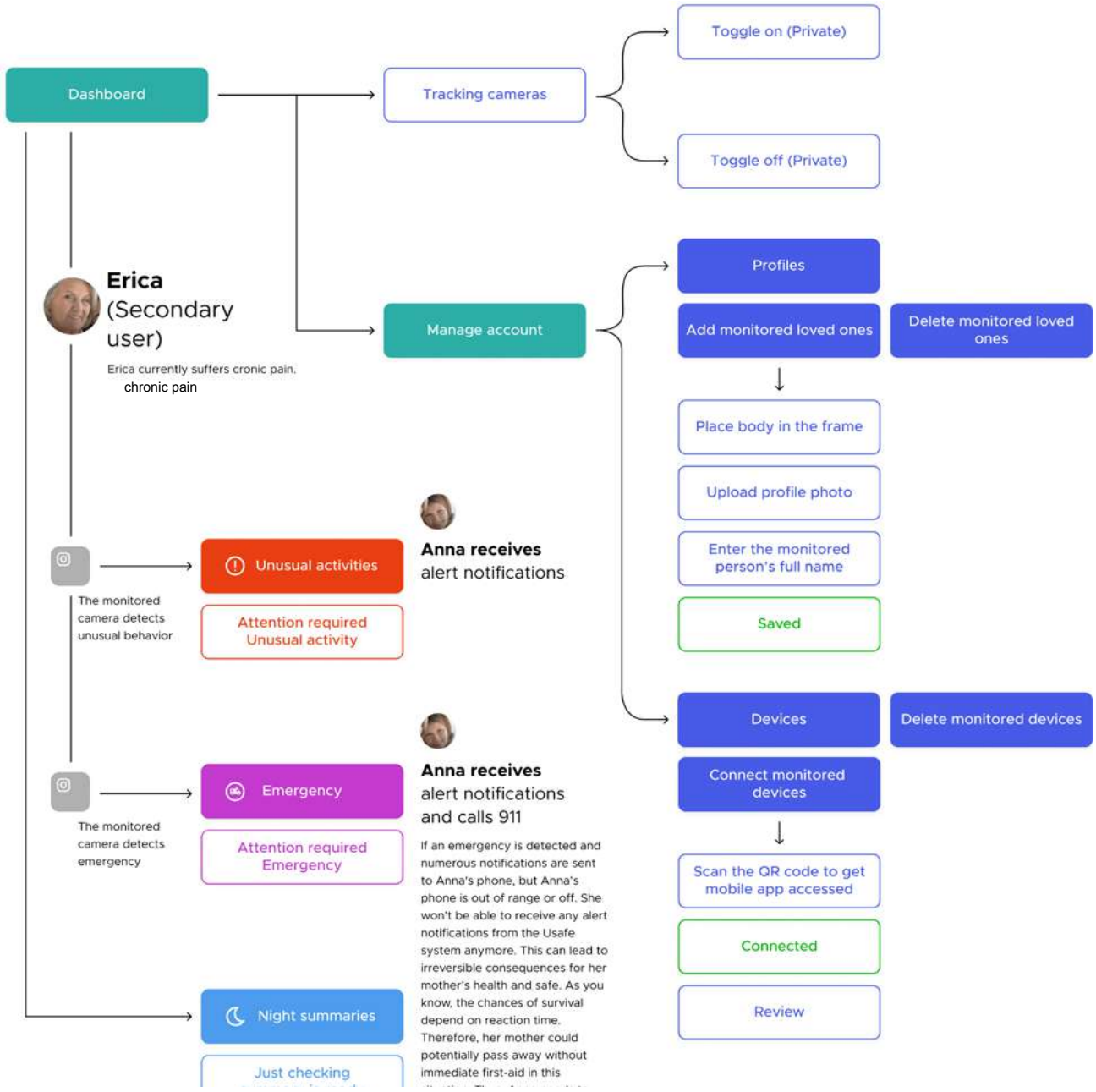


Figure 31. Second part of Information Architecture for the Usafe app

4.3.5 Wireframes

A rough wireframe is for beginning laying the foundation of visual design, user interface and user experience. The wireframe creates the structure—the backbone—of the entire project layout, making it easier later to build individual parts (Cao, 2020). In other words, wireframes are low fidelity prototypes and more about planning the flow of the user experience than the final visual outcomes, which will be addressed in later design. The wireframes, Figure 32 to Figure 42, highlight some featured screens of the Usafe platform, including the Welcome screen, Sign-up screen, Account Verification screen, the screens showing the process of adding monitored people and connecting monitoring devices, dashboard screen and Summary screen.

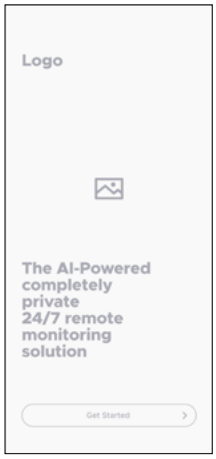


Figure 32

Welcome

In User Interface (UI)/User Experience (UX) mobile design, the Welcome screen is a brief introductory screen that shows up when new users open an app, website, or interactive experience. It usually consists of brand identity and brand name, which is recognized throughout the entire design. In the Welcome screen, I want the users to learn the app's main goal and purpose once they land for the first time.

Figure 33

Register / Login

Users land on this screen when the button, Get Started, is hit in the Welcome screen. New users get a chance to register. A brief video tutorial is provided for them to watch how the sign-up process works step-by-step. Returning users can directly sign in to get to the main dashboard.

Figure 34

Sign-up

The users provide their email address for the next step of account verification, first name, last name, and the password for any other login. Of course, the user reviews the Terms of Service and Privacy Policy of the Usafe app to learn and understand that their interests and private data are protected. The purpose of this is to inform users about the company's collection and use of the personal data of users (Privacy Policies vs. Terms & Conditions, 2020).

Figure 35

Account Verification

For data security purposes, the system sends a verification code to the user's provided email address. The user enters the code below to confirm their account. The email address will be the username for further login.

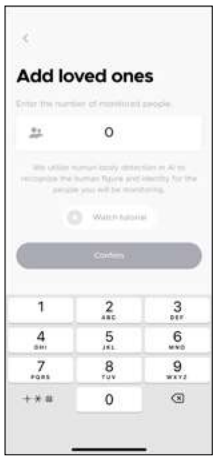


Figure 36

Entering the Number of Monitored People

On this screen, the user has to provide how many people they want to monitor. The system should know the number so that the set-up work can process in the following screens. If the user wants to learn how the process works, they can watch the tutorial.

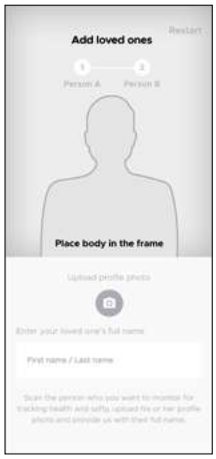


Figure 37

Body-Scan, Profile Photo and Full Name for the Monitored Person

The users add their monitored loved ones to the system. The user holds the phone to perform a body scan for their monitored elderly by placing them in the screen frame. The function is implemented by the Memory Allocator of Human Body Detection (HBD) in Artificial Intelligence (AI). Therefore, the system could memorize the scanned body frame. The user is also needed to upload the profile photo and enter the monitored person's full name.

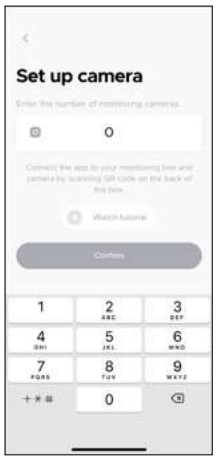


Figure 38

Entering the Number of Monitoring Devices

On this screen, the user has to clarify how many monitoring devices they want to set up. The system should know the number so that the set-up work can process in the following screens. If the user wants to learn how the process works, they can watch the tutorial.

Figure 39

Scanning QR Code

The user should scan the provided QR code that could be found on the back of each monitoring device to get their mobile app active and accessed. In the previous screen, if the number of a monitoring device that the user enters is two, then the user may prepare two devices and scan the QR code twice.

Figure 40

Confirmation for Connected Devices

On this screen, users get a chance to review the camera's quality and learn how to switch between Linear Figure Mode (LFM) and Real Body View Mode (RBVM) by clicking the bold text on the bottom. A toggle control is distributed to each camera because every family has different conditions. It is unpredictable how many monitoring boxes the user may purchase and where they will be placed. For example, if the camera is placed on the bathroom table, the data gathered by the sensor and camera reflected on the app screen provides real-time activities of the elderly to family caregivers. In the meantime, the caregivers can select the LFM to protect their loved ones' privacy in this particular case. Thus, such a function could provide users with flexibility and customizability against data insecurity concerns.

Figure 41

Dashboard

On this screen, users can keep monitor of the activities of their monitored loved ones in their homes through the installed monitoring/built-in sensory device. The system pushes alerts to the user's phone for emergency or non-emergency situations. If an emergency happens to any monitored person, calling 911 by family caregiver is the most direct solution. The entry for calling 911 is in the upper right corner of the screen.

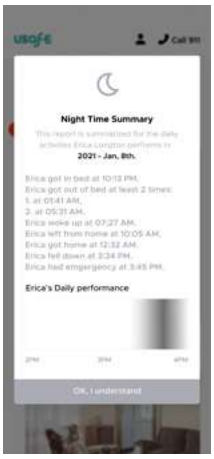


Figure 42

Night Time Summary

Every night the family caregiver receives a push notification to learn the nighttime summary for their loved ones. This screen helps the monitored people confirm that their routine is going well and helps family caregivers understand if adjustments are needed. Family caregivers can learn about what specific activities that their loved ones perform during the day through text information and gradient-coloured data visualization.

4.4 Final Colour Prototypes and Short Film Scenario

In the colour prototypes, I integrate two User Experience (UX) methods to build the system. First, the direction of the story is led by a defined user-flow. Of course, a story needs a hero. I use the two defined personas to represent the goal for my project. The personas use the caregiving service that I design. I see the personas as real people and base my decisions on building the best solution for the people while developing the interactive prototypes. In other words, I am creating a product or service for them. On top of that, without a mature user-flow as support, a successful story can never exist. According to Camren Browne (2019), the user flow lays out the user's movement through the product, mapping out every step the user takes—from entry point right through to the final interaction. Figure 47 to Figure 84 illustrate the pathway that my personas take through interfaces when interacting with a product.

Figure 43 provides a pre-review for the interactive prototypes which can be viewed in the Figma platform. URL: **https://www.figma.com/proto/8w9Bw6lQILPA6354hspz3W/Designing-an-Analysis-System-to-Track-Unusual-Behavioural-Patterns-of-Elderly-Living-Alone?node-id=3200%3A0&scaling=min-zoom&page-id=1%3A2**. You may login with your Google account. Or, you can check the prototypes via the provided short film scenario: URL: **https://vimeo.com/491499723**

All the human photos shown on the app design are used as design materials. They are properly cited in the section of Bibliography. Photos are created by pixelheadphoto digitalskillet, Rocketclips, Inc., Ollyy and aslysun.

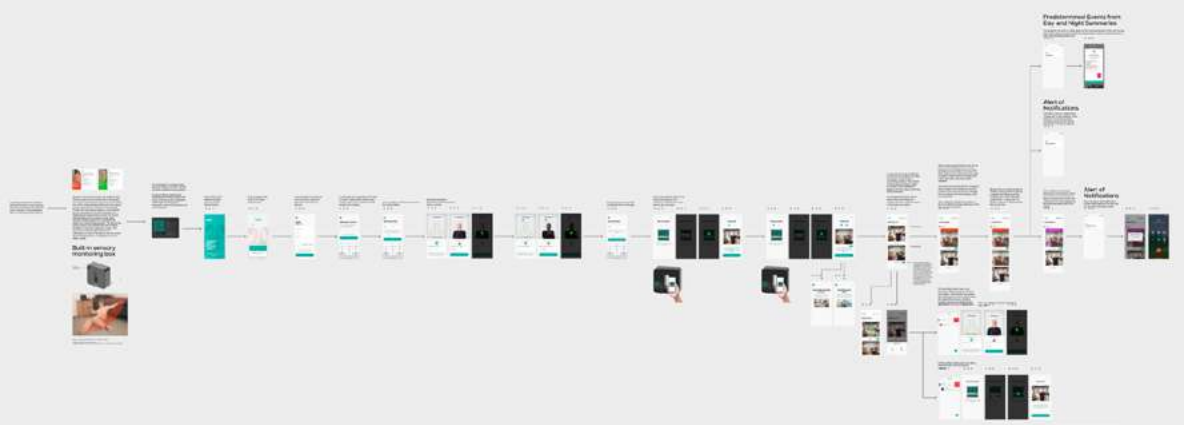


Figure 43. Interactive Prototypes for the Usafe App on Figma

The Narrative and User-flow

According to the story for the primary persona, Anna and secondary persona Erica, in Chapter 3, the prototypes allow the narrative to act out. Because Anna is a daughter who lives far away from her mother, Erica (the monitored elderly), Anna worries about her mother staying independently at home without care and support. Anna decides to use technologies to help her monitor Erica's daily activities and routine by using the Usafe sensory monitoring system (Figure 44) to monitor Erica's safety and health. The device has a built-in sensor and a camera, which can be easily installed on the wall or placed on a table. The device can accurately detect and send notifications to family members in real-time when abnormal behaviours or any emergency occur, as shown in Figure 45.

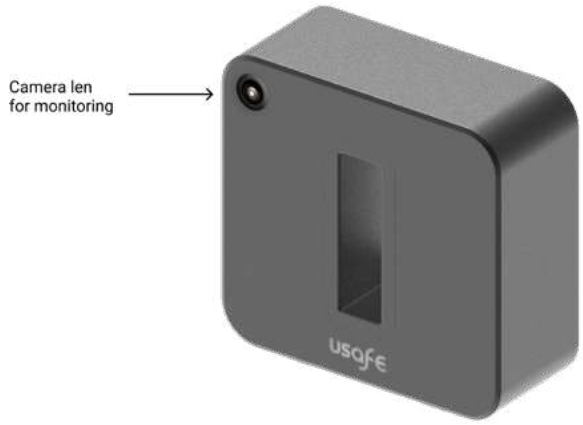


Figure 44. Built-in Sensory Monitoring System

Figure 45. Falling Down Accident (Image by WRGP)

The installation is quick and easy. Anna just needs to confirm that she has Wi-Fi in her mother's residential place. As Anna finishes installing and calibrating the monitoring box in one of their rooms, she needs to download the designated mobile app following the instruction sticker on the back of the monitoring box, as shown in Figure 46.

Figure 46. Instruction for Usafe

Figure 47

Anna lands on the Welcome Screen. She hits the Get Started button to the next screen.

Figure 48

Anna is asked if this is the first time using the app. If it is, she needs to sign up. If she is a returning user, then she can directly sign in to the dashboard.

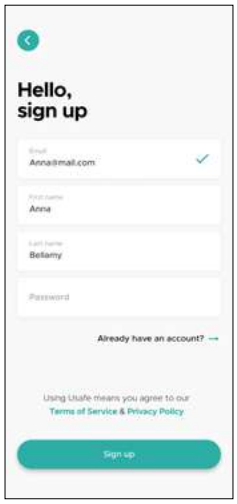


Figure 49

Anna is asked to provide her first and last name, email and password in the sign-up process.

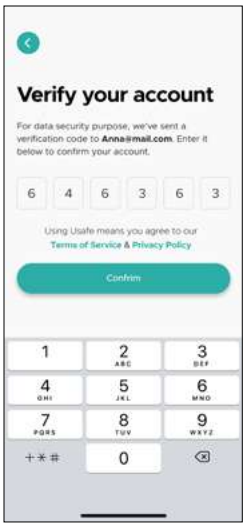


Figure 50

Protecting a user's data is a must. The Usafe system sends Anna a verification code for security.

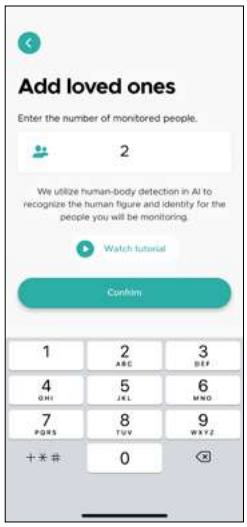


Figure 51

Anna is adding her loved ones to the Usafe system.

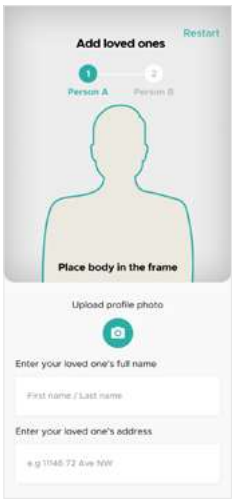


Figure 52

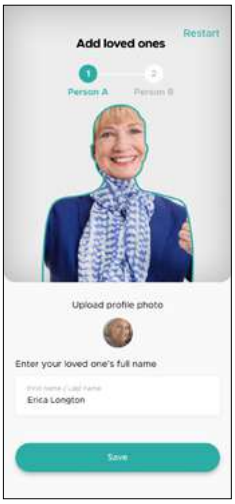


Figure 53

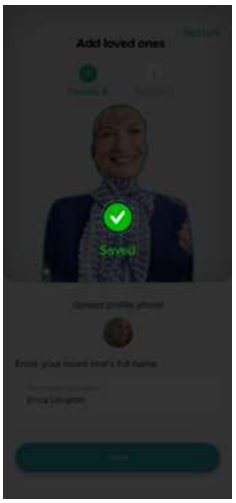


Figure 54

By providing the elderly's general information including full name and address. Usafe records them in the system. Now Anna is trying to add the first monitored elderly into the Usafe system. The one on camera now is Anna's mother, Erica.

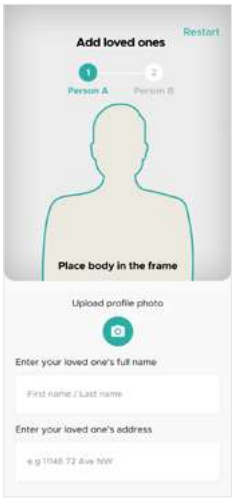


Figure 55

Figure 56

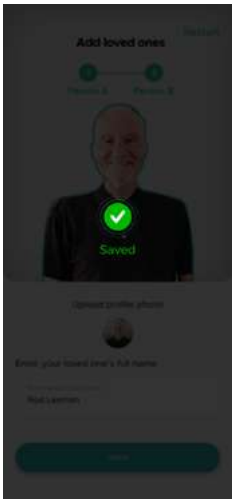


Figure 57

Now Anna is trying to add the second monitored elderly into the Usafe system. Not only can Anna buy a set of sensory boxes for her mother, but also she is able to buy and install another set of sensory boxes for another loved one, which is her uncle. So Anna's mother, Erica, gets a set of boxes in her home, and then Anna's uncle gets another set of boxes in his home as well. So Anna can monitor both of them through numerous boxes located at different places in one app. As you can see, Anna could add another person if needed after her mother.

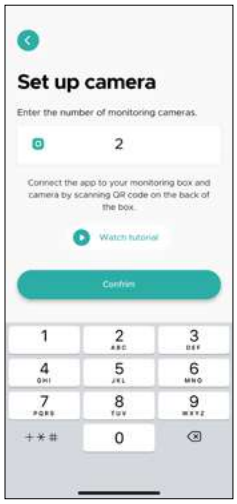


Figure 58

Anna is connecting the monitoring boxes to the app.

Figure 59

Anna scans the QR code for the first monitoring box to access the app.

Figure 60. User Scanning the QR Code

Figure 61

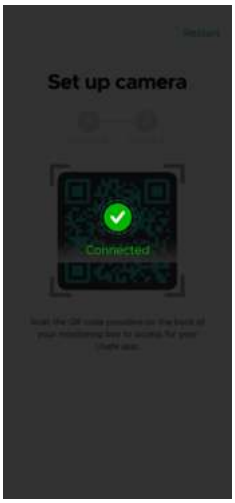


Figure 62

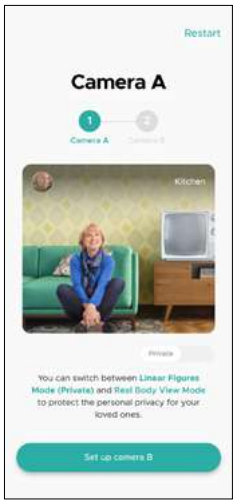


Figure 63

As the first physical sensory box is successfully set up, and Anna's mother is on camera, Anna can switch the live stream camera between Linear Figure Mode (LFM) and Real Body View Mode (RBVM) to protect the personal privacy for her loved ones.

Figure 64

Figure 65. User Scanning the QR Code

Figure 66

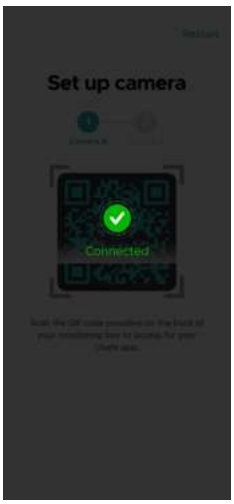


Figure 67

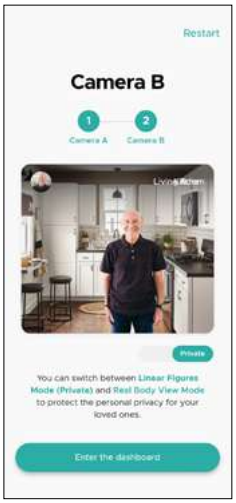


Figure 68

Figure 69

Figure 70

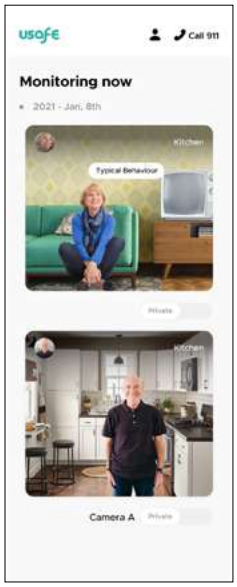


Figure 71

As Anna lands on the dashboard screen, she will find the live stream of the installed monitoring cameras. How many live-stream videos are shown on the dashboard depends on how many monitoring boxes Anna gets.

On the dashboard, Anna will be able to check her mother and uncle's daily activities at different areas of their home at any time.

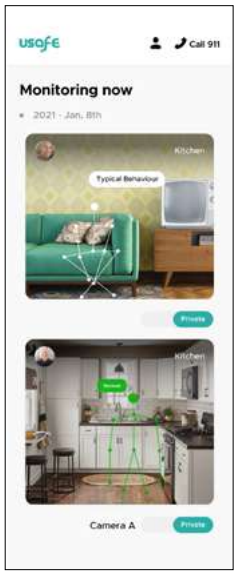


Figure 72

The Linear Figure Mode (LFM) can be turned on and off anytime as Anna wants.

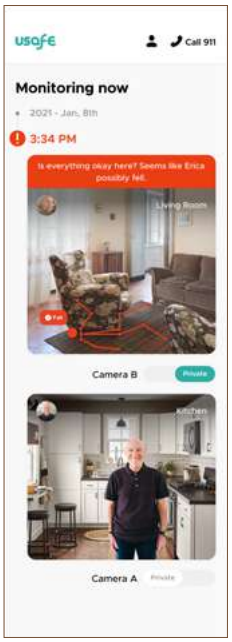


Figure 73

When an event happens (here is only for the status of Unusual Behaviour), a short description is provided on the top of the short video clip to review what is going on right now and compare next to the "live view" the panel is selected.

According to the chronological order of occurrence, the video monitoring panel for people suffering unsafe events will be moved to the top of the screen.

The AI detects and defines the status in terms of different human behaviours from the imageing informatics and the sensor.

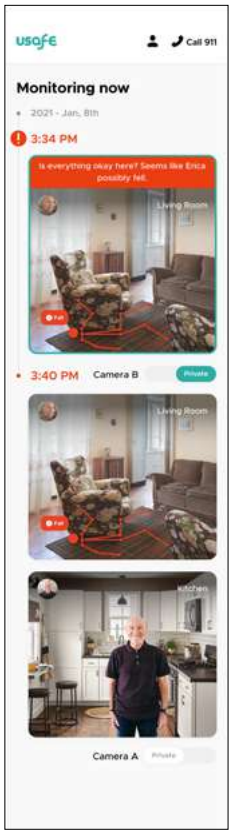


Figure 74

Because this is not an emergency, the event will send as a regular feed following by the first panel as a video clip marked with an “orange dot” for family caregivers to keep monitoring their loved ones.

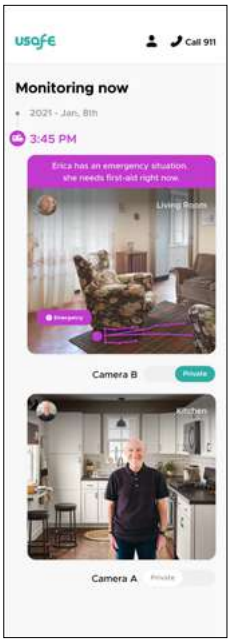


Figure 75

Suppose the situation continuously develops into an emergency. In that case, if the monitored person has not recovered, that means this situation turns out to be a possible emergency, and the lines will turn purple.

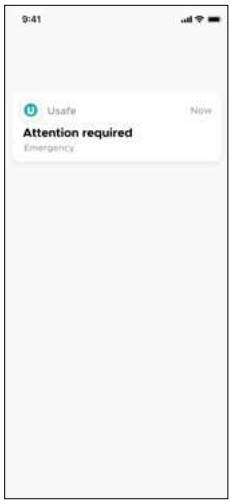


Figure 76

Alert Notification

Anna will get an alert notification on her mobile app, and she may call 911 for immediate help.

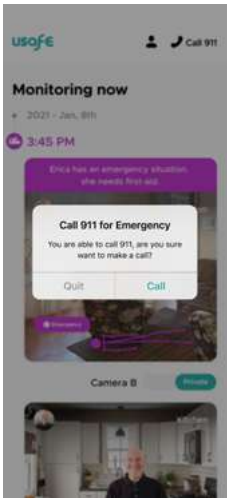


Figure 77

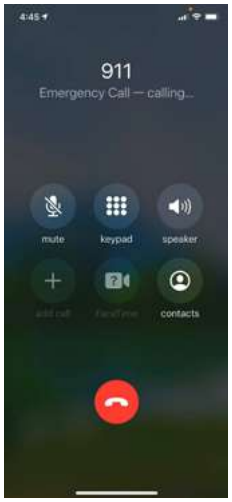


Figure 78

Usafe employs safety redundancy features in case of non-communication or other possible technology issues. For example, if after numerous emergency notifications are sent to the primary user (in this case Anna) and there is no appropriate response the Usafe system will take first aid measures. Because Erica's address was provided to the Usafe's remote monitoring team while Anna was trying to register and set up those sensory boxes, the team is able to call 911 to ask the hospital emergency department to send an ambulance to Erica's home right away.

Figure 79

Alert Notification

The alert is sent as a regular feed "Orange dot" to Anna. If her loved ones are behaving in unusual activities, she will still be notified, but no action is required.

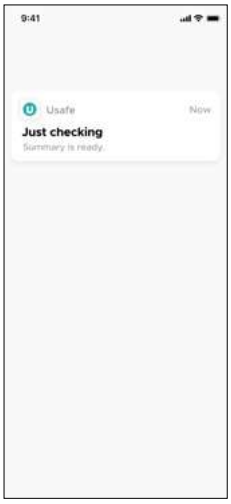


Figure 80

Predetermined Events from Day and Night Summaries

Anna will receive a daily report for the monitored person at the end of the day. The context of summaries could be like eating habits, leaving and monitoring home or falls, walk and sleep patterns etc.

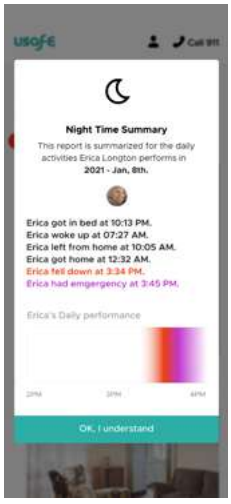


Figure 81

Anna is able to set her preferences for how and when to receive reports and updates within the app. She can decide to her reports daily or weekly. She is not able to turn off her reports until she shuts down all the sensory boxes, disconnects the app from those boxes and deletes her account in the app.

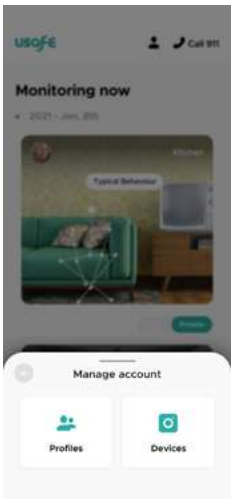


Figure 82

Figure 83

In the profiles screen, the users can add or delete people to and from the system. These people are usually the elderly that the users added during the registration process. Deleting function ensures the elderly private data is removed. Users can add more people anytime they want.

Figure 84

On the screen, users can add or delete devices from the system anytime.

4.5 User Testing and Feedback

User testing is an essential part of the User Experience (UX) design process. It typically consists of evaluating a product by researching it with your representative users. The form usually is one-to-one interviews conducted face-to-face by a qualified UX researcher (What is User Testing? 2020). Please note that this is just initial testing feedback and there would be more robust user testing through the app development process at each stage. Due to Covid-19 and limited time for my thesis research project, I invited three family caregivers who speak English to test the experience of using the interfaces for an initial user testing. Instead of having open-ended questions, I utilized a scale system to gather feedback. Several close-ended questions are needed to let participants share their thoughts. According to Vinay Raghu (2015), the system usability scale is a good tool to gather subjective feedback. The questionnaires with full results for participant A, B and C are shown in Tables 7, 8 and 9 in Appendices.

Based on my users' feedback, I realize they care about their personal information and how their data is used. The ideal interface should be simple to operate and safeguard against attempts to steal users' private information. Delivering such a design is typically framed as a trade off between usability and security (Sharma, M. 2021). On top of that, even though the Usafe system addresses the major problem of family caregivers about caring their loved ones, one of my participants still has some worries about the safety and health of their elderly parents. This is because they do not fully trust in using technologies. Instead, they believe that humans will influence the decision of the technology, which could be only used for assistance sometimes. Overall, my participants found it easy to use the Usafe app because the testing process made it easy for them to get what they expected through the modern style of the interface.

If the interface is easy to use, it is often less secure. If it's secure, it is often more challenging to use. This tradeoff is a myth. My participants' feedback reminds me to design simply and securely without compromising the quality of either. Here, UX designers play a critical role by ensuring that both technical demands and user needs are met (Sharma, 2021).

In many ways, My role is as an interpreter. I decipher technical requirements and make them understandable for users. I also exercise situational awareness by deciding when to focus on simplicity or sophisticated security measures. Balance is critical, but it can only be achieved by including all stakeholders from the earliest design stages (Sharma, 2021).

4.6 Summary

In this chapter, I not only clarified the design planning and steps, but I also identified the design opportunities to frame the design problems, prioritizing the elements about family caregivers, their elderly loved ones and specific technologies. Locating design opportunities has been useful in expanding my design thinking and addressing problems. It allows me to focus on exploring the objectives and creativity of visual communication by framing the issues.

I used User-Centered Design (UCD), a design methodology that is not limited to interface design or design techniques, so I included the users in aspects of the interface prototype design. Not only that, but I also focused on testing usability, user characteristics, usage scenarios, user tasks, and user flow. Through a multi-stage problem-solving process, I analyzed and hypothesized how users used the product and conducted user testing in real-world scenarios to validate and correct the app. I admit that I might not fully understand the user's initial usage and learning curve in a practical way. Such testing validates the UCD to help close the loop. Finally, I optimized the app based on my observations of what users could want and need to do with the product, rather than forcing them to change their habits to fit the product.

Chapter 5: Evaluation and Reflection of Designed Response

Chapter Introduction

In this chapter, I will make a comprehensive evaluation and review of my design and the research that supports the decisions made. Design is about problem-solving, as we know. Design lies in looking deep into the users' desires and societal needs to devise innovative ideas and responses that offer usefulness and help to address identified issues. To address the issue, we should first thoroughly appreciate the need to have a consistent view of it throughout the design process. First, I ask what problems I have worked to address for my target users in this project? What kind of needs, goals did I meet for them?

Secondly, I will undertake a review of the completed Information Architecture. Each feature on the screen should be styled, scaled or otherwise distinguished by its particular significance. Considering the defined users and their priorities, the most relevant design issues would be listed. Do these priorities represent the visual hierarchy of the numerous elements on the screen?

For the User Interface (UI), I will evaluate if the UI guides the user's focus to where they need to go and what they need to do. Is the design straightforward (not too many colours, pictures, fancy patterns, or formats that do not add value), and transparent (does it use visual symbols to direct the consumer to his/her goal)? Are the primary behaviour and important details visually separated from other information? What is the minimum amount of UI that enables content to be identified and transmitted effectively to the users? Is the layout aesthetically pleasing?

For the design patterns, according to Jacob's Law, users spend most of their time on other sites. This means that users prefer your site to work the same way as other sites (Yablonski, 2020). This means using solutions that are already known to resolve a specific problem effectively. I will evaluate the visual elements (menus, searches, text areas, dividers) considered in design If there is any common patterns between these elements?

5.1 Problem Space

A. Problems Targeted by the Design

The Usafe app attempts to address the problems faced when taking care of the elderly. In most cases, elderly live alone as they wish to retain their independence. Consequently, they may be involved in some form of accident, or they experience mental distress. At that age, some elderly start experiencing the cognitive effects of ageing that results in more physical and mental health problems among their population. According to Hassen, Dghais & Hamdi (2019), mobile health technology and services for elderly and disabled persons are being developed and implemented providing low cost and secure IoT systems.

As the older population ages, their muscles and bones usually begin to weaken, they lose their eyesight, hearing, and their mobility is limited. Moreover, many seniors have dementia and Alzheimer's disease, which affects close to 10 percent of individuals aged over 65 years and increases to 32 percent to people who are aged more than 85 years (Pardue-Spears, 2018). Therefore, due to the physical or mental conditions, close to 60% of all individuals above 65 require assistance with a single daily living activity. As such, there are benefitst to using modern technology to monitor them so they can be safe (Living with Disability series, help with activities of daily living for people with a disability, 2010).

B. Whether the Design Meet the Users' Needs, Goals, Limitations, and Context of Use

The Usafe app is designed to meet the users' needs, goals, limitations, and context of use. The effectiveness of the app can be seen in its design. First, as the feedback tables show from my user testing results in the Appendices, the average satisfaction score of all tables is above 3.0 out of 5.0. It is obvious that the app is user-friendly, which means that it can be operated efficiently. The ease of use sees how the graphic interface has been designed because the system uses sensors as shown from Figure 68 to Figure 75 in Chapter 4. Such factors have been researched by Cornet et al. (2020) to evaluate an app for the elderly.

All that is needed is to install sensors and connect them to the app. When that is achieved, anytime a senior using the Usafe system encounters an emergency (e.g. a fall, heart attack), a push notification

should appear on the app, highlighting the senior's condition at the moment as shown in Figure 76, Figure 79 and Figure 80 in Chapter 4. On the dashboard screen, there is a button to call 911 as shown in Figure 75 and Figure 77 in Chapter 4. Other numbers, such as that of neighbours and nurses, can also be linked to become part of the emergency notification system.

C. User's Life Safety is Enhanced By Using the App

Some elderly are losing vision, and they could hit obstacles in their homes, and this could result in physical injuries. If a severe injury occurs, such as a broken leg or hip, it could be impossible for the individual to reach the phone to call 911. The Usafe app takes care of such a situation since it has a button that could be pressed by family caregivers to create an alert.

5.2 Information Architecture

A. The Most Important Things to Address in This Design Problem

Among the things to consider while addressing the problem of apps include making the User Interface (UI) simple, intuitive, and convenient. For instance, the text displayed on the Usafe app should be large enough to be legible, and adjustable as needed. The app should also avoid complex features as well as unnecessary elements (Mózer, 2019). Mobile devices that have a simple design can attract users since they do not need complex interaction. According to Harte (2017), the elderly require simple apps to operate. Since the Usafe app should also be concerned with motion detection, there is a need to calibrate the app to make it possible to detect abnormal behaviour.

The use of sensor cameras is essential in monitoring the elderly. The camera should also have a night vision display and a motion tracker, an accelerometer, a compass, and an altimeter. It is also essential to resolve the older adult's need to call for emergency medical help if necessary. That problem could be resolved using a key with a button meant for that purpose.

B. Efficacy

The visual hierarchy of the different elements on the screen reflects those goals. I have designed several characteristics of the app that include the size, contrast, colour, texture, and style, among others. Based on the UI design of the app, a user is informed concerning what is going on. The visual hierarchy used has reduced the amount of effort needed for the user to engage with the product. According to Kingston (2020), colour and contrast are used to make objects stand out. That concept has been applied in the app broadly.

5.3 User Interface (UI) Design

A. Whether User Interface (UI) Guides the User to Where He/She's Trying to Go

The User Interface (UI) does a good job of guiding the user where he/she is trying to go. That is evident in the way the app has been created. For instance, when installing the app for the first time, a user is guided on how the installation is done through an onboarding procedure. During the process, one can see that UI has been designed in a way that makes it familiar as well as learnable, even if being used for the first time, as one of the participants felt that he was very confident using this app (Appendix, 3.0. User Testing Feedback and Scores) . The Information Architecture has also been structured in such a way that a user can easily locate the information that they require to carry out their intended goal. The app has also been designed to call emergency services through the app, and that makes it convenient.

B. Is the Design Simple and Clear?

The design of the Usafe app has been made to be simple and clear. To begin with, the logo is simple and easy to read so that it can be easily be selected among the apps on a device. Additionally, the app does not use a lot of colours. A total of nine colours have been used, so it is not confusing. Additionally, the Metropolis font has been used since it provides the app with a modern as well as geometric feel.

The UI in the app can intelligently guide a user through the products since it makes it feel familiar as well as learnable even if they are using it for the first time. Based on the design, the controls of UI have a consistent colour in all the shapes that they take. Therefore, it should not be confusing for a user. The icons that have been used are few, and each one of them represents a given meaning or activity. Through those icons, it is possible to understand the certain alert notification such unusual behaviors and medical emergencies which elderly could perform, since they become very obvious once they are understood for the first time.

C. Isolation Effect

According to Chakraborty (2017) and Kerti (2018), the Isolation Effect is a phenomenon where individuals value something different depending on whether it is perceived in isolation, or it is next to an alternative. Isolation Effect is present on the app, and it can be seen in services that the app offers, such as daily or monthly updates providing the general wellbeing of loved ones. Moreover, the app should have push

notifications that appear on the user's screen. Additionally, the notification icons have to appear different from each other since that is how they can be differentiated.

D. A Minimum Amount of User Interface (UI) That Should Allow the Content to Be Found and Effectively Communicate to the User

According to Ball (2016), Occam's Razor advises individuals to seek a solution that is more economical and that the simplest explanation is usually the best one. Therefore, I use a minimum amount of UI that should allow the content to be found and effectively communicate to the user. The UI does not have unnecesarry complications that might divert the attention of users. It focuses on the key actions that the app has been designed to achieve. That means the amount of UI used is enough to make the app usable.

E. Aesthetic Usability Effect

According to Chakraborty (2020), the Aesthetic-Usability Effect is a phenomenon where individuals perceive designs that are more aesthetic and easier to use compared to those that are less aesthetically pleasing. I believe that the design of the Usafe app is aesthetically pleasing since it has been designed with graphics for a modern look, especially for the use of soft shadows, which means the UI looks more in-depth. In general, the shadows make the UI elements more "Clickable," and they help differentiate the hierarchy between contents. Moreover, the images and colours which are used give it a high-definition clarity look.

5.4 Design Patterns

A. Components Seen in the Design

There are several components that can be seen in the design. To begin with, visual design can be seen in the design, colours, and icons. The name of the app, Usafe, is a brand in itself. Moreover, there are notifications of the app such as that showing the number of people who are monitored using the app, the one showing the activities, emergency, and manage accounts, among others have been designed in different ways since they perform different functions.

The menu of the application has also been designed to show the components that are required to take action using the app. What that means is that the menu is the centre of the application, so it is where all the shortcuts can be found to direct a user to where information can be found. Additionally, the design has a search box that can be used to reach the needed functions. That way, it offers quick access to such information.

The application also contains the fields where a user can enter the required information. For instance, when registering, one is required to enter the details as requested by the app since the information is needed for security purposes. Additionally, there are dividers in the app that separates the texts from the user information. In most cases, the divider is a space displaying the colours of the general theme.

B. Common Patterns

The common design seen is the general theme of the app. As shown in the Figure 85 next page, that is the primary colour named Light Sea Green for the Usafe App, which is seen everywhere except in situations where there are notifications. There is a need to have uniformity because it helps the users understand a normal procedure and one that requires special attention. When there is a colour representing the general theme, it becomes easy to determine when user input is required. However, in situations where the elderly being monitored require attention, the app should turn purple to catch the attention of its users. Such characteristics make the usability of the app easier to use.

Information entry areas and forms on the Usafe system are also straightforward and predicable to use. They have been designed to collect the user input through queries that the user is required to input. In the app, there are text fields that collect information; after them information has been gathered, it is contained

in the app to help monitor the elderly and display the necessary information as intended.

Figure 85. Primary Colour of the Usafe App

5.5 Summary

A. What I Have Learned From Designing For The Elderly

In my research I have been reading about ways to improve caregiving for elderly living independently. I cannot help but think about getting the elderly service easier by involving creative technology and the Human-Centered Design (HCD) mindset. My path began and was embedded in learning, compassion, and development. That was the moment I struggled for my ego. My graduate thesis study was packed with anecdotes, memories, successes and claims. Yet I am trying to learn, understand, and be informed about my challenges. My project puts my elderly relatives and me together, helps us feel heard and less isolated. I have been empathetic about my elderly participants and their caregivers. I try to start my design process by learning to perceive people through their eyes and catch a fragment of what they are doing. My graduate thesis project helped me cultivate compassion, friendship, and affection. I got to chat, to communicate, and most importantly, got to work with my users for helping to refine my growth.

B. What I Have Learned From Designing A Caregiving App

When creating an app, it is essential to do the necessary research since it is the only way one can focus on a project that addresses a societal project or strikes a chord with the audience. It is also essential to identify the target audience. In this case, the audience is the elderly living alone or in nursing assisted facilities.

Before the design begins, all the factors or situations that the app intends to address should be considered since that is the only that the problem is going to be resolved. From there, a user interface should be designed that could most likely support individuals who are less conversant with technological devices. In this case, several factors should be considered, such as the quality of the user experience that is intended, the complexity or simplicity required in the app, and the frameset for the development of the application.

Attention needs to also be paid to the design aspect of the app. For instance, there should be no unnecessary elements. The information that the app uses and communicates should be seamless. There should be a minimum input field, and since this is a serious app, there should be limited use of notifications. The technical features of the device should be decided early to enable the proper design of the project.

In this case, Usafe has been designed in a way that works to address the problems of elderly. Therefore, there was a need to come up with a design that takes care of the user needs, goals, limitations, as well as the context of use. As such, there is a need to come up with a design that could resolve the problem. Achieving that should require coming up with a proper app with excellent design patterns.

Chapter 6. Conclusion

As the conclusion of my research, this chapter provides a review of my research study results, and the challenges and limitations I faced during the project. I conclude with a focus on the future possible works needed for this research field. Recommendations are provided based on the outcomes of the research. These components allow me to consider more future design opportunities and increases the likelihood of improving the performance of a caregiving service and its applications.

6.1 Research Findings

AI Technology-enabled Interventions Supporting Families to Take Better Care of Elderly Parents

Many of us have been staying at home since the beginning of the COVID-19 global pandemic. During this time we have increasingly used video conferencing applications to remain connected to each other for work or school and streaming sites to pass the time. However, home isolation can be extra challenging for older adults, particularly those who do not have advanced digital literacy skills. For instance, it may be challenging for them to book a medical appointment, deal with e-banking and order food supplies. They need help to stay in contact with each other. It is also essential to ensure that older adults connect with their family members.

My research notes that adult children living far away from their parents can find it challenging to take care of their parents. Innovative technologies are one means of addressing this challenge. According to Matin, & Islam, 2012, the Wireless Sensor Network (WSN) utilizes battery-powered wireless sensors for monitoring atmosphere parameters such as temperature, moisture and light strength, and micro-level events, such as walking and sleeping, utilizing electrical devices, for example, in the realm of assisted living technology. Assisted living technologies use a network of smart home-connected equipment intended to support the elderly. They integrate with a motion sensor and a touch sensor that operate together to provide real-time data. These technologies can help in developing safety/well-being monitoring applications with AI accounting for clinical and ethical considerations. The resultant solutions can strengthen treatment, support independent living, and enable elderly adults to stay healthy

(BMC Geriatrics. 2020).

AI Technology Benefits for the Global Caregiving Landscape for an Ageing Population

As the ageing of the global population increases and the task of caring for the elderly becomes more complex, intelligent caregiving has become a promising and feasible solution. While the service level is improving significantly, the ethical issues involved in intelligent elderly care also bring various risks and hazards that cannot be ignored.

As socio-economic development increases the average life expectancy of the population, the ageing challenge becomes more significant (China Civil Affairs, 2017). Population ageing is a severe challenge for both developed and developing countries. And this is complicated because the demographics of developing and developed countries differ significantly from each other. In line with global developments, for example, the number of older adults in China has increased dramatically, and the ageing of the population is also on the rise. How to ensure healthy living and improve services for the elderly has become a major social challenge that needs to be addressed. At the same time, the number of older adults living alone is also on the rise, resulting in a further increase in the elderly dependency ratio. With the gradual improvement of living standards, the demand for multi-level and diversified services for the elderly continues to grow, making the need for elderly care increasingly urgent and the task increasingly difficult.

In the face of the increasing demand for elderly care, traditional care methods and systems cannot meet the growing demand. The introduction of AI technology into the elderly care industry has made intelligent caregiving, a compelling means to help alleviate the challenges. Implementing AI in healthcare has greatly improved the efficiency of caregiving service and laid the foundation for improving the quality of caregiving service (BMC geriatrics, 2017). Therefore, the new mode of intelligent elderly service with AI technology becomes a promising and feasible solution to achieve the goal of building a home-based, community-based, institution-supplemented, and medical-integrated elderly service system (China Civil Affairs, 2017).

The breakthroughs and rapid development of AI technology have profoundly changed people's life and work styles, providing support and new ways to comprehensively resolve the growing challenge of elderly care. AI technology, while serving human society, has also created many contemporary ethical issues and

aroused widespread concern. The ethical problems of intelligent elderly care services are also common to general ethical issues of AI. The main manifestations are: the ethical problems of protecting the rights and interests of the elderly care recipients in various aspects of their personality and dignity.

Ethical Concerns Related to Privacy & Security of Elderly Users

The rapid development of AI has brought profound changes to society. While AI brings economic value and social benefits, it also creates ethical risks. As a significant application of AI in ageing care, intelligent caregiving is naturally faced with ethical issues.

The Universal Declaration of Human Rights states: “No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honour and reputation. Everyone has the right to the protection of the law against such interference or attacks”. Among them, privacy is seen as a right and a widely recognised human value (American Journal of International Law, 1983). To better provide comprehensive ageing care, smart care systems collect large amounts of user data. In general, the private data collected from daily activities of the elderly is proportional to the total data collected. The more data that is collected, the more private data is collected, and the higher the risk of compromise. And, since smart care is often used in the personal space of the care recipient (e.g., the bedroom), more data is private, the risk of compromise is further increased. The real-time collection, transmission, and video data analysis will inevitably lead to concerns about privacy leaks. The introduction and application of the corresponding intelligent elderly monitoring system products have been widely questioned. The possible leakage of elderly users’ data, while violating their privacy rights, also dramatically increases the level of potential harm. The potential leaking of this data, which contains more and more complete user information, increases the possibility of malfeasance, which is even worse for the ageing population, which is already vulnerable to fraud.

Some ethical considerations include:

a. **Ensuring the Right to Know:** Improve the usability and reduce the complexity of intelligent care to ensure the right to know the personal privacy of elderly care recipients. At the design level, we should emphasize the simplicity and ease of operation of intelligent care. At the delivery stage, we should consider the progressive use of the Human-Body Detection (HBD) from simple to complex and the strategy of phased opening up of functions.

b. **Balancing Caregiving with Autonomy:** The balance between caregiving and the autonomous will of the elderly is difficult to grasp. We should put the safety of the user in the first place, and fully respect the autonomous will of the elderly under the premise of ensuring the safety of the elderly users. Technically, how to correctly judge crisis situations and intervene when elderly users are unable to make decisions or when autonomous decisions threaten the safety of the elderly; design-wise, how to strike a balance between the elderly's sensitivity to privacy and the family caregivers' right to know the elderly's physical condition, and how to respect the elderly's privacy to the greatest extent possible while safeguarding the elderly's health. Careful consideration is needed to achieve this.

c. **Respecting Group Differences and Ensuring Social Equity:** At the design level, designers should comprehensively consider cost and usability, and design different appearance and interaction strategies in order to meet the needs of groups for smart care products. At the level of social responsibility, support the research and promotion of smart care products, integrate some smart care products into the social care system, promote smart care products to the market, and accelerate the upgrading and transformation of the industry in order to improve the acceptance of users in the actual use process. In addition, the smart care market should be regulated and controlled as a social resource to better promote social equity.

Recommendations for Designing the Artificial Intelligence (AI)/Internet of Things (IoT) Ecosystem for a Remote Monitoring Caregiving App

When designing a remote tracking caregiving app, my first concern was to make the user experience navigable and highly usable. I worked to put the concept of "people-oriented technology" into practice, combining the precision of technology with the warmth of humanity to make users feel that this remote

monitored caregiving application is a useful, loveable and affordable smart senior care application.

First, from the technical aspect, the front-end camera, online cloud infrastructure and AI-related capabilities were my key considerations. The front-end camera should be a normal camera or an AI-capable camera. Although the cloud can provide rich computing and storage resources, it is more important to provide a series of standard AI services. The building blocks of home video monitoring ecosystem includes; sound and image monitoring standardized scenes, human shape recognition, fall recognition, face comparison, sound detection, etc. These capabilities are optimized for home monitoring scenes to provide custom scene capability interfaces to meet all scene requirements. This is why the capabilities and strengths of these technologies can be fully reflected in the use of fall sensors and motion sensors.

Typically, 50% of people over the age of 65 are unable to get up after a fall, and prolonged lying on the floor can lead to complications and possibly death from dehydration (Pardue-Spears, 2018). The Usafe sensor sends a signal to the smart home control centre, and the control centre opens an alarm to remind the elderly that if they cannot turn off the alarm within 30 seconds, the alarm message will be sent to a relative or the relatives can immediately contact the rescue agency to carry out first-aid.

Second, at the level of design aesthetics in my graduation project, since the elderly (the secondary users) are an indirect group, they do not have the opportunity to directly interact with the interface. So my primary audience is the family members who take care of their senior loved ones. It is important to simplify the design of the interface in order to achieve more effective and accurate communication during caregiving, this includes:

a. Large fonts and contrasting colours are essential.
b. Individual screens should be designed with as few visual elements as possible.
c. All icons used in the app and physical devices should be easily identifiable.
d. Interface elements, such as menus and buttons, should be easily distinguishable from text.
e. Graphics and clickable icons should be clearly distinguishable.

Considering that most of my primary group of users is middle-aged, they are not that sensitive to digital applications because they did not grow up with technologies. Thus, most of them don’t get used to using

new technologies such as digital devices, automation and the internet. It is challenging to deal with numerous control centres and buttons, and they may be confused and intimidated if problems arise. The system I designed should be easily managed from a single operating platform.

6.2 Limitations

Negative Impacts Brought by Artificial Intelligence (AI)

There are two main limitations which should be significantly considered. First, an increasing amount of people choose to not trust AI. Once reason why humans do not trust the use of AI is because they do not trust people or things that make decisions for them. AI lacks the characteristics we use to gain trust (McFarland, 2020). The biggest obstacle to the development of AI is the lack of human trust. Humans are reluctant to trust machines because the cold rational mind of AI cannot understand human emotional thinking and the ethical and moral norms of humans. We find it hard to trust intelligent processing models to make “humane” judgments when faced with ethical and moral choices. In the end, humans are different from AI. And human beings are inherently superior. Second, The development of AI has played a significant role in improving human efficiency over the past 10 years, changing the way we work, and even helping to lead the direction of human development, however, there have always been negative impacts of AI. An issue to reflect on is the increasing unemployment rate due to the use of AI technology. Although there are still many jobs in society that are relatively untouched by AI under the influence of new technologies such as AI and the related IoT, jobs in industries ranging from assembly line factories in manufacturing to truck drivers in the transportation industry have been found to be invariably challenged by the threat of AI transformation (Philips, 2018). As payment systems, computer vision, and natural language learning become more prevalent, jobs such as parking attendants, waiters, cashiers, cleaners, restaurant managers, and even restaurant chefs may be replaced by AI. For example, in my case, the use of home automation for health monitoring and care could result in the loss of jobs for licensed healthcaregivers, so all we can say is that there has been no comprehensive and deep moral consensus on the widespread use of AI yet, but it is an inevitable trend.

Missing Face-To-Face Interaction Because of the Use of AI

I believe that the widespread use of AI could subconsciously hinder human-to-human emotional communication. As family members use intelligent care systems to monitor the health and safety of the elderly, the emotional connection between them may fade over time due to physical distance, possibly resulting in growing farther apart, which can lead to unnecessary misunderstandings. We should understand that the new technologies are only intended to improve the quality of our lives, however, we cannot replace them. If we rely on the convenience of new technology without thinking about it, we would

lose the value and meaning of why this technology exists.

Challenges with Cross-Generational Communication

It is always a challenge for me to communicate with the elderly. This was especially true for my graduate school project. When interviewing them, I needed to consider many factors, such as if it is comfortable and acceptable to elderly participants when talking in order to get the information I need. In addition, I learned how to build trust and create a good dialogue with ageing participants without hurting their privacy. So what are some reasons why I had difficulty communicating with my elderly respondents when I tried to collect data? First off, I have found that hearing loss affects the transmission and understanding of verbal communication. This decreases the accuracy of message delivery. Secondly, some respondents were slower to respond, due to changes in hearing, memory, etc., consenquently, the respondents' ability of receiving information and sensitivity to the external world is reduced, resulting in communication difficulties. Thirdly, organizing a cross-generational conversation requires me to listen to what my elderly participants say patiently, accept different opinions, speak about my questions clearly, and consider what specific topics the elderly could receive. Furthermore, due to Covid-19, it was more challenging to interview my research participants as I had to meet them online by Zoom rather than face-to-face.

Challenges with Designing a Remote Caregiving Application

My design is committed to be user-friendly. In addition to the involvement of certain AI technologies, when designing an application to remotely monitor elderly people living alone, accuracy of information delivery is critical. This is reflected in the use of straight and simplified UX language, as well as the appropriate use of visual components when communicating accurate information. Furthermore, when I was trying to design the settings of the caregiving application, I carefully considered maximizing privacy for seniors. This could provide elderly users more trust in new technology applications.

Affect of Covid-19 and Limitations of MDes Level Study

Ideally I could have run in-person usability testing sessions with my participants to test the initial design prototypes that I created. It is impossible to fully observe what I want to learn for improving my design through online means. Also, my research project is a limited MDes level study that does good work but needs much more research, work and refinement to move things forward.

6.3 Recommendations for Future Research

Data obtained from the literature review and analysis of the interviews and surveys noted that with the growth of new technologies, including Artificial Intelligence (AI) and Internet of Things (IoT), there is a strong need for a new approach to technology. At the same time, we still have a lot of room for imagination based on these existing benefits. In terms of remote monitoring of the health and safety for the elderly, for example, we are not only reaping the benefits of the technology, but also the opportunity to establish a systematical framework and standards for an effective and beneficial elderly care.

The establishment of an elderly remote wireless monitoring system could help to alleviate the shortage of medical resources caused by the ageing of the population, and by means of this system, the relevant personnel, including relatives or guardianship centres, could be able to keep abreast of any sudden changes in the physical condition of the monitored elderly. And through video interaction, they might be able to further understand the detailed condition of the monitored elderly, make appropriate medical recommendations, and establish a good framework and standard for elderly care and database for medical diagnosis.

In context, you can see that my future research direction is not just about the interaction between technology, applications and users, but also an intersection of technology and service design. In terms of these considerations, there are several application prospects that should be considered.

a. Whether this framework can properly monitor the lives of elderly people living alone and can allow the elderly to protect their privacy.
b. If the framework can be applied to nursing homes and related industries, then it might greatly benefit the service and management of the elderly.
c. For elderly people living alone, the successful implementation of the framework has alleviated their concerns about their health and safety.
d. For families, it relieves the burden and stress of caring for the elderly parents.

Data Regulation and Data Ownership

One of the future recommendations I would suggest is for stronger regulation of data ownership between the Usafe healthcare administrative team, family caregivers and monitored elderly users.

As Naveen (2019) noted, the government regulates data ownership to avoid privacy breaches and guarantee that businesses are responsible while using new technology. Established companies gather data from their consumers to continue to improve goods and formulate strategies. Aggressive data gathering, on the other hand, may be detrimental to consumers. This is because these businesses are capable of manipulating their consumers via the usage of sensitive data.

From this, we can see that the Usafe healthcare team can collect data from monitored elderly users within the Usafe system, but they do not own the data while providing their service. The data ownership should belong to the monitored elderly users.

Self-contained or Distributed Model

Cloud computing may make the data of monitored elderly and family carers more secure. However, like with most services in healthcare, businesses may need to continue to monitor data security after selecting the appropriate provider and signing a binding contract. According to Jonah (2018), most of the experts of Artificial Intelligence (AI) and Internet of Things (IoT) agreed that these days, moving healthcare related data to the cloud is a step up for security.

“Cloud based solutions have matured to a point where they are more secure than local server solutions alone,” said Hector Rodriguez in 2020, Microsoft’s Worldwide Health chief information security officer. “The reality is that these solutions, when properly integrated, should and do strengthen an enterprise’s overall cybersecurity posture by adding additional layers of security and monitoring.”

Of course, this does not imply that cloud solutions are inherently more secure than local ones. Many additional variables have a role, including the calibre of the team engaged. However, since a cloud provider can concentrate only on security, while an in-house team is responsible for a variety of tasks, they have an edge.

Expansion of the System

A wearable device could provide further valuable information concerning the health of users, allowing family caregivers to not only monitor their loved ones at home but also track their safety when the elderly leave the house. This would expand the range and possibility of support that Usafe could provide.

Possible Future Engaement

As a result of the iterative process of design and usability testing, I have identified some effective methods of implementing the home-based monitoring system, not only by increasing the shareability of elderly health information among caregivers, elderly loved ones, and the Usafe healthcare team, but also by tailoring design to the possibilities and limitations of mobile health for this segment of users.

Therefore, user interface design and acceptance testing are critical for health and safety monitoring systems targeted at elderly people who live on their own in their own homes. I would want to continue to utilise the user-centered design approach in the development of the Usafe system, engaging family caregivers in the usage of the app and providing feedback to me via the use of co-creation techniques in future research.

Future Iterations and Features

Many places and components make up the Usafe healthcare system: the Usafe mobile app, physical sensory boxes, the back-end user operating system of the Usafe healthcare team, and first-aid emergency clinics are all part of the system. So not only does the Usafe system need mobility, but it also requires the ability to interact and cooperate with individuals who are located in various geographical areas. Mobile devices meet this requirement by providing a variety of communication options, including voice and video calling, texting, e-mailing, multimedia messaging, and video conferencing, among other things. Additional integration possibilities include incorporating features and functions into the Usafe mobile application and back-end user operating system for the Usafe healthcare team. Therefore, when family caregivers face emergency conditions such as a dead mobile phone or an inconsistent signal, the Usafe healthcare team may be able to react more promptly and efficiently, perhaps saving the lives of monitored senior users. However, when an actual emergency arises, family caregivers may use these capabilities to convey their requirements to the Usafe healthcare team in a more precise manner.

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Appendices

1.0. Ethics Application

Notification of Approval

Date:	October 5, 2020
Study ID:	Pro00103145
Principal Investigator:	Yihao Zhang
Study Supervisor:	Aidan Rowe
Study Title:	Enable elderly suffering from physical chronic illness to stay longer at home by tracking and analyzing unusual behavioural patterns with the intervention of Artificial Intelligence.
Approval Expiry Date:	October 4, 2021

Approved Consent Form:	**Approval Date**	**Approved Document**
	2020-10-05	Consent Form-Elderly Participants
	2020-10-05	Consent Form-Expert Participants
	2020-10-05	Consent Form-Relatives Participants
	2020-10-05	Consent Form-Adult Caregivers Participants

Thank you for submitting the above study to the Research Ethics Board 2. Your application, including the following, has been reviewed and approved on behalf of the committee:

- Chat Site Letter of Initial Contact-Elderly, Version 6, September 22, 2020;
- Chat Site Letter of Initial Contact-Experts, Version 3, September 22, 2020;
- Email Letter of Initial Contact-Relatives, Version 4, September 22, 2020;
- Chat Site Letter of Initial Contact-Adult Caregivers, Version 3, September 29, 2020;
- Online Survey for Relatives of Elderly, Version 2, August 27, 2020;
- Interview Questions for Elderly Participants, Version 2, August 27, 2020;
- Interview Questions for Human-Computer Interaction Expert Participant, Version 2, August 27, 2020;
- Interview Questions for Artificial Intelligence Experts Participant, Version 1, August 27, 2020;
- Interview Questions for Health Aging Experts Participant, Version 1, August 27, 2020;
- Interview Questions for Adult Caregivers Participants, Version 3, September 29, 2020.

Approval by the Research Ethics Board does not encompass authorization to recruit and/or interact with human participants at this time. Researchers still require operational approval as applicable (eg AHS, Covenant Health, ECSD etc) and where in-person interactions are proposed, institutional and operational requirements outlined in the** Resumption of Human Participant Research - June 24, 2020 **must be met.

Sincerely,

Ubaka Ogbogu, LLB, BL, LLM, SJD
Chair, Research Ethics Board 2

Note: This correspondence includes an electronic signature (validation and approval via an online system).

UNIVERSITY OF ALBERTA

Date: October 6, 2020 1:45:54 PM Print Close

ID: Pro00103145 View: 1.1 Study Identification
Status: Approved

1.1 Study Identification

*All questions marked by a red asterisk * are required fields. However, because the mandatory fields have been kept to a minimum, answering only the required fields may not be sufficient for the REB to review your application.*

Please answer all relevant questions that will reasonably help to describe your study or proposed research.

1.0 * **Short Study Title** *(restricted to 250 characters)*:
Designing an Analysis System to Track Unusual Behavioural Patterns of Elderly Living Alone

2.0 * **Complete Study Title** *(can be exactly the same as short title)*:

Enable elderly suffering from physical chronic illness to stay longer at home by tracking and analyzing unusual behavioural patterns with the intervention of Artificial Intelligence.

3.0 * **Select the appropriate Research Ethics Board (***Detailed descriptions are available at here***):**
Research Ethics Board 2

4.0 * **Is the proposed research:**
Unfunded

5.01 * **Name of local Principal Investigator:**
Yihao Zhang

6.0 * **Type of research/study:**
Graduate Student

7.0 **Investigator's Supervisor***(required for applications from undergraduate students, graduate students, post-doctoral fellows and medical residents to REBs 1 & 2. HREB does not accept applications from student PIs)*:
Aidan Rowe

8.01 **Study Coordinators or Research Assistants:** People listed here can edit this application and will receive all email notifications for the study:

Name	Employer

There are no items to display

9.01 **Co-Investigators:** People listed here can edit this application and will receive email notifications *(Co-investigators who do not wish to receive email, should be added to the study team below instead of here).*
If your searched name does not come up when you type it in the box, the user does not have the Principal Investigator role in the online system.

Click the following link for instructions on how to Request an Additional Role.

Name	Employer
There are no items to display	

10.01 Study Team: *(co-investigators, supervising team, and other study team members) - People listed here cannot view or edit this application and do not receive email notifications.*

Last Name	First Name	Organization	Role/Area of Responsibility	Phone	Email
There are no items to display					

ID: Pro00103145 View: 1.5 Conflict of Interest
Status: Approved

1.5 Conflict of Interest

1.0 * **Are any of the investigators or their immediate family receiving any personal remuneration (including investigator payments and recruitment incentives but excluding trainee remuneration or graduate student stipends) from the funding of this study that is not accounted for in the study budget?**
○ Yes ● **No**

2.0 * **Do any of investigators or their immediate family have any proprietary interests in the product under study or the outcome of the research including patents, trademarks, copyrights, and licensing agreements?**
○ Yes ● **No**

3.0 * **Is there any compensation for this study that is affected by the study outcome?**
○ Yes ● **No**

4.0 * **Do any of the investigators or their immediate family have equity interest in the sponsoring company? (This does not include Mutual Funds)**
○ Yes ● **No**

5.0 * **Do any of the investigators or their immediate family receive payments of other sorts, from this sponsor (i.e. grants, compensation in the form of equipment or supplies, retainers for ongoing consultation and honoraria)?**
○ Yes ● **No**

6.0 * **Are any of the investigators or their immediate family, members of the sponsor's Board of Directors, Scientific Advisory Panel or comparable body?**
○ Yes ● **No**

7.0 * **Do you have any other relationship, financial or non-financial, that, if not disclosed, could be construed as a conflict of interest?**

○ Yes ● **No**

Please explain if the answer to any of the above questions is Yes:
Not Applicable

Important
If you answered YES to any of the questions above, you may be asked for more information.

ID: Pro00103145 View: 1.6 Research Locations and Other Approval
Status: Approved

1.6 Research Locations and Other Approvals

1.0 * **List the locations of the proposed research, including recruitment activities. Provide name of institution, facility or organization, town, or province as applicable**
Both the interview and survey will be conducted online with (including subject area experts and elderly people).

Both interview and survey will be conducted through social platforms such as Zoom and Google Hangouts.

2.0 * **Indicate if the study will use or access facilities, programmes, resources, staff, students, specimens, patients or their records, at any of the sites affiliated with the following** *(select all that apply):*
Not applicable

List all health care research sites/locations:
Not Applicable

3.0 **Multi-Institution Review**

* **3.1 Has this study already received approval from another REB?**

○ **Yes** ● **No**

4.0 **If this application is closely linked to research previously approved by one of the University of Alberta REBs or has already received ethics approval from an external ethics review board***(s)*, **provide the study number, REB name or other identifying information. Attach any external REB application and approval letter in the Documentation Section ➔ Other Documents.**
Not Applicable

ID: Pro00103145 View: 2.1 Study Objectives and Design
Status: Approved

2.1 Study Objectives and Design

1.0 * **Provide a lay summary of your proposed research which would be understandable to general public**

I am researching how to enable the elderly to continue living at home safely and longer by tracking and analyzing any unusual behavioural patterns and how The Future Of Smart Homes/Independent Senior Living can be developed and constantly improved by integrating the concepts of User-Centered Design (UCD), Artificial Intelligence (AI) and Internet of Things (IoT). It is essential to consider human nature, which has an broad variety of uses, from home protection to home treatment, and the ultimate goal of rendering intelligent homes fully autonomous. The enhancement of senior services is also one of the most critical fields for technological evolution. As a result, the caregiver will recognize what is happening by staring at his loved one's everyday life and the safety of the elderly can be maximized and ensured.

2.0 * **Provide a full description of your research proposal outlining the following:**

- **Purpose**
- **Hypothesis**
- **Justification**
- **Objectives**
- **Research Method/Procedures**
- **Plan for Data Analysis**

Purpose/Hypothesis/Justification

How to allow elderly to live safely longer? I believe that artificial intelligence(AI) technology has a wide array of uses in the health service sector. These uses may include health tracking, imaging, and data informatics, among others. Human body recognition provides technological supports which involves an algorithm to track daily activities of elderly. Especially, the use of AI in body detection and sensory tracking may save human power and money. At the same time, AI ensures faster decision-making. The technology provides an opportunity for the collection of accurate information that enables decision-makers to act as soon as possible. My study will focus on tracking and analyzing unusual behavioural patterns of elderly parents who stay at home alone.

Objectives

I am going to I focus on providing tracking and analyzing unusual behavioral patterns of elderly people who stay alone at home, which will benefit for those families which have service request of elderly caregiver service for their parents. Therefore, a different method of tracking system can be tested, especially tailored for seniors at home. It is capable of detecting crashes or actions that suggest a safety risk, sound anomaly recognition, which offers useful information into how seniors navigate their day and night schedules. Therefore, family members can get real-time push
notifications if there are any concerning unusual behaviours occurred. This ensures that medical help delivers quicker than any other senior care options. Actions should often be checked at a later time, meaning treatment can be improved easily by users health care providers. This unique type of service is an innovative approach that can postpones the need for home nursing and assisted living.

Research Methods

Semi-Structured Interviews

1. Interviews with elderly people (Secondary Users).
2. Open-Ended Interviews with expert in Artificial Intelligence and Human-Computer Interaction.
3. An open-ended interview with expert in Health Aging.

Online Survey

1. An online survey for the relatives of elderly people (Primary Users).

User-Centered Design Approaches

1. User Journey Map Creation.
2. User Personal Development.
3. User Empathy Maps Creation & Evaluation.
4. Usability Testing.

Plan for Data Analysis

1. Data collected from the above-noted research activities will be analyzed for systematic results and placed in disseminated forms.
2. Qualitative and quantitative surveys to validate interactions from the above-mentioned user testing.

3.0 **Describe procedures, treatment, or activities that are above or in addition to standard practices in this study area** *(eg. extra medical or health-related procedures, curriculum enhancements, extra follow-up, etc)*:
Not Applicable

4.0 **If the proposed research is above minimal risk and is not funded via a competitive peer review grant or industry-sponsored clinical trial, the REB will require evidence of scientific review. Provide information about the review process and its results if appropriate.**
Not Applicable

5.0 **For clinical trials, describe any sub-studies associated with this Protocol.**
Not Applicable

ID: Pro00103145 View: 2.2 Research Methods and Procedures
Status: Approved

2.2 Research Methods and Procedures

Some research methods prompt specific ethical issues. The methods listed below have additional questions associated with them in this application. If your research does not involve any of the methods listed below, ensure that your proposed research is adequately described in Section 2.1: Study Objectives and Design or attach documents in the Documentation Section if necessary.

1.0 * **This study will involve the following***(select all that apply)*
Internet-based Interaction with Participants (excluding internet surveys or data collection over internet without human interaction)
Interviews and/or Focus Groups
Surveys and Questionnaires (including internet surveys)

NOTE 1: Select this ONLY if your application SOLELY involves a review of paper charts/electronic health records/administrative health data to answer the research question. If you are enrolling people into a study and need to collect data from their health records in addition to other interventions, then you SHOULD NOT select this box.

NOTE 2: Select this option if this research ONLY involves analysis of blood/tissue/specimens originally collected for another purpose but now being used to answer your research question. If you are enrolling people

into the study to prospectively collect specimens to analyze you SHOULD NOT select this box.

ID: Pro00103145 View: 2.4 Internet-based Interaction with Human Participants

Status: Approved

2.4 Internet-based Interaction with Human Participants

1.0 Internet-based Research

1.1 Will your interaction with participants occur in private internet spaces (eg. members only chat rooms, social networking sites, email discussions, etc)?

● **Yes** ○ No

1.2 Will these interactions occur in public space(s) where you will post questions initiating and/or maintaining interaction with participants?

○ Yes ● **No**

2.0 Describe how permission to use the site(s) will be obtained, if applicable:

The only research method that needs the use of website support is online survey. The website which provides creative survey questions does not need permission.

3.0 * If you are using a third party research tool, website survey software, transaction log tools, screen capturing software, or masked survey sites, how will you ensure the security of data gathered at that site?

Since I will use Typeform to conduct my survey, I will maintain the security of my account by using secure passwords and protecting them as necessary. Therefore, other uses on Typeform will not be able to review my research questions.

4.0 If you do not plan to identify yourself and your position as a researcher to the participants, from the onset of the research study, explain why you are not doing so, at what point you will disclose that you are a researcher, provide details of debriefing procedures, if any, and if participants will be given a way to opt out, if applicable:

Not Applicable

5.0 * How will you protect the privacy and confidentiality of participants who may be identified by email addresses, IP addresses, and other identifying information that may be captured by the system during your interactions with these participants?

I will only use my own laptop to conduct online interviews by Zoom or Google Hangouts and online survey via Typeform. No one is allowed to check my data without my agreement.

Also, I will clean the cookies from my website browsers after getting all the results from survey.

ID: Pro00103145 View: 2.5 Interview and/or Focus Groups

Status: Approved

2.5 Interview and/or Focus Groups

1.0 **Will you conduct interviews, focus groups, or both? Provide detail.**
First of all, I will be arranging a few interviews with elderly people and adult friends who are my secondary and primary users for my research subject. In these interviews, I will clarify several concerns including, expectations, demands, pain points and comfortable points for the elderly people, who tend to stay by themselves. Also, they are often in need of support services but unable to afford them.

Secondly, I will be conducting a systematic expert interviews online with suitable experts (e.g. Artificial Intelligence, Human Computer Interaction, Healthy Aging, etc.

2.0 **How will participation take place (e.g. in-person, via phone, email, Skype)?**
Each interview will optimally be conducted online via internet (VoIP) such as Zoom, Google Hangouts.

3.0 **How will the data be collected (e.g. audio recording, video recording, field notes)?**
Audio from each interview will be recorded and relevant portions of the audio will be transcribed.

The reason why I use audio or video recording to record the interview is because that I need to go back to review all the information that participants has provided after the interview is finished, this will keep me away from forgetting every important information received during the interview while I write the transcription in my thesis report.

ID: Pro00103145 View: 2.9 Surveys and Questionnaires (including Online)

Status: Approved

2.9 Surveys and Questionnaires (including Online)

1.0 **How will the survey/questionnaire data be collected (i.e. collected in person, or if collected online, what survey program/software will be used etc.)?**
The data from my survey will be collected via the online survey tool Typeform.com. The relatives of elderly as my primary audience are the participants for the online survey conduction.

2.0 **Where will the data be stored once it's collected (i.e. will it be stored on the survey software provider servers, will it be downloaded to the PI's computer, other)?**
The data will be only saved and downloaded to the principal investigator's laptop. Without my agreement, no one can access my laptop to check the data. I will also clean the cookies of which browser I used to conduct the survey in Typeform.

Typeform's infrastructure is hosted by Amazon Web Services (AWS). Their main servers are located in Virginia, USA and backup servers are located in Frankfurt, Germany.

3.0 **Who will have access to the data?**
Only the PI. The faculty supervisor does not have access to the survey

data. However, if he wants to review the data, I will have to give him permission first.

ID: Pro00103145 View: 3.1 Risk Assessment
Status: Approved

3.1 Risk Assessment

1.0 * **Provide your assessment of the risks that may be associated with this research:**
Minimal Risk - research in which the probability and magnitude of possible harms implied by participation is no greater than those encountered by participants in those aspects of their everyday life that relate to the research (TCPS2)

2.0 * **Select all that might apply:**

Description of Possible Physical Risks and Discomforts

No	Participants might feel physical fatigue, e.g. sleep deprivation
No	Participants might feel physical stress, e.g. cardiovascular stress tests
No	Participants might sustain injury, infection, and intervention side-effects or complications
No	The physical risks will be greater than those encountered by the participants in everyday life

Possible Psychological, Emotional, Social and Other Risks and Discomforts

No	Participants might feel psychologically or emotionally stressed, demeaned, embarrassed, worried, anxious, scared or distressed, e.g. description of painful or traumatic events
Possibly	Participants might feel psychological or mental fatigue, e.g intense concentration required
No	Participants might experience cultural or social risk, e.g. loss of privacy or status or damage to reputation
No	Participants might be exposed to economic or legal risk, for instance non-anonymized workplace surveys
No	The risks will be greater than those encountered by the participants in everyday life

3.0 * **Provide details of all the risks and discomforts associated with the research for which you indicated YES or POSSIBLY above.**
During the interviews, both of my elderly participants and adult friends participants may have to concentrate on the questions I ask them and clearly provide me answers about what in their minds. Due to my questions are all about their personal experience related to elderly caregiving, they may feel frustrated when they try to recall back to their experiences.

4.0 * **Describe how you will manage and minimize risks and discomforts, as well as mitigate harm:**
Participants can stop their interviews at any time.

5.0 **Is there a possibility that your research procedures will lead to unexpected findings, adverse reactions, or similar results that may**

require follow-up *(i.e. individuals disclose that they are upset or distressed during an interview/questionnaire, unanticipated findings on MRI, etc.)***?**

○ Yes ● **No**

6.0 **If you are using any tests in this study diagnostically, indicate the member(s) of the study team who will administer the measures/instruments:**

Test Name	Test Administrator	Organization	Administrator's Qualification

There are no items to display

7.0 **If any research related procedures/tests could be interpreted diagnostically, will these be reported back to the participants and if so, how and by whom?**
Not Applicable

ID: Pro00103145 View: 3.2 Benefits Analysis
Status: Approved

3.2 Benefits Analysis

1.0 * **Describe any potential benefits of the proposed research to the participants. If there are no benefits, state this explicitly:**
There are no benefits from the participants.

2.0 * **Describe the scientific and/or scholarly benefits of the proposed research:**
My proposed research subject will help me process information from certain touchpoints and attitude of my participants. It can also assist me to achieve participants' objectives. For instance, I would strive to better understand the mind of target users. As a result, this will facilitate the development of my solutions that I am going to deliver.

3.0 **If this research involves risk to participants explain how the benefits outweigh the risks.**
Not Applicable

ID: Pro00103145 View: 4.1 Participant Information
Status: Approved

4.1 Participant Information

1.0 * **Will you be recruiting human participants** *(i.e. enrolling people into the study, sending people online surveys to complete)***?**

● **Yes** ○ No

1.1 Will participants be recruited or their data be collected from Alberta Health Services or Covenant Health or data custodian as defined in the Alberta Health Information Act?

○ Yes ● **No**

ID: Pro00103145 View: 4.2 Additional Participant Information

Status: Approved

4.2 Additional Participant Information

1.0 Describe the participants that will be included in this study. Outline ALL participants *(i.e. if you are enrolling healthy controls as well):*

1. Appropriate experts to interview in Artificial Intelligence, Human-Computer Interaction and Health Aging.
2. Elderly people who stay alone at home without caregiving service.
3. Adult caregivers (My current landlord) who can provide by their experience of using technology in taking care of elderly parents.
4. The family relatives of those elderly people who wish to track daily activities and condition of their older relatives.

2.0 * **Describe and justify the inclusion criteria for participants** *(e.g. age range, health status, gender, etc.):*

1. Experts in the field of human body detection of Artificial Intelligence, Human-Computer Interaction and Health Aging.
2. Elderly people aged between 50 and 90. This particular group pf people usually prefer to live by themselves at home without caregiving service.
3. Adult caregivers who have elderly at their homes to take care of. They are using certain Artificial Technology to look after their elderly parents.
4. Relatives who may take responsibility to take care of their elderly family members.

3.0 Describe and justify the exclusion criteria for participants:

Participants do not need any training before getting involved in my research study.

4.0 Participants

4.1 How many participants do you hope to recruit *(including controls, if applicable?)*
16
4.2 Of these, how many are controls, if applicable?

4.3 If this is a multi-site study, how many participants do you anticipate will be enrolled in the entire study?

5.0 Justification for sample size:
(3 Experts participants, 4 Elderly participants, 7 Elderly relatives participants, 2 Adult caregivers participants) The following research methods will:

1. Appropriate experts in Artificial Intelligence, Human-Computer Interaction and Health Aging.
2. Online Interviews with Elderly (Secondary Users).
3. Online survey for the relatives of elder people. They could be their adult children (Primary Users).
4. Online Interviews with adult caregivers (Primary Users).

ID: Pro00103145 View: 4.4 Recruitment of Participants (non-Health)

Status: Approved

4.4 Recruitment of Participants (non-Health)

1.0 Recruitment

1.1 How will you identify potential participants? Outline all of the means you will use to identify who may be eligible to be in the study *(i.e. response to advertising such as flyers, posters, ads in newspapers, websites, email, list serves, community organization referrals, etc.)*
Online survey for adult relatives of elderly
> Participants are the family relatives of the elder I will be interviewing. They are my primary audience.

Online Interview for Elderly
> Two of these seniors who I will be interviewing are my family members.

> Another two elderly I will be interviewing are grandpa and grandma of one of my friends

They are also my secondary target users to research.

Online Interview for adult caregivers
> I will be interviewing with my current landlord and her husband. They are my primary audience.

Online Interview for Artificial Intelligence Expert
> The first artificial intelligence interviewee is one of my co-workers in the last company.

Online Interview for Human-Computer Interaction Expert
> An expert who holds her master's degree in Human-Computer Interaction.

Online Interview for Health Aging Expert
> A Health Aging expert who works at the Department of Human Ecology at the University of Alberta.

1.2 Once you have identified a list of potentially eligible participants, indicate how the potential participants' names will be passed on to the researchers AND how will the potential participants be approached about the research.
I will send the invitation of my interview via email to my participants. The way I get the email from my expert participants is listed below
For Health Aging expert: email address is from the expert online profile at https://apps.ualberta.ca/directory/person/jfast
For Human-Computer Interaction Expert: We used to be classmates in Ohio State University. I got her email when we were in the same group doing a school project.
For Artificial Intelligence Expert: This expert used to be my co-worker, I got his email when we worked together.
For all the Elderly people from my family, I will directly ask them by Wechat.

For all the Elderly people from my friend's family, my friend will be responsible for helping me ask his grandparent's Wechat.

For all the adult caregivers, I will directly ask them by Wechat.

Once the participants who have contacted back and agreed to be part of the study, the researcher would send them the consent forms and further

details for the research and accordingly plan out the schedule with the participant.

My participants will be asked to participate in my interviews with online chat platforms such as Zoom or Google Hangouts.

2.0 Pre-Existing Relationships

2.1 Will potential participants be recruited through pre-existing relationships with researchers *(e.g. Will an instructor recruit students from his classes, or a physician recruit patients from her practice? Other examples may be employees, acquaintances, own children or family members, etc.)*?

● **Yes** ○ No

2.2 If YES, identify the relationship between the researchers and participants that could compromise the freedom to decline *(e.g. clinician/patient, professor/student)*
One of the two elderly I will be interviewing is my family. They are my grandma and grandpa from my father's side.

Another two elderly I will be interviewing is grandpa and grandma of one of my friends.

The adult caregivers I will be interviewing are my current landlord and her husband.

The adult relatives of the elderly I will be sending survey to are my mother, father, two uncles (My father's brothers), one aunt (My mother's sister), and my cousin's father and mother.

2.3 How will you ensure that there is no undue pressure on the potential participants to agree to the study?
I will be able to know immediately whether they might be willing to move ahead or not when we communicate. If my participants have any questions or confusion, I will patiently explain what I intend to do and how the research should be continued. If they want me to slow down my speed of talking, I will follow what they ask me to do in order to make them more comfortable during interviews.

The form set up for survey questions will be simple to answer. If my respondents have any technical issues, they can also email me or contact me by other ways. I will be available to support them to finish questions anytime. They can always refuse to answer any questions that appeared in my survey.

Older people may find it difficult when they use the Internet. I will ask my family members to help set up any technical requirements.

I will ask one of the fellow graduate student from University of Alberta to help me with the process of obtaining consent from individuals which I have pre-existing relationship with and the fellow graduate student is going to explain the potential participant that they do not have to participate if they do not want to. If my participants refused, there is no social obligations that they take. If my participants accepted my interview/survey invitation, I will let my participants know that they do not face any social obligations during interviews/surveys as well. I will make sure to tell them that their perspectives and opinions will provide more clear information with my projects and help me decide how I could better design the digital service for my target users, which are elderly people being alone at home without caregivers.

3.0 Will your study involve any of the following? *(select all that apply)*

None of the above

ID: Pro00103145 View: 4.5 Informed Consent Determination

Status: Approved

4.5 Informed Consent Determination

1.0 Describe who will provide informed consent for this study*(i.e. the participant, parent of child participant, substitute decision maker, no one will give consent requesting a waiver)*

My participants will directly give the signed consent by email form to the researcher by email electronically. If any concerns may occur, I will ask them to resend me a copy.

1.1 Waiver of Consent Requested

If you are asking for a waiver of participant consent, please justify the waiver or alteration and explain how the study meets all of the criteria for the waiver. Refer to Article 3.7 of TCPS2 **and provide justification for requesting a Waiver of Consent for ALL criteria (a-e)**

Not Applicable

1.2 Waiver of Consent in Individual Medical Emergency

If you are asking for a waiver or alteration of participant consent in individual medical emergencies, please justify the waiver or alteration and explain how the study meets ALL of the criteria outlined in Article 3.8 of TCPS2 (a-f)**.**

Not Applicable

2.0 How will consent be obtained/documented? Select all that apply

Signed consent form

If you are not using a signed consent form, explain how the study information will be provided to the participant and how consent will be obtained/documented. Provide details for EACH of the options selected above:

All the participants will obtain their consent forms by email.

3.0 Will every participant have the capacity to give fully informed consent on his/her own behalf?

● **Yes** ○ No

4.0 What assistance will be provided to participants or those consenting on their behalf, who may require additional assistance? *(e.g. non-English speakers, visually impaired, etc.)*

Not Applicable

5.0 * **If at any time a PARTICIPANT wishes to withdraw from the study or from certain parts of the study, describe when and how this can be done.**

Participants can email me to request their withdrawal of their data provided at all times without consequence if they feel that their information should not be taken by others. I will definitely replay their email within 2 days and follow their requests. I will delete all the data and recorded videos that I saved in my laptop and send them screenshots as a proof.

6.0 **Describe the circumstances and limitations of DATA withdrawal from the study, including the last point at which participant DATA can be withdrawn** *(i.e. 2 weeks after transcription of interview notes)*
Data can be withdrawn anytime after the survey date I had with each participant.
Participants in my interviews can withdraw their data at all times after the interview. I will delete all the recorded videos I made during the interview from my laptop and send screenshots to my participants as a proof.

7.0 **Will this study involve any group(s) where non-participants are present? For example, classroom research might involve groups which include participants and non-participants.**
○ Yes ● **No**

ID: Pro00103145 View: 5.1 Data Collection
Status: Approved

5.1 Data Collection

1.0 * **Will the researcher or study team be able to identify any of the participants at any stage of the study?**
● **Yes** ○ No

2.0 **Primary/raw data collected will be** *(check all that apply)***:**
Anonymous - the information **NEVER** had identifiers associated with it (eg anonymous surveys) and risk of identification of individuals is low or very low
Directly identifying information - the information identifies a specific individual through direct identifiers (e.g. name, social insurance number, personal health number, etc.)
Indirectly identifying information - the information can reasonably be expected to identify an individual through a combination of indirect identifers (eg date of birth, place of residence, photo or unique personal characteristics, etc)

3.0 **If this study involves secondary use of data, list all original sources:**
Not Applicable

4.0 **In research where total anonymity and confidentiality is sought but cannot be guaranteed** *(eg. where participants talk in a group)* **how will confidentiality be achieved?**
Not Applicable

ID: Pro00103145 View: 5.2 Data Identifiers
Status: Approved

5.2 Data Identifiers

1.0 * **Personal Identifiers:** will you be collecting - at any time during the study, including recruitment - any of the following *(check all that apply)***:**
Surname and First Name
Initials
Email Address
Full Date of Birth

Year of Birth
Age at time of data collection
Other

If OTHER, please describe:
Social media information: Zoom number / Skype number

2.0 **Will you be collecting - at any time of the study, including recruitment of participants - any of the following** *(check all that apply)***:**
There are no items to display

3.0 * **If you are collecting any of the above, provide a comprehensive rationale to explain why it is necessary to collect this information:**
For the experts, only their professional background would be used to share the perspectives as that would help me to understand the appropriate knowledge.

4.0 **If identifying information will be removed at some point, when and how will this be done?**
Pseudonyms will be used to replace original information upon request by the participants including elderly, relatives and experts at all times.

5.0 * **Specify what identifiable information will be RETAINED once data collection is complete, and explain why retention is necessary. Include the retention of master lists that link participant identifiers with de-identified data:**
For the expert interviews: The full name, including Surname and First Name, professional positions, and/or place of employment of participants will be retained with their interviews to lend their interview responses authority and convincingly show their positions as an expert in their field of work. Email address and social media numbers will also be retained to follow-up with participants for any post-interview at all times.

For the elderly interviews: The full name, including Surname and First Name, age of participants will be retained with their interviews to lend their interview responses authority and convincingly show their personal life stories. Email address and social media numbers will also be retained to follow-up with participants for any post-interview at all times.

6.0 **If applicable, describe your plans to link the data in this study with data associated with other studies (e.g within a data repository) or with data belonging to another organization:**
Not Applicable

ID: Pro00103145 View: 5.3 Data Confidentiality and Privacy
Status: Approved

5.3 Data Confidentiality and Privacy

1.0 * **How will confidentiality of the data be maintained? Describe how the identity of participants will be protected both during and after research.**
All the personal information will be protected and be kept encrypted on an external hard drive. They won't be exposed electronically and physically. Also, the data of participants will not be shared to any third-party individuals or organizations.

Every online interview conducting through Zoom or Google Hangouts will

be protected by setting up password. That means participants will receive my password first, then you will be able to access the room. The interviews will be recorded, and will be saved in my laptop. All the recording records will not be accessed by any third party and other people.

2.0 **How will the principal investigator ensure that all study personnel are aware of their responsibilities concerning participants' privacy and the confidentiality of their information?**
I do not have study personnel.

3.0 **External Data Access**

* **3.1 Will identifiable data be transferred or made available to persons or agencies outside the research team?**
○ **Yes** ● **No**

ID: Pro00103145 View: 5.4 Data Storage, Retention, and Disposal
Status: Approved

5.4 Data Storage, Retention, and Disposal

1.0 * **Describe how research data will be stored, e.g. digital files, hard copies, audio recordings, other. Specify the physical location and how it will be secured to protect confidentiality and privacy.** *(For example, study documents must be kept in a locked filing cabinet and computer files are encrypted, etc. Write N/A if not applicable to your research)*
Since I use Typeform to collect my data, I am responsible for obtaining the consent of my respondents and for ensuring they know about Typeform's Terms of Service and Privacy Policy.

I will send Typeform survey via email, tell my respondents exactly how I plan to use my data in my email body. Let them know that by completing the Typeform, they are agreeing to the terms.

When informing my respondents about how I plan to use their information, I will specify the following:
1: What type of data I am collecting: email address, personal info, etc.
2: How I plan to use the information once I have collected it.
3: How to get in contact, should they have any questions.

The data that I have collected will be directly exported from Typeform in my own laptop as PDF files.
All the research data that I will be collecting from participants and their personal information will be kept on an encrypted backup of my files in my own laptop and phone.

Only the student researcher (Yihao, Zhang) can access the data.

2.0 * **University policy requires that you keep your data for a minimum of 5 years following completion of the study but there is no limit on data retention. Specify any plans for future use of the data. If the data will become part of a data repository or if this study involves the creation of a research database or registry for future research**

use, please provide details. *(Write N/A if not applicable to your research)*
There is no future use planned for the data.

3.0 If you plan to destroy your data, describe when and how this will be done? Indicate your plans for the destruction of the identifiers at the earliest opportunity consistent with the conduct of the research and/or clinical needs:
The data will be retained for 5 years following the completion.

After 5 years, I am going to use a program to wipe my specific files where data is located at my laptop I am going to use DBAN, which is a free data destruction program* that completely erases files on a both hard drive or files in laptop. This includes all personal files, operating systems and installed programs.

ID: Pro00103145 View: Documentation
Status: Approved

Documentation

Add documents in this section according to the headers. Use Item 11.0 "Other Documents" for any material not specifically mentioned below.

Sample templates are available by clicking HERE.

1.0 Recruitment Materials:

Document Name	Version	Date	Description
DISREGARD	0.03	9/15/2020 1:45 PM	
DISREGARD	0.03	9/15/2020 1:45 PM	
DISREGARD	0.03	9/15/2020 1:45 PM	
DISREGARD	0.02	9/29/2020 10:15 AM	

2.0 Letter of Initial Contact:

Document Name	Version	Date	Description
Chat Site Letter of Initial Contact-Elderly	0.06	9/22/2020 4:13 PM	
Chat Site Letter of Initial Contact-Experts	0.03	9/22/2020 4:13 PM	
Email Letter of Initial Contact-Relatives	0.04	9/22/2020 4:14 PM	
Chat Site Letter of Initial Contact-Adult Caregivers	0.03	9/29/2020 10:18 AM	

3.0 Informed Consent / Information Document(s):

3.1 What is the reading level of the Informed Consent Form(s):

3.2 Informed Consent Form(s)/Information Document(s):

Document Name	Version	Date	Description

	Document Name	Version	Date	Description
	Consent Form-Elderly Participants	0.09	9/22/2020 4:18 PM	
	Consent Form-Expert Participants	0.09	9/22/2020 4:18 PM	
	Consent Form-Relatives Participants	0.06	9/22/2020 4:19 PM	
	Consent Form-Adult Caregivers Participants	0.03	9/29/2020 10:22 AM	

4.0 Assent Forms:

Document Name	Version	Date	Description

There are no items to display

5.0 Questionnaires, Cover Letters, Surveys, Tests, Interview Scripts, etc.:

	Document Name	Version	Date	Description
	Online Survey for Relatives of Elderly	0.02	8/27/2020 11:56 AM	
	Interview Questions for Elderly Participants	0.02	8/27/2020 11:57 AM	
	Interview Questions for Human-Computer Interaction Expert Participant	0.02	8/27/2020 11:57 AM	
	Interview Questions for Artificial Intelligence Experts Participant	0.01	8/27/2020 11:58 AM	
	Interview Questions for Health Aging Experts Participant	0.01	8/27/2020 11:59 AM	
	Interview Questions for Adult Caregivers Participants	0.03	9/29/2020 10:25 AM	

6.0 Protocol/Research Proposal:

Document Name	Version	Date	Description

There are no items to display

7.0 Investigator Brochures/Product Monographs:

Document Name	Version	Date	Description

There are no items to display

8.0 Health Canada No Objection Letter *(NOL)*:

Document Name	Version	Date	Description

There are no items to display

9.0 Confidentiality Agreement:

Document Name	Version	Date	Description

There are no items to display

10.0 Conflict of Interest:

Document Name	Version	Date	Description
There are no items to display			

11.0 Other Documents:
For example, Study Budget, Course Outline, or other documents not mentioned above

Document Name	Version	Date	Description
There are no items to display			

ID: Pro00103145 View: SF - Final Page
Status: Approved

Final Page

You have completed your ethics application! Click "Continue" to go to your study workspace.

This action will NOT SUBMIT the application for review.

Only the Study Investigator can submit an application to the REB by selecting the "SUBMIT STUDY" button in My Activities for this Study ID:Pro00103145.

2.0. Interview Data

The following documents contain the Initial Recruitment Profiles, Information Letter and Consent Form, Interview Script, signed consent forms from the 16 interview participants, and the transcribed portions from each interviews.

2.1. Recruitment Profiles

During these interviews, biographical details were gathered from conversations. Here are the brief biographies of my participants, which have been recognised.

Xiaoyue Su (Primary Users) - Adult Caregivers Interview (Participant A)

Xiaoyue is my current Landlord. She has not only to manage her house for renting, but also does he go to every weekday. Consequently, there is a bit of time for her to visit her parents frequently. Her parents are living independently in their own house. The main concern for her is that she always worries her parents getting hurt at home, so she tries her best to find a time to visit her parents once a week. She has already set up caregiving technology at her parents' house. Because her parents have now any knowledge on technology, she is responsible for figuring out all the settings and connections to make sure the system runs normal. She believes that technology would be great to change the way how she used to take care of her parents. She also believes that technology can keep her parents away from getting fallen at home. Fortunately, her parents accept her suggestions and love the use of technology.

Guojian Fu (Primary Users) - Adult Caregivers Interview (Participant B)

Guojian is my Landlord's husband. He is very busy at work too. As same as his wife, he doesn't often visit his parent as well. His mother is 82 years old now, and she tends to live independently. Her mother has rheumatoid arthritis, meaning she has multiple mobility concerns. The biggest concern for him is logistics because they've spent over half of their time at work and taking care of their children. He has ever asked her mom to live with their family many times before, but her mom showed her unwillingness. Instead, she preferred to live by her own independently. However, his family's old generations don't mind if technology is involved. They believe technology can not only provide them privacy but does also keep them safe.

Hongshu Yu (Elderly-Secondary Users) - Elderly Interview (Participant C)

Hongshu is grandma of one of my friends. She's 65 years old. She finds how to keep doing the stuff she likes, including certain changes that matter a lot to her. She doesn't do it as easily as she used to do, however she can deal with it. She gets some chronic pains now and she has some long history of some issues. She is on-medication, therefore, she's concerned about losing her independence and becoming restricted to living in a care home, so she seeks to remain on top of it. She's more the prevention things she should perform. She focuses on every opportunity she gets to move. She's excited with the changes she has made; she seems a bit better than she felt she was a year earlier. And her equilibrium has changed, leaving her less afraid to slip.

Guanglu Zhang (Elderly-Secondary Users) - Elderly Interview (Participant D)

Guanglu is grandpa of one of my friends. He's 67 years old. He lives with my friend's grandma in the care home as well. Sometime GuangLu and friend's grandma spend leisure time with my friend's family. My friend's grandpa lives with his wife in the care home. He rejected his two children for moving to take care of them at the care home a few years ago.

Wenying Dong (Elderly-Secondary Users) - Elderly Interview (Participant E)

Wenying is my grandma from my father's family. She's 70 years old, and she lives with my grandpa. She does have a caregiver visiting her every day. The caregiver is only 20 minutes away from them, but she has arthritis, so she has a lot of problems with mobility. Even though my family is close to her, it's hard to get to her quickly.

Chuanwen Zhang (Elderly-Secondary Users) - Elderly Interview (Participant F)

Chuanwen is my grandpa from my father's family. He's 72 years old. He is an energetic person who enjoys the world. He enjoyed trying different things, but he never had time to do so. He decided to spend more time in leisure exercise and social work. He needs to continue so that he can relax in his retirement. He needs to be in touch with his relatives and friends and meet new people. He has technological knowledge and utilises the Internet to interact regularly with others. He still wants to learn the application, because he thinks it will finally improve his life experience.

Dayi Zhang (Relatives-Primary Audience) - Relatives Survey (Participant G)

Dayi is my cousin's mother. She lives in Canada bow and she is a teacher who always works hard at work. She has strong responsibilities to his company so she is super busy and works 10 hours per day in average from Monday to Friday. She lives with his parents. She doesn't hire any caregivers to take care of their parents. She has ever bought a tracking device to her parents because her father has ever got lost while going for a walking alone. Not only taking care of her own parents, but she has also helped others' parents because their children barely take care of them due to multiple reasons. Dayi is a very kind and nice person.

Mingyu Li (Relatives-Primary Audience) - Relatives Survey (Participant H)

Mingyu was a mom-at-home for much of her childhood. Now that her children have all grown up and left the home, she spends her free time working on arts and crafts projects such as drawing, crafting, and photographing. However, she has to help her husband to take care of his elderly parents sometimes, making sure they are wealthy. She knows technology better than her husband.

Yan Zhang (Relatives-Primary Audience) - Relatives Survey (Participant I)

Yan is my mother. She is 59 years ago now. Even though he retired from work at 55, she still works on some infrastructural projects of high-speed railway nationwide, so she is super busy. She doesn't live with my grandparents, but she sometimes goes their care home to see them twice a month. My mother lives in Tianjin, China but my grandparents live in Beijing, China. My mother understands how to use technology, she carries phones at all times to keep connected with family and friends around her.

Li Zhang (Relatives-Primary Audience) - Relatives Survey (Participant J)

Li is my aunt from my mother's family, she is my mother's sister. She has retired but she doesn't always go to see her parents. She feels the bond with her elders may be complicated, and often she also holds the complain of long past family resentments that her parents were not really close and cared for her while she thought she was small. Her own lives may even be wobbly since, alongside her treatment, she should manage work and friends and her own wellbeing. She is confused on what precisely are her obligations to her elderly parents.

Hong Zhang (Relatives-Primary Audience) - Relatives Survey (Participant K)

Hong is my uncle, and he is my father's brother. He doesn't live far from his elderly parents. He calls his parents twice a week to check if they need anything for help. He has poor knowledge in using technology. He cared for her mother when he was in his early 50's when she was 70 and when he was in the mid 70's, he took care of his father. Since he worked full time and had a teen at home, but his parents didn't want to go and were worried about having the feeling of illness surrounded.

Bin Zhang (Relatives-Primary Audience) - Relatives Survey (Participant L)

Bin is my uncle, and he is my father's second brother. He is a CEO of an Blockchain company located at Shanghai. He travels a lot worldwide so he barely has time to take care of his family and his elderly parents. He does enjoy their company, but he also finds himself looking for excuses to see them less often.

Yichao Jin (AI Expert) - Expert Interview

Yichao n is an AI expert with a keen interest in building great products. He is professional in building and creating intuitive and simplistic UI/UX. He has experienced from leading product and tech across multiple startups within app/web-development, Human-Body Recognition, computer vision, smart construction, chat-bot, data collection, as well as sports technology.

Lee Bing (Human-Computer Interaction) - Expert Interview

Bing has more than four years of experience working in UX Design in the field of healthcare technology, travel industries and travel industries. HCI provides her with multidisciplinary field of study to learning and focusing on the design of computer technology in her career. She also focuses user research and investigation to support her every tech team.

Dr. Lili Liu (Older Adults and Family Caregivers) - Expert Interview

Professor Liu is a former professor in the School of Public Health and Health Systems of University of Walterloo. Her research examines ways technologies can help older adults and family caregivers. Her expertise includes Ageing and dementia, Caregiving for persons living with dementia, Health technologies

and Mixed methods research approaches. One of her ongoing projects is developing an app using predicted risk levels to recommend personalized strategies for people with dementia at risk of going missing.

2.2. Recruitment Letter

For Adult Friends Participants

UNIVERSITY OF ALBERTA

Department of Art & Design
Faculty of Arts
3-98 Fine Arts Building
Edmonton, Alberta, Canada T6G 2C9
www.ualberta.ca/ARTDESIGN Tel: 780.492.3261
Fax: 780.492.7870
REB ID: Pro00103145

Chat Site Recruitment Letter for Adult Caregivers Participants

Study Title: Designing an Analysis System to Track Unusual Behavioural Patterns of Elderly Living Alone

Dear Participant:

Hello, my name is Yihao, Zhang and I am a Visual Communication Design graduate student in the Arts & Design Faculty in University of Alberta. As part of my master thesis research project, I am researching how to enable the elderly to continue living at home safely and longer by tracking and analyzing any unusual behavioural patterns and how The Future Of Smart Homes/Independent Senior Living can be developed and constantly improved by integrating the concepts of User-Centered Design (UCD), Artificial Intelligence (AI) and Internet of Things (IoT). I am recruiting adult friends who have their elderly parents to take care of to better understand their expectations, demands, pain points and comfortable points.

Participation in the study will take approximately 60 minutes. If you would like to participate, I will ask that you provide your personal experience and other general questions in your everyday life. Please review the questions in details from the PDF where interview questions are displayed in the attached PDF.

Participation is voluntary and there are no consequences for choosing not to participate or withdrawing from the study. Confidentiality of all participants will be maintained. The data will be kept secure and password protected. Your data will be only stored in my personal laptop and will not be exposed to any third party.

Any additional questions regarding the project can be directed to me, Yihao, Zhang at yihao6@ualberta.ca. Please email me if you're interested in participating in this study.

Respectfully,
Yihao, Zhang, Principle Investigator:
Visual Communication Design Graduate Student
University of Alberta

For Elderly Participants

UNIVERSITY OF ALBERTA

Department of Art & Design
Faculty of Arts
3-98 Fine Arts Building
Edmonton, Alberta, Canada T6G 2C9
www.ualberta.ca/ARTDESIGN Tel: 780.492.3261
Fax: 780.492.7870
REB ID: Pro00103145

Chat Site Recruitment Letter for Elderly Participants

Study Title: Designing an Analysis System to Track Unusual Behavioural Patterns of Elderly Living Alone

Dear Participant:

Hello, my name is Yihao, Zhang and I am a Visual Communication Design graduate student in the Arts & Design Faculty in University of Alberta. As part of my master thesis research project, I am researching how to enable the elderly to continue living at home safely and longer by tracking and analyzing any unusual behavioural patterns and how The Future Of Smart Homes/Independent Senior Living can be developed and constantly improved by integrating the concepts of User-Centered Design (UCD), Artificial Intelligence (AI) and Internet of Things (IoT). I am recruiting elderly who tend to stay by themselves to better understand their expectations, demands, pain points and comfortable points.

Participation in the study will take approximately 60 minutes. If you would like to participate, I will ask that you provide your personal experience and other general questions in your everyday life. Please review the questions in details from the PDF where interview questions are displayed in the attached PDF.

Participation is voluntary and there are no consequences for choosing not to participate or withdrawing from the study. Confidentiality of all participants will be maintained. The data will be kept secure and password protected. Your data will be only stored in my personal laptop and will not be exposed to any third party.

Any additional questions regarding the project can be directed to me, Yihao, Zhang at yihao6@ualberta.ca. Please email me if you're interested in participating in this study.

Respectfully,
Yihao, Zhang, Principle Investigator:
Visual Communication Design Graduate Student
University of Alberta

For Expert Participants

Department of Art & Design
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3-98 Fine Arts Building
Edmonton, Alberta, Canada T6G 2C9
www.ualberta.ca/ARTDESIGN Tel: 780.492.3261
Fax: 780.492.7870
REB ID: Pro00103145

Chat Site Recruitment Letter for Expert Participants

Study Title: Designing an Analysis System to Track Unusual Behavioural Patterns of Elderly Living Alone

Dear Participant:

Hello, my name is Yihao, Zhang and I am a Visual Communication Design graduate student in the Arts & Design Faculty in University of Alberta. As part of my master thesis research project, I am researching how to enable the elderly to continue living at home safely and longer by tracking and analyzing any unusual behavioural patterns and how The Future Of Smart Homes/Independent Senior Living can be developed and constantly improved by integrating the concepts of User-Centered Design (UCD), Artificial Intelligence (AI) and Internet of Things (IoT). I am recruiting elderly who tend to stay by themselves to better understand their expectations, demands, pain points and comfortable points.

Participation in the study will take approximately 60 minutes. If you would like to participate, I will ask that you provide your personal knowledges that allow me to have a focused, conversational and two-way communication with the people who provide supportive concepts/perspectives between Artificial intelligence, Human-Computer Interaction and Care of the Elderly with me. Hence, a systematic overview will help me better understand how to untilize technol-ogies to bridge the gap between digital world and the field of caregiving. Please review the questions in details from the PDF where interview questions are displayed in the attached PDF.

Participation is voluntary and there are no consequences for choosing not to participate or withdrawing from the study. Confidentiality of all participants will be maintained. The data will be kept secure and password protected. Your data will be only stored in my personal laptop and will not be exposed to any third party.

Any additional questions regarding the project can be directed to me, Yihao, Zhang at yihao6@ualberta.ca. Please email me if you're interested in participating in this study.

Respectfully,
Yihao, Zhang, Principle Investigator:
Visual Communication Design Graduate Student
University of Alberta

For Relative Participants

UNIVERSITY OF ALBERTA

Department of Art & Design
Faculty of Arts
3-98 Fine Arts Building
Edmonton, Alberta, Canada T6G 2C9
www.ualberta.ca/ARTDESIGN Tel: 780.492.3261
Fax: 780.492.7870
REB ID: Pro00103145

Email Recruitment Letter for Relatives of Elderly Participants

Study Title: Designing an Analysis System to Track Unusual Behavioural Patterns of Elderly Living Alone

Dear Participant:

Hello, my name is Yihao, Zhang and I am a Visual Communication Design graduate student in the Arts & Design Faculty in University of Alberta. As part of my master thesis research project, I am researching how to enable the elderly to continue living at home safely and longer by tracking and analyzing any unusual behavioural patterns and how The Future Of Smart Homes/Independent Senior Living can be developed and constantly improved by integrating the concepts of User-Centered Design (UCD), Artificial Intelligence (AI) and Internet of Things (IoT). I am recruiting the relatives of elderly who tend to stay by themselves to better understand how you normally take care of your elderly parents.

Online survey in the study will take approximately 20 minutes. If you would like to participate, I will ask that you provide your personal experience and other general questions regarding your personal experiences of elderly caring.

Participation is voluntary and there are no consequences for choosing not to participate or withdrawing from the study. Confidentiality of all participants will be maintained. The data will be kept secure and password protected. Your data will be only stored in my personal laptop and will not be exposed to any third party.

Any additional questions regarding the project can be directed to me, Yihao, Zhang at yihao6@ualberta.ca. Please email me if you're interested in participating in this study.

Respectfully,
Yihao, Zhang, Principle Investigator:
Visual Communication Design Graduate Student
University of Alberta

2.3. Information Letter and Signed Consent Form

For Adult Caregiver Participants

UNIVERSITY OF ALBERTA
RESEARCH ETHICS OFFICE

Interview Information Letters and Consent Form (For Adult Caregivers Participants)

Study Title: Designing an Analysis System to Track Unusual Behavioural Patterns of Elderly Living Alone

Research Investigator:

Yihao, Zhang
Department of Art & Design
3-98 Fine Arts Building
University of Alberta
Edmonton, AB, T6G 2C9
yihao6@ualberta.ca
+1 (587)-974-3419

Supervisor:

Aidan Rowe
Department of Art & Design
3-98 Fine Arts Building
University of Alberta
Edmonton, AB, T6G 2C9
aidan.rowe@ualberta.ca
+1 (780)-492-8591

Background

- You are invited to participate in this study to contribute to the design of technology to provide significant support for the community in tracking and analyzing any unusual behaviours of elderly people without caretakers, using intelligent devices that support their daily lives.
- Interviews will be conducted online through Zoom and will be used to collect information in terms of your ideas, opinions or experiences based on your needs, expectations, demands, pain-points, comfort points related to elderly who tend to stay by themselves at home. Often, this group of users require care taking service but they are unable to afford the high-cost of care-taking services. It is important to consider that your responses will be extremely useful and helpful as one of the most critical components in my research.
- The study's findings are used to inform my dissertation. The information I receive from you will also allow me to form development ideas for this research.

Purpose
The work seeks to offer a significant support to the family to detect and evaluate abnormal behavioural patterns in their elderly parents who do not have caregivers in their homes through the use of smart devices. My work will also concentrate on elderly people with an awareness of their context, suffering and desires in order to develop possible solutions by making a range of development assumptions based on my target audience's cultural background, preferences, individual attitudes and living patterns.

Study Procedures
- For this study I will be conducting 2 semi-structured interviews with adult caregivers.
- As an adult caregivers interview I will follow a semi-structured format, where you would be expected to engage with me in a dialogue focused on the themes of my study, specifically in the overlap between your experience in your life and my research project. My interview will

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follow a guide and lead-in questions, but otherwise the goal is to have a conversation that follows an open-ended format.

- Each interviewee will be expected to engage in one interview of approximately 60 minutes.
- Your interview will optimally be conducted online via internet (VoIP) such as Zoom, Google Hangouts, etc.
- Audio from each interview will be recorded and relevant portions of the audio will be transcribed.
- Type(s) of data to be collected:

> 2 adult caregivers participants one-one interviews (60 minutes in length) that follow a format of back-and-forth dialogue, reflection and critique.
> Your name, age will be publicly identified/associated with your interview responses. Pseudonyms will be used on request.
> Interviews will be recorded using a digital voice recorder and then relevant portions of the interview will be transcribed. I will index and mark meaningful sections from each interview and then further analyze the data to reveal interrelationships and themes.
> All audio data from your interview will be retained and possibly reused for future studies.

- Procedures for reviewing and responding to your interview data:

> I will upload the raw data (audio recording) from your interview into a secure, encrypted Google Drive folder within 2 weeks after your interview date and email you a private link. You will have the ability to edit, change or withdraw data that you have contributed via an ongoing back-and-forth dialogue with me, for the 6 weeks following your receipt of the raw data (i.e. from the day that I email you the link to your interview audio).
> Any follow-up conversations will also be audio recorded.
> Relevant portions of the interviews and follow-up conversations will be transcribed. I will index and mark meaningful sections from each interview and then further analyze the data to reveal interrelationships and themes.

- Portions of audio data recorded during your interview may be used as written quotes in the study document.

- **The research portion of this project will run from November 2020 to no later than September 2021.**

Benefits
This interview will not specifically benefit the participant. The knowledge that I get from this interview can allow me to better understand how I can improve and provide a better life for the elderly.

Risk
There are no foreseeable risks for the participant resulting from participation in this research.

Voluntary Participation
You are under no obligation to participate in this interview. Participation is completely voluntary. However, withdrawal during the interview is possible at any time up to one week after the collection of data.

Confidentiality & Anonymity

- The intended uses of this research are for thesis research and writing only. Participants will not be personally identified in any of these.

- All data will be kept confidential, with the Primary Investigator being the only person with access to the data.
- Anonymity during the interview will be guaranteed.
- All the research data that I collect from participants and personal information of participants will be kept on an encrypted backup of my files in my own laptop.
- Participants will not receive a copy of a report of the research findings but you can contact the Principal Investigator if you have an interest in receiving such materials.
- I will not use the data that I collect from participants during the interview for any other future research.

Contact Information

If you have any further questions regarding this interview or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement

I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Xiaoyue Su	11/05/2020
Participant's Name (printed) and Signature	Date
Yihao Zhang	2020. 11. 05
Name (printed) and Signature of Person Obtaining Consent	Date

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- All data will be kept confidential, with the Primary Investigator being the only person with access to the data.
- Anonymity during the interview will be guaranteed.
- All the research data that I collect from participants and personal information of participants will be kept on an encrypted backup of my files in my own laptop.
- Participants will not receive a copy of a report of the research findings but you can contact the Principal Investigator if you have an interest in receiving such materials.
- I will not use the data that I collect from participants during the interview for any other future research.

Contact Information

If you have any further questions regarding this interview or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement

~~I have read this form~~ and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Guojian Fu	11/05/2020
Participant's Name (printed) and Signature	Date
Yihao Zhang	2020.11.05
Name (printed) and Signature of Person Obtaining Consent	Date

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For Elderly Participants

UNIVERSITY OF ALBERTA
RESEARCH ETHICS OFFICE

Interview Information Letters and Consent Form (For Elderly Participants)

Study Title: Designing an Analysis System to Track Unusual Behavioural Patterns of Elderly Living Alone

Research Investigator:

Yihao, Zhang
Department of Art & Design
3-98 Fine Arts Building
University of Alberta
Edmonton, AB, T6G 2C9
yihao6@ualberta.ca
+1 (587)-974-3419

Supervisor:

Aidan Rowe
Department of Art & Design
3-98 Fine Arts Building
University of Alberta
Edmonton, AB, T6G 2C9
aidan.rowe@ualberta.ca
+1 (780)-492-8591

Background

- You are invited to participate in this study to contribute to the design of technology to provide significant support for the community in tracking and analyzing any unusual behaviours of elderly people without caretakers, using intelligent devices that support their daily lives.
- Interviews will be conducted online through Zoom and will be used to collect information in terms of your ideas, opinions or experiences based on your needs, expectations, demands, pain-points, comfort points related to elderly who tend to stay by themselves at home. Often, this group of users require care taking service but they are unable to afford the high-cost of care-taking services. It is important to consider that your responses will be extremely useful and helpful as one of the most critical components in my research.
- The study's findings are used to inform my dissertation. The information I receive from you will also allow me to form development ideas for this research.

Purpose
The work seeks to offer a significant support to the family to detect and evaluate abnormal behavioural patterns in their elderly parents who do not have caregivers in their homes through the use of smart devices. My work will also concentrate on elderly people with an awareness of their context, suffering and desires in order to develop possible solutions by making a range of development assumptions based on my target audience's cultural background, preferences, individual attitudes and living patterns.

Study Procedures
- For this study I will be conducting 6 semi-structured interviews with elderly relatives in my home.
- As an elderly interview I will follow a semi-structured format, where you would be expected to engage with me in a dialogue focused on the themes of my study, specifically in the overlap between your experience in your life and my research project. My interview will

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follow a guide and lead-in questions, but otherwise the goal is to have an conversation that follows an open-ended format.

- Each interviewee will be expected to engage in one interview of approximately 60 minutes.
- Your interview will optimally be conducted online via internet (VoIP) such as Zoom, Google Hangouts, etc.
- Audio from each interview will be recorded and relevant portions of the audio will be transcribed.
- Type(s) of data to be collected:

> 6 elderly participants one-one interviews (60 minutes in length) that follow a format of back-and-forth dialogue, reflection and critique.
> Your name, age will be publicly identified/associated with your interview responses. Pseudonyms will be used on request.
> Interviews will be recorded using a digital voice recorder and then relevant portions of the interview will be transcribed. I will index and mark meaningful sections from each interview and then further analyze the data to reveal interrelationships and themes.
> All audio data from your interview will be retained and possibly reused for future studies.

- Procedures for reviewing and responding to your interview data:

> I will upload the raw data (audio recording) from your interview into a secure, encrypted Google Drive folder within 2 weeks after your interview date and email you a private link. You will have the ability to edit, change or withdraw data that you have contributed via an ongoing back-and-forth dialogue with me, for the 6 weeks following your receipt of the raw data (i.e. from the day that I email you the link to your interview audio).
> Any follow-up conversations will also be audio recorded.
> Relevant portions of the interviews and follow-up conversations will be transcribed. I will index and mark meaningful sections from each interview and then further analyze the data to reveal interrelationships and themes.

- Portions of audio data recorded during your interview may be used as written quotes in the study document.

- **The research portion of this project will run from November 2020 to no later than September 2021.**

Benefits
This interview will not specifically benefit the participant. The knowledge that I get from this interview can allow me to better understand how I can improve and provide a better life for the elderly.

Risk
There are no foreseeable risks for the participant resulting from participation in this research.

Voluntary Participation
You are under no obligation to participate in this interview. Participation is completely voluntary. However, withdrawal during the interview is possible at any time up to one week after the collection of data.

Confidentiality & Anonymity

- The intended uses of this research are for thesis research and writing only. Participants will not be personally identified in any of these.

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- All data will be kept confidential, with the Primary Investigator being the only person with access to the data.
- Anonymity during the interview will be guaranteed.
- All the research data that I collect from participants and personal information of participants will be kept on an encrypted backup of my files in my own laptop.
- Participants will not receive a copy of a report of the research findings but you can contact the Principal Investigator if you have an interest in receiving such materials.
- I will not use the data that I collect from participants during the interview for any other future research.

Contact Information

If you have any further questions regarding this interview or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement

I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Hongshu Yu — Participant's Name (printed) and Signature — 2020.11.13 — Date

Name (printed) and Signature of Person Obtaining Consent — NOV 13/2020 — Date

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- All data will be kept confidential, with the Primary Investigator being the only person with access to the data.
- Anonymity during the interview will be guaranteed.
- All the research data that I collect from participants and personal information of participants will be kept on an encrypted backup of my files in my own laptop.
- Participants will not receive a copy of a report of the research findings but you can contact the Principal Investigator if you have an interest in receiving such materials.
- I will not use the data that I collect from participants during the interview for any other future research.

Contact Information

If you have any further questions regarding this interview or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement

I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Yihao Zhang — 2020.11.15

Participant's Name (printed) and Signature — Date

Name (printed) and Signature of Person Obtaining Consent — NOV 15/2020 Date

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- All data will be kept confidential, with the Primary Investigator being the only person with access to the data.
- Anonymity during the interview will be guaranteed.
- All the research data that I collect from participants and personal information of participants will be kept on an encrypted backup of my files in my own laptop.
- Participants will not receive a copy of a report of the research findings but you can contact the Principal Investigator if you have an interest in receiving such materials.
- I will not use the data that I collect from participants during the interview for any other future research.

Contact Information

If you have any further questions regarding this interview or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement

I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Wenling Dong — Participant's Name (printed) and Signature — Date: 11/02/2020

Name (printed) and Signature of Person Obtaining Consent — Date: NOV 02/2020

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- All data will be kept confidential, with the Primary Investigator being the only person with access to the data.
- Anonymity during the interview will be guaranteed.
- All the research data that I collect from participants and personal information of participants will be kept on an encrypted backup of my files in my own laptop.
- Participants will not receive a copy of a report of the research findings but you can contact the Principal Investigator if you have an interest in receiving such materials.
- I will not use the data that I collect from participants during the interview for any other future research.

Contact Information

If you have any further questions regarding this interview or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement

I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Chuanwen Zhang — 11-02-2020

Participant's Name (printed) and Signature — Date

— NOV 02/2020

Name (printed) and Signature of Person Obtaining Consent — Date

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For Relatives Participants

UNIVERSITY OF ALBERTA
RESEARCH ETHICS OFFICE

Survey Information Letters and Consent Form (For Relatives Participants)

Study Title: Designing an Analysis System to Track Unusual Behavioural Patterns of Elderly Living Alone

Research Investigator:

Yihao, Zhang
Department of Art & Design
3-98 Fine Arts Building
University of Alberta
Edmonton, AB, T6G 2C9
yihao6@ualberta.ca
+1 (587)-974-3419

Supervisor:

Aidan Rowe
Department of Art & Design
3-98 Fine Arts Building
University of Alberta
Edmonton, AB, T6G 2C9
aidan.rowe@ualberta.ca
+1 (780)-492-8591

Background

- You are invited to participate in this study to contribute to the design of technology to provide significant support for the community in tracking and analyzing any unusual behaviours of elderly people without caretakers, using intelligent devices that support their daily lives.
- Survey questions will be conducted online via Typeform and will be used to collect information in terms of your ideas, opinions or experiences based on your needs, expectations, demands, pain-points, comfort points of your personal experience related to how your take care of your elderly parents who tend to stay by themselves at home. Often, this group of users require care taking service but they are unable to afford the high-cost of care-taking services. It is important to consider that your responses will be extremely useful and helpful as one of the most critical components in my research.
- The study's findings are used to inform my dissertation. The information I receive from you will also allow me to form development ideas for this research.

Purpose

The work seeks to offer a significant support to the family to detect and evaluate abnormal behavioural patterns in their elderly parents who do not have caregivers in their homes through the use of smart devices. My work will also concentrate on elderly people with an awareness of their context, suffering and desires in order to develop possible solutions by making a range of development assumptions based on my target audience's cultural background, preferences, individual attitudes and living patterns.

Study Procedures

- For this study I will be conducting an online survey with a few relatives who have their elderly parents to take care of from my family.
- As an online survey I will follow a survey question format, where you would be expected to answer each question listed and you should be focusing on the themes of my study,

specifically in the overlap between your personal experience with your elderly parents and my research project.
- Your survey will be expected to participate in one survey of approximately 20 minutes.
- Your survey will optimally be conducted online via Tyoeform.com.
- Responses from each survey will be transcribed.
- Type(s) of data to be collected:

> 7 relatives one-one survey (20 minutes in length) that follow a format survey questions format.
> Any responses from your survey will be transcribed. I will index and mark meaningful sections from each survey answers and then further analyze the data to reveal interrelationships and themes.
> All the data from your survey will be retained and possibly reused for future studies.

- Procedures for reviewing and responding to your survey data:

> I will upload the raw data (audio recording) from your interview into a secure, encrypted Google Drive folder within 2 weeks after your interview date and email you a private link. You will have the ability to edit, change or withdraw data that you have contributed via an ongoing back-and-forth survey with me.
> Any follow-up answers will also be added into my raw data.
> Relevant portions of the survey and follow-up conversations will be transcribed. I will index and mark meaningful sections from each survey and then further analyze the data to reveal interrelationships and themes.

- **The research portion of this project will run from November 2020 to no later than September 2021.**

Benefits
This survey will not specifically benefit the participant. The knowledge that I get from this survey can allow me to better understand how I can improve and provide a better life for the elderly.

Risk
There are no foreseeable risks for the participant resulting from participation in this research.

Voluntary Participation
You are under no obligation to participate in this survey. Participation is completely voluntary. However, withdrawal during the survey is possible at any time up to one week after the collection of data.

Confidentiality & Anonymity
- The intended uses of this research are for thesis research and writing only. Participants will not be personally identified in any of these.
- All data will be kept confidential, with the Primary Investigator being the only person with access to the data.
- Anonymity during the survey will be guaranteed.
- All the research data that I collect from participants and personal information of participants will be kept on an encrypted backup of my files in my own laptop.
- Participants will not receive a copy of a report of the research findings but you can contact the Principal Investigator if you have an interest in receiving such materials.
- I will not use the data that I collect from participants during the survey for any other future research.

Contact Information
If you have any further questions regarding this survey or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement
I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Dayi zhang — 11-21-2020
Participant's Name (printed) and Signature — Date

NOV 21/2020
Name (printed) and Signature of Person Obtaining Consent — Date

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Contact Information
If you have any further questions regarding this survey or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement
I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Qing Yu Li
Participant's Name (printed) and Signature

11/17/2020
Date

Name (printed) and Signature of Person Obtaining Consent

NOV 17/2020
Date

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Contact Information
If you have any further questions regarding this survey or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement
I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Participant's Name (printed) and Signature — Date: 2020年11月27/19

Name (printed) and Signature of Person Obtaining Consent — Date: NOV 27/2020

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Contact Information
If you have any further questions regarding this survey or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement
I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Li Zhang — Participant's Name (printed) and Signature — 11. 14. 2020 — Date

Name (printed) and Signature of Person Obtaining Consent — Nov 14/2020 — Date

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Contact Information
If you have any further questions regarding this survey or study, please do not hesitate to contact Yihao. Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement
I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Yihao Zhang — 11.16.2020
Participant's Name (printed) and Signature — Date

Name (printed) and Signature of Person Obtaining Consent — Nov 16/2020
Date

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Contact Information
If you have any further questions regarding this survey or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement
I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Bin Zhang — 11.20.2020
Participant's Name (printed) and Signature — Date

Name (printed) and Signature of Person Obtaining Consent — NOV 20/2020 Date

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For Expert Participants

UNIVERSITY OF ALBERTA
RESEARCH ETHICS OFFICE

Interview Information Letters and Consent Form (For Expert Participants)

Study Title: Designing an Analysis System to Track Unusual Behavioural Patterns of Elderly Living Alone

Research Investigator:

Yihao, Zhang
Department of Art & Design
3-98 Fine Arts Building
University of Alberta
Edmonton, AB, T6G 2C9
yihao6@ualberta.ca
+1 (587)-974-3419

Supervisor:

Aidan Rowe
Department of Art & Design
3-98 Fine Arts Building
University of Alberta
Edmonton, AB, T6G 2C9
aidan.rowe@ualberta.ca
+1 (780)-492-8591

Background

- You are invited to participate in this study to contribute to the design of technology to provide significant support for the community in tracking and analyzing any unusual behaviours of elderly people without caretakers, using intelligent devices that support their daily lives.
- Interviews will be conducted online through Zoom and will be used to collect information on your ideas, opinions, or experiences based on your knowledges in the field of Artificial Intelligence (AI), Human-Compuetr Interaction(HCI) and/or Care of the Elderly. Interviews occur based on the agreement of both parties have made before through email or phone. Furthermore, since not only is my project driven by the use of Artificial Intelligence, but also certain HCI and Care of the Elderly approaches will be covered. Therefore, conducting an interview with you allows me to have a focused, conversational and two-way communication with the people who provide supportive concepts/perspectives between AI, HCI and HA with me. In this method, I encourage you to have the freedom to express your views in your own terms.
- The study's findings are used to inform my dissertation. The information I receive from you will also allow me to form development ideas for this research.

Purpose

The work seeks to offer a significant support to the family to detect and evaluate abnormal behavioural patterns in their elderly parents who do not have caregivers in their homes through the use of smart devices. My work will also concentrate on elderly people with an awareness of their context, suffering and desires in order to develop possible solutions by making a range of development assumptions based on my target audience's cultural background, preferences, individual attitudes and living patterns.

Study Procedures

- For this study I will be conducting 3 semi-structured interviews with experts and industry professionals in the areas of Artificial Intelligence, Human-Computer Interaction, and Care of the Elderly

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- As an expert interview I will follow a semi-structured format, where you would be expected to engage with me in a dialogue focused on the themes of my study, specifically in the overlap between your area of expertise and my research project. My interview will follow a guide and lead-in questions, but otherwise the goal is to have an conversation that follows an open-ended format.
- Each interviewee will be expected to engage in one interview of approximately 60 minutes.
- Your interview will optimally be conducted online via internet (VoIP) such as Zoom, Google Hangouts, etc.
- Audio from each interview will be recorded and relevant portions of the audio will be transcribed.
- Type(s) of data to be collected:

> 3 experts one-one interviews (60 minutes in length) that follow a format of back-and-forth dialogue, reflection and critique.
> Your name, position and institution will be publicly identified/associated with your interview responses. Pseudonyms will be used on request.
> Interviews will be recorded using a digital voice recorder and then relevant portions of the interview will be transcribed. I will index and mark meaningful sections from each interview and then further analyze the data to reveal interrelationships and themes.
> All audio data from your interview will be retained and possibly reused for future studies.

- Procedures for reviewing and responding to your interview data:

> I will upload the raw data (audio recording) from your interview into a secure, encrypted Google Drive folder within 2 weeks after your interview date and email you a private link. You will have the ability to edit, change or withdraw data that you have contributed via an ongoing back-and-forth dialogue with me, for the 6 weeks following your receipt of the raw data (i.e. from the day that I email you the link to your interview audio).
> Any follow-up conversations will also be audio recorded.
> Relevant portions of the interviews and follow-up conversations will be transcribed. I will index and mark meaningful sections from each interview and then further analyze the data to reveal interrelationships and themes.

- Portions of audio data recorded during your interview may be used as written quotes in the study document.

- **The research portion of this project will run from November 2020 to no later than September 2021.**

Benefits
This interview will not specifically benefit the participant. The knowledge that I get from this interview can allow me to better understand how I can improve and provide a better life for the elderly.

Risk
There are no foreseeable risks for the participant resulting from participation in this research.

Voluntary Participation
You are under no obligation to participate in this interview. Participation is completely voluntary. However, withdrawal during the interview is possible at any time up to one week after the collection of data.

Confidentiality & Anonymity

- The intended uses of this research are for thesis research and writing only. Participants will not be personally identified in any of these.
- All data will be kept confidential, with the Primary Investigator being the only person with access to the data.
- Anonymity during the interview will be guaranteed.
- All the research data that I collect from participants and personal information of participants will be kept on an encrypted backup of my files in my own laptop.
- Participants will not receive a copy of a report of the research findings but you can contact the Principal Investigator if you have an interest in receiving such materials.
- I will not use the data that I collect from participants during the interview for any other future research.

Contact Information

If you have any further questions regarding this interview or study, please do not hesitate to contact Yihao, Zhang at yihao6@ualberta.ca. When you finish signing the form, please return this form to me by sending me an email.

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta. If you have questions about your rights or how research should be conducted, you can call (780) 492-2615. This office is independent of the researchers.

Consent Statement

I have read this form and the research study has been explained to me. I have been given the opportunity to ask questions and my questions have been answered. If I have additional questions, I have been told whom to contact. I agree to participate in the research study described above and will receive a copy of this consent form. I will receive a copy of this consent form after I sign it.

Participant's Name (printed) and Signature	Date 21/15/21
Yihao Zhang Name (printed) and Signature of Person Obtaining Consent	21.01.15 Date

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Confidentiality & Anonymity

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Bin Lee 李冰 — Participant's Name (printed) and Signature

11 | 14 | 2020 — Date

Yihao Zhang — Name (printed) and Signature of Person Obtaining Consent

20.11.14 — Date

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Confidentiality & Anonymity

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Lili Liu _____ Oct 23, 2020

Participant's Name (printed) and Signature — Date

Yihao Zhang _____ 20.10.15

Name (printed) and Signature of Person Obtaining Consent — Date

2.4. Interview/Survey Transcripts

Note: Some transcripts the participants expressed in this section are not original words of them because they answered in the way of Mandarin, Chinese, and some of them do not like me to show original words they said on my thesis report, thus I only summarize some key points which are supportive to my research. Due to the fact that these participants are non-English speakers, I therefore translated their words in English directly.

Xiaoyue Su

(Primary Users) - Adult Caregivers Interview

Yihao: Do you have any problems that worry your mom? And how do you think the latest care-giving technology is going to support her family?

Xiaoyue: *Both of my parents live on their own. They live right next to me so maybe they're 20 minutes away, I think. But it's fine, it's a nice gap, and it also provides them with freedom. My elderly mother's need to have help or assistance with daily chaos took a gradual course from the time she was unable to pay her bills because of the inability to handle the internet, which was essential in sorting out her related financial issues. She had also lost her mobility, making it a challenge to move around as she used to, and so, she needed help to run the daily errands. Inabilities associated with ageing piled up with different needs, such as help with doing her grocery shopping, preparing meals, and reminding her to eat, as well as assistance in taking her tablets. She needed support doing her laundry, cleaning her apartment, as well as her personal hygiene. In recent years, my dad is definitely her primary caregiver, but my dad wants his freedom as well. So he goes out and does business, he does errands, he doesn't even try to take my mom with him. She really wouldn't want to go. But my mom is-not that she's suffering from Alzheimer's, because right now she's having some visions, because she's already had some issues with a long past. And right now she's doing it for her medications. Whether my dad needs to run around to get something, even if he's out of the door, maybe he's in the yard, maybe he's going to have an episode, I guess it's going to worry me, so he may be up on the top of the stairs, or maybe she's just in the kitchen because she neglected to turn anything off. That's the big challenge, so she's missing something right now. He's going to send me a call to let me know whether he needs to go out for the day if he's going out and having lunch with his friends and family or whatever. I'm going to go over there if I can, and most of the time. So if I can't bear it for a second, then we're going to try to get it done together. Maybe she's*

going to come over to the building, or maybe I'm going to interrupt the period. It is though, disconcerting.

Yihao: Have you had your parents tried any caregiving technology in their home? If yes, how could your parents react with it?

Xiaoyue: In our situation, being able to protect their privacy without being invasive would be a wonderful thing to be able to realise that I can look at it at any moment, and just make sure Mon is okay. As I said, going up and down the stairs in particular, and now that she is losing her equilibrium, that is definitely her primary concern. Yet, security is a positive idea. Dad's going to do it all. My mum, I'd have to talk to her to get on board, but I think she'd actually forget that she's in her role if she said it the right way, just to be honest. It's not like she has no mobile, I hope, and she's a bit hard to hear, but if you ring the door, maybe she's not going to pick up the phone. So there may have been something to do with it, You're just calling and testing her or even talking, which makes me nervous because she's not answering her phone. It's really tense. You know, I just want to know if she's all right, particularly because Dad's just been on his merchandise, and I'm just calling to say hey, "or check her up, and she's not answering. Theoretically, it's 20 minutes to get there because I can't get in contact with her So, I'd want you to suggest, drop everything in the kitchen, juggle.

Yihao: How do you see your freedom when spending time taking care of your elderly parents?

Xiaoyue: *Only if you take care of yourself, you can have the strength to take care of others, you sacrifice yourself, see? The last to suffer is the people you take care of, no one can protect him/her as meticulous as you, no one can listen to him/her like you. I think the decision to help my parent was my own free will because I could have denied or neglected. If I spend too much time sacrificing my freedom for my elderly parents, I might be no longer able to guarantee a good quality of life for them and ourselves. I know my mom has a lot of personal needs in daily life. However, without caregivers, they face a harder life for sure. As a daughter, It was perfectly fine to help my mother for most of her personal needs, but for example I could not help her in the shower, it was not right for me. Thus, I may hire a caregiver in the future, and send them to the care home. Just finding someone and a place to take care of them in the professional way.*

Yihao: How would technology make your family's life easier?

Xiaoyue: *In our situation, it will be a wonderful idea to be willing to encourage them to maintain their*

freedom without being invasive and understanding that I can glance at it at any moment to make sure my mom's all right. If any kinds of technology can be the proper measure for solving our problem, I should learn more about it. You sometimes know without having freedom between us, our relationship may become embarrassing at some points, consequently, my energy can be taken away. Taking care with my mom, It was motivating to see my effort of assisting my mother working perfectly because it gave me positive energy and was never an energy loss. I believed that my mother needed to have the best life while staying at home and that really motivated us as a family caregiver. What I meant by best life is not only providing high quality of life, but freedom can also be guaranteed.

Guojian Fu

(Primary Users) - Adult Caregivers Interview

Yihao: Do you have any challenges of caring for your mom? And how do you consider how advanced caregiving technology could help her family?

Guojian: *So, my mom's 82 years old, and she lives by herself, but she's visited by a caregiver every day. She's just 15 minutes away from us, but she has rheumatoid arthritis, which ensures she has a number of trouble with movement. The caregiver I hired really helped me in taking care of my mom. I want to keep my own life maintained but at the same time fulfill with my her needs. Making parents to feel better while ageing was a driving factor that made me to meet their needs. Having known them in my life, I could easily see what they need and realized they were happy and feeling satisfied. Due to we are so busy in our own life, even though we live next to my mother, it's complicated for us to get to her easily often. Logistics is the main challenge. You can't be in college twice at a time, or you're picking up your child, or you're going to have to speak to your mom. Time is the second challenge. Only finding the opportunity to do it in the day, I mean, sometimes I feel guilty, but I think we should see her every day, and we don't. Instead of seeing her every day, we visit her each weekend. And it's bad because she's my wife, so you've got kids at the end of the day you've got a job, and there's just not enough time. We also asked her a number of times to come and live with us, only to see what she would think, because we're happy to make some improvements. I asked her if she might come and stay, but she didn't want someone to live with her. My mom prefers to live independently, and that makes life a little more difficult because she's not 100 per cent independent of the knowledge of people and her abilities to move about. But there's a matter of versatility. She's out talking, like she's fallen a number of times. I don't believe I was concerned that she fell down at the time, because we didn't even know about it. She fell back into the bathtub and then told us that she had sunk and struggled to drag herself out. As she crossed, she collapsed outside, because she was asleep, and someone saw her, helped her sit down and brought her back to her home. But it was only after the fact that we were able to find out about this and we never even knew when she collapsed, even when she was in distress, that she had the help she needed. Once I think about my mother-in-law, she won't be able to call for help if she crashes. Because of the moments she stumbled, her head hurt pretty bad, really. Second, my mother-in-law does not use English. She knows Chinese, so she's not going to call for help, and while she's conscious, she doesn't hesitate to make an urgent phone call or call.*

Yihao: Have you had your Mother-in-Law tried any caregiving technology in their home? If yes, how come?

Guojian: *She's wearing a necklace and if she's in distress, she's supposed to press it so other people want to talk with her via the box and message them, call the emergency services. Yet she was knocked unconscious when she fell, so she didn't push it and sometimes she simply didn't take it around. It's waterproof, like it was in the ocean, although at the time she didn't wear it. We just have peace of mind and it's better than nothing, but that's what we've got right now.*

Yihao: How do you see your freedom when spending time taking care of your elderly parents?

Guojian: *If someone makes me to take his/her orders, especially when helping meet essential needs, I would probably tell him/her that I want to make a choice myself. I believe it was my decision and motive to help my elderly parents, and so I should decide the tasks to assist. I believe that my parents are kind enough, they understand how painful for middle-aged adults when they have pressure from work, have to take their children at the same time to take care of elderly parents. Thus, my parents won't put pressure on me, they can handle their own lives as much as they can. At the end of the day if they are getting weak with their mobility, I could even hire a professional senior caregiver for them.*

Yihao: How would technology make your family's life easier?

Guojian: *She would have been delighted to have it, I suppose. I don't believe she would be happier to have any kind of technical connection to know that if she slips, something is monitoring her, if she can't communicate to us properly, as long as it's something she doesn't have to contend with. If it was plug-and-play and installed and someone else was doing everything or having care of the parameters. As long as it wasn't something she had to handle. A big part of the difficulty is only trying to find one that suits, because it's not too intrusive.*

Hongshu Yu

(Elderly-Secondary Users) - Elderly Interview

Yihao: What is your age range?

Hongshu: *I am 65 years old now, and I am truning 66 years old next year on May.*

Yihao: Do you have children? If so, how many? Do they visit and help take care of you?

Hongshu: *I have one daughter and a son. They are both well into middle age. My children have ever asked me if I wanted to come to live with them because my children said they didn't see any other option at that point before care home, but my husband and I rejected. A few weeks ago, I moved to a care home while their dad was in the hospital. My children helped us to decorate our care home. They tried to make the new apartment as similar as possible to the old one. I have chronic pain, and I need a care home professional caregiver who can help me with my daily life because II know my children are busy. I feel very satisfied because I rarely bother my children with my problems. They have jobs and family, meaning they are independent on their own. I am happy taking care of myself. Everybody came together to get me settled after so much change. Other relatives in our family, some of them live far away, they all pitched in. So I think we are lucky.*

Yihao: Please describe your health condition.

Hongshu: *I have some chronic pains issues and I can't live without taking medications. I feel people automatically think that I can't talk, I can't do other things because chronic pains makes people lose their independence. I think the hardest things for me was to push past those barriers, and let people know I can handle stuff by myself in my life, and let people know that I am the person, with normal feelings and normal thoughts, and my body wasn't just like everyone else's. When there is a constant chronic pain, and that is what I started to have, and then the pain that gets to be severe, and then pain that steals things and take away things, that's really difficult for my everyday life. In 2015, I got chronic fatigue after a batch of glandular fever, and I mean that's a difficult condition anyway, but, on top of the cerebral palsy, it nearly finished me in the sense that, my mobility had declined significantly.*

Yihao: What best describes your current living arrangement? Do you live in a retirement home, community or your own family home?

Hongshu: *I live in the care home or retirement home with my husband. Lucky, our care home program very much encourages seniors living here to personalize their rooms. When we first moved here, they asked us if there are any colours we don't like. So we had our freedom to choose our own Colours and my children helped us decorate it accordingly. We had to think about the availability of the transport for our children who come visit us or our friends even though my friends live with us 4 days a week for now. But also we had to think about getting our staff here.*

Yihao: Do you have any mobility problem to get around? If so, please describe in details.

Hongshu: *Yes, I do have mobility problems because of the constant chronic pain. I've been having symptoms since a few years ago. Since then, I have been having the mobility challenges. I have challenge of getting out of bed every morning, so I can't move around in bed. It's hard for me to get in and out of the chair can also be a challenge. Because I have a mobility challenge in one area, I have it in another or all three. My children bought me a walker, it is a walking aid, it is not intended to help me sit down or stand up, but preventing me from falling or other physical risks. I also got a mobility tool for getting out of bed, which offers a stable guidance for mobility tasks like getting in and out of bed. It also helps me to transfer in and out of bed more effectively, I got better balance and better stability.*

Yihao: Please describe about your daily activities at home.

Hongshu: *Yesterday I was going to eat a biscuit, go tolit up and down up and down, because I am living in care home. I like doing things myself and I don't like to give up my independence and I might be a little slower, however, I can still do things for myself like dressing, and sometimes cooking. I know I can't look after myself fully but I hope to try my best to do what I can do.*

Yihao: What factors could impact your overall happiness? (e.g. doing household chores, getting exercise)

Hongshu: *Because I have the constant chronic pain, I got to the point of, Why I am still here? The god treats unfairly. Not only the chronic pain brings out too much uncertainty and inconvenience to me, but does it also affect my family's life because they have to spend time taking care of me in their free time. I haven't thought about sharing my situation with others who are not ones of my family members. In Chinese, you share some of your personal information, but there are some parts that cannot be shared. For instance, it is hard to share family matters with outsiders because it is rarely people to understand you, and rumours will spread. The general observation of Chinese. This is not the life I want. This whole*

thing is meaningless. If this is going to be the rest of my life, perhaps, it would be better if I didn't have it. The worst thing is not feeling my value anymore because I lost my independence. And this is why I prefer to keep my illness private.

Yihao: Do you consider yourself limited or isolated from social connections? If so, what is your result of feeling distressed from being socially isolated?

Hongshu: *I guess I'm spending a lot of time on my own, but I don't feel alone. I've got a lot of passions. I've had a lot of strong encouragement. I'm not feeling lonely. I feel like family and friends are welcoming and involved even though I am living in this care home now. I sometimes feel like I'm an old burden because I always have to have somebody to take care of me because of my chronic pain. Because I have a mobility issues, it's hard impossible for me to participate any activities in my community outdoor without caregivers or family members being around, I sometimes feel I am isolated from outside the world.*

Yihao: From any do you seek help when you be alone at home suffering physical or mental health and issues in everyday life? What measures do you propose to solve them?

Hongshu: *I would share my converns with my family, talk to my loved ones openly and honestly. Maybe sometimes I consider including others who care about us in the conversation will help us get it through. I sometimes even have prepared some nots before our conversation or a list of concerns because I always forget things. The nots can help us focused and let my family know that I'm truely concerned. Next if I found a variety of outward warning indicators of weight loss or negative mood, depending on the case, I can inform my family and schedule a doctor's appointment. And I would like to ask for a follow-up appointment and for any prescription that might have been provided. Occasionally, I fell, but in my care home bedroom I removed the carpets and any potential hazards. To stop falls or handrails on the exterior steps, my family members helped me set up a grab bar in the toilet. Dad and I can't go to the closest store to purchase food, but we're saying something to help us out with the home care facility. These lovely individuals also do everything from cleaning the flat, preparing meals and running errands and assisting with regular activities such as bathing and washing, so when I feel good, I will dress on my own.*

Yihao: Do you like to live independently or live with your adult children?

Hongshu: *I am happy staying separately away from my children because there are many elderly people who are unhappy than me. I think if I live with my children, I can indeed enjoy the family happiness of having children and grandchildren around and having a good time. However, If my children and I live*

under the same roof, there will inevitably be bumps and bruises over time. Some small differences may lead to conflicts. The conflict is deep. It is difficult to reconcile. The final result is often the elderly and children, which are distressed. Therefore, some elderly people like us prefer to live alone as long as their living conditions allow. However, as I am getting older, I also need the care of my children. Therefore, if possible, we can live in the same neighbourhood or live near my children's homes. You know It has been said that parents and their children after they start a family, can keep a bowl of soup away from each other. In other words, if they live not far away from each other, and a bowl of soup is sent over, just not cold. Therefore, if there are conditions, the elderly and children do not need to live together, live in the same neighbourhood or live a little closer to relatively better. In this way, in my case, my children and I can visit each other to take care of each other and not to live together, bump and bang.

Yihao: Do you have a smart phone that can run application programs?

Hongshu: *Yes, my son brought me a phone last year, but I don't use any apps because I don't know how use them. I keep my family in touch through calling.*

Yihao: Do you use your phone's Apps? If so, how frequent is that?

Hongshu: *I use Wechat to talk to my family. My family calls me everyday to ask how are we doing and feeling everyday.*

Guanglu Zhang

(Elderly-Secondary Users) - Elderly Interview

Yihao: What is your age range?

Guanglu: *I'm 67 years old.*

Yihao: Do you have children? If so, how many? Do they visit and help take care of you?

Guanglu: *I have two children. My children used to come over to my place once two weeks because their mom and I live in the western part of downtown, Shanghai. However, my children used to live in Hangzhou, which has 3 hours driving distance from us. In those years, our health conditions were kinda stable, so we didn't need too many helps and cares from our children, and we didn't hire a caregiver to take of us. We knew that our children had to look after their children and were very bust at work, so we didn't want to put pressure on them because my family members will have less trouble if I take care of myself, because it is a good and necessary idea which makes me feel better. We tried to deal with the life by ourselves as much as we could. In recent years, as we grew older, our health has been gradually getting worse, especially their mom suffering from constant chronic pain, thus we realised we could no longer have our way on dealing with certain things in everyday life. My children asked me to move to our care home, but I rejected. Although they wanted to live with us to ensure our health is in good condition and give necessary supports when we need life assistance, but I felt I didn't like it.*

Yihao: Please describe your health condition.

Guanglu: *I am very active generally speaking and moving. I'm quite flexible except my shoulders and neck. I've had arthritis in the upper spine since my 50s and that affects the arms of course but otherwise my left shoulder has a frozen shoulder that's only this high being right-handed. I have kept the right one pretty mobile, I can reach up and down as much as I can, so I am feeling I am fortunate. However, I normally contact social workers from the elderly center for assistance in case I'm in serious health problems. Other tasks like taking medications and visiting the doctor, I do it myself, meaning I run my daily errands to strength my health.*

Yihao: What best describes your current living arrangement? Do you live in a retirement home, community or your own family home?

Guanglu: *I live with my wife at our care home. For my care home, I am satisfied with the place we are living in. We got good services from the program. Our services provide a much-needed service for us and other ageing people living here, and home bound seniors in our area. Well, it turns out we I can go shopping fairly often. If we want fresh food, if we want to eat fresh food, I can either go buy myself or senior care will do that for us. Sometimes, our children will do that for us too when they visit us. By the way, senior care can take us to the store. They help us buy food. They remind us of that it is we said we wanted. They make us feel, okay, somebody cares about us. Somebody cares about whether I survive or not. That is wonderful.*

Yihao: Do you have any mobility problem to get around? If so, please describe it in details.
Guanglu: *I do not have any problems to move around. I do some exercises outdoors in our community sometimes to keep my current health condition. I come to exercise downstairs of our building each day. It's been a habit. Exercise is good for health especially mobility. After doing the exercise, I'll feel refreshed. Health is of vital importance. Without health, you'll get nothing.*

Yihao: Please describe your daily activities at home.
Guanglu: *I try to keep my apartment clean. So that my children and others don't feel we are messy around. I also like to read newspaper, watching news on TV. Discussing with people about current international political matters. Sometimes, my children call to talk to us, so we feel not alone anymore. Additionally, our care home stuffs sometimes arrange ageing people to participate for exercising. The exercise is good and it certainly helps. In the morning I'm all stiff because of arthritis when I get up but when I finish with the exercise, I feel so flexible that I can do so much more.*

Yihao: What factors could impact your overall happiness? (e.g. doing household chores, getting exercise). Do you consider yourself limited or isolated from social connections? If so, what is your result of feeling distressed from being socially isolated?
Guanglu: *I volunteer across our community, with the exception of taking care of my wife. I've found that being with the kids brings me the emphasis. I've got a regular routine right now and I hope I should make a change to the community. When I retired from my profession, I felt sad and lonely. In my town, I signed up for a government scheme offering "second lives" and flexible working hours for the elderly in the region. I am now paying to help in the nearby kindergarten, where my full-time duties can be split into shifts to provide part-time care for several pensioners. I like it I can talk to a lot of people. I do the high-*

five, and I shake the paws of each.

Yihao: From any do you seek help when you be alone at home suffering physical or mental health and issues in everyday life? What measures do you propose to solve them?

Guanglu: *I play Tai Chi every morning because I have arthritis because we are all get special health and benefit from it. I joined a Tai Chi program for people with arthritis. In our practice, Taichi greatly improved my joint pain and physical function.*

Yihao: Do you like to live independently or live with your adult children?

Guanglu: *Living with children is a "difficult" problem. Because of differences in lifestyle and education, many ageing friends I know who are about the same age as me are reluctant to live with their children when housing conditions allow. Because of different living habits, it is not comfortable to live together. Young people and the elderly have different eating habits, work, and rest schedules. Like my children, due to work pressure, pay more attention to nutrition and calorie intake in their diet, so they like to eat more meat and heavy food, while for the elderly whose digestive system is declining or have various chronic diseases, it is better to have a light diet, so it is difficult for both sides to achieve unity in diet. In terms of work and rest, the elderly have a more regular life and usually go to bed early and get up early, while children generally prefer to sleep late. This makes both parties uncomfortable and feel tired of living together. If I live with my children for a long time, I may vent my emotions in my daily life when I am unhappy with them, and I feel that complaining plus whining tends to have a negative impact on me psychologically. Why would I vent my emotions? It's because most parents tend to have too high expectations of their children. So I try to understand and lower the expectations of my children. Now I have minimized my expectations toward my children. However, we have several tea gatherings in a year and I feel happy. They have their life and they are all very busy developing themselves.*

Yihao: Do you have a smart phone that can run application programs?

Guanglu: *My children bought me a one and bought another one for their mom. I basically do not use it. I am interested in using the internet to browse news, but I don't always use it.*

Yihao: Do you use your phone's Apps? If so, how frequent is that?

Guanglu: *I do not use any apps except Wechat because that could keep my children and I in touch.*

Wenying Dong

(Elderly-Secondary Users) - Elderly Interview

Yihao: What is your age range?

Wenying: *I am 70 years old.*

Yihao: Do you have children? If so, how many? Do they visit and help take care of you?

Wenying: *Yes, I have 2 sons and one daughter. They lived with their family outside of the town. I have 6 grandchildren also. They seldom visit us, especially on holidays. Because of their work and school, it's not possible to take a visit here frequently. But some of them helped us when it needs it as their parents required them. I have a caregiver who takes care of mine and lives close to my home. So I don't worry too much about my life.*

Yihao: Please describe your health condition.

Wenying: *As an older adult of 70 years old, my current health condition isn't fine. I am suffering from severe joint pain, which they called arthritis. This affects my neck, lower back, and thigh of mine. I couldn't sit and stand so long. Sometimes, this pain sustains so long in the head and neck area after sleeping or resting.*

Yihao: What best describes your current living arrangement? Do you live in a retirement home, community, or your own family home?

Wenying: *I live with my husband in a retirement apartment in the town. My children are living far away from us. My caregiver helps me with lifting, bathing, dressing, toileting, etc. But she doesn't live with us, sometimes I felt the need of emergency care, that time it's hard for me to find someone. My neighbors help me with their companionship and friendly behavior.*

Yihao: Do you have any mobility problems to get around? If so, please describe it in detail.

Wenying: *Yes, I do have some mobility problems. I can't walk freely to wherever I want, it's a bit hard for me to move around in my own living place and I also need a help when I go outdoor. Most of the time, I need help from my husband and caregiver. I felt pain over the leg joint. I need help while going up or*

going down the stairs. And sometimes I forgot something which I need to do that creates more problem.

Yihao: Please describe your daily activities at home.

Wenying: *I wake up early in the morning and then after brushing and washing, dressed up. Then I prepare our breakfast and my caregiver comes later. Sometimes I walked into my garden and read the newspaper. In the afternoon, I took my lunch and watch movies or read a book. I take rest a lot at this time. I normally visit the nearby flower market whenever I feel lonely, or do some window shopping in a nearby mall. I can bring myself into laughing by watching films and TV series because they make me feel relaxed. In the evening, I prepare and take my dinner and then watch TV for a while. Finally, I go to the bed early. My caregiver always reminds me about my medications.*

Yihao: What factors could impact your overall happiness? (e.g. doing household chores, getting exercise)

Wenying: *I like to do some household works and help my caregiver when she works. I love the company of others. Sometimes I feel lonely and then I walked in my garden and talk with my neighbors. This makes me happy. When my children and grandchildren visited my home, this makes me most happy.*

Yihao: Do you consider yourself limited or isolated from social connections? If so, what is your result of feeling distressed from being socially isolated?

Wenying: *I do have limited social connections with my surroundings. I do have regular contact with my caregivers. But I see my children after a long interval. We do talk over the phone. But I think if I have more people surrounding me that would help me a lot. I always love people's company.*

Yihao: From any do you seek help when you be alone at home suffering physical or mental health and issues in everyday life? What measures do you propose to solve them?

Wenying: *Sometimes I feel so lonely. When my caregiver stayed at my home, I talk with her. But when I am alone, I talk with my husband, but as he also suffers the same as me so, we sometimes watch old movies and hear old songs to make ourselves happy. In the case of physical difficulties, I do suffer a lot when someone not available in my home. I try to call my caregiver over the phone at that time.*

Yihao: Do you like to live independently or live with your adult children?

Wenying: *For my situation, I think I have to live independently. Living independently for the elderly is beneficial for us and our next generation. For example, many son-in-law just live with their mother-in-law not long ago. The two feelings are as good as mother and son. Once they get along for a long time, they will find their respective shortcomings, this time, the conflict is easy to happen. I have no idea whether my son-in-law will be happy staying with me or not. He may like me to the day, but tomorrow is uncertain. Many sons-in-law before marriage will consider whether to live with me. After all, we may have a competitive relationship.*

You know In-laws and sons-in-law are a generation apart in youth so that there is an unbridgeable generation gap. The age gap means that the generations are different. The way of life is even more diverse, and there is really no way that the habits of two generations living together are the same. I prefer not to live with them because young people order delivery online instead of cooking, eat noodles, milk tea. We feel that this is too malnourished to eat, that is, young people endure not to eat, but do not let the number of times to eat, the problem comes.

Yihao: Do you have a smart phone that can run application programs?

Wenying: *Yes, I have a smart phone, my son gave me and taught me how to make a call.*

Yihao: Do you use your phone's Apps? If so, how frequent is that?

Wenying: *I use mobile apps in very less frequent, I can't understand maximum applications. Sometimes, I open the weather app to learn the forecast, and sometimes I check the news. Smart phone today is pretty much convenient for people now. But I don't see myself relying on technology in the long run. It is not healthy and hurts our body. You should not use it frequently too.*

Chuanwen Zhang

(Elderly-Secondary Users) - Elderly Interview

Yihao: What is your age range?

Chuanwen: *I am 72 years old.*

Yihao: Do you have children? If so, how many? Do they visit and help take care of you?

Chuanwen: *I have 2 sons. They regularly visit and take care of me. They live close to my living place.*

PYihao: lease describe your health condition.

Chuanwen: *I am a very energetic person. Still I do regular exercises. I can walk and run in the morning and evening. I feel so fresh with my body condition at this age. Few months ago, I took medications for some migraine issue. But now, it seems okay. Sometimes, I got cramp in my leg after a long walking. Doctor's advice me to exercise moderately. Overall, I am good in my present condition.*

Yihao: What best describes your current living arrangement? Do you live in a retirement home, community, or your own family home?

Chuanwen: *I live in my apartment home. I have no caregiver still. Because I can do all of my work in myself. There are all facilities present in my apartment. Sometimes, I need help in past due to migraine issue and cramp. That time my children comes back to my apartment and help me. I do enjoy the company of them.*

Yihao: Do you have any mobility problems to get around? If so, please describe it in detail.

Chuanwen: *No, I don't have any mobility problems. Still, at the age of 72, I can walk and run. I do regularly go jogging in the morning and met new peoples. Some of these are my age and some are young. But someday, because of over-exercise, I got a cramp in my leg, but that diminished soon.*

Yihao: Please describe your daily activities at home.

Chuanwen: *I wake up very early in the morning, then brush my teeth, take a bath, and get dressed. In the morning, I go jogging with my friends. Then I come back and prepare my breakfast. Normally, I avoid heavy breakfast in the morning and avoid any meat products. I ate a lot of vegetables. Then I watch TV*

and read the newspaper to update me with the latest news. In the afternoon, I prepare my lunch and take a nap in the afternoon. I have three peers whom we meet almost every day, doing regular morning exercise while chatting and sharing during the day. There a tea gathering group that I can join after the morning exercise and this often brings a lot of joy. In the evening, I prepare my supper and after eating I again watched TV and then go to the bed early.

Yihao: What factors could impact your overall happiness? (e.g. doing household chores, getting exercise)

Chuanwen: *From the very young age, I love travelling; I travelled and make friends a lot even in recent years, but we have been suggested by the gov to remain staying at home because Covid-19 this year. I am a very much energetic and active person. I run my everyday errands, such as preparing meals, going to market, and doing household chaos. Furthermore, I am happy because I take care of myself and sometimes, hang out with friends to play majiang for over ten years. This helped me get accompany by other peoples after my retirement. I love gardening; I used to have a neat and clean garden in my backyard when I lived in the first floor in my last apartment. Every day, I don't miss walking and running with peoples. I always dance in the garden which is just right to cross the street from my apartment block with other elderly people whose ages are basically the same as mine.*

Yihao: Do you consider yourself limited or isolated from social connections? If so, what is your result of feeling distressed from being socially isolated?

Chuanwen: *I normally reschedule my daytime social engagements whenever I feel lonely and go out for a walk. For instance, I go out to navigate on the internet, visit the elderly center, and socialize with people, singing Cantonese opera, and listening to Cantonese opera, among others. I consider myself as very lucky to have social connections. I sometimes roam with peoples and talk to them every morning during jogging. Likewise, I have a good connection with my neighbours. They sent me gifts on occasions. I have many friends in the social media and this WeChat helps me to connect with them.*

Yihao: From any do you seek help when you be alone at home suffering physical or mental health and issues in everyday life? What measures do you propose to solve them?

Chuanwen: *Few months back, I got severe migraine problem, and this felt me sick for some days. That time I felt the need of support from my family. I called my children to come and take me to the doctor. I have the facility to call during any emergency problem. As well recently, I found a WeChat group where*

people help to the others whenever someone seeks some help. During my last leg cramp, I post here for a solution. Experts suggest me about what to do and what not.

Yihao: Do you like to live independently or live with your adult children?

Chuanwen: *My children and I have our own circle of friends. Elders and children living together, can not be separated, but must achieve spiritual independence. I don't like my children caring around me too much day and night, they should go out to have their own circle of friends and maintain their own interests. In addition, as elders I need to give young people a few suggestions: young people had better be financially independent. When a "growing child". There is no one right or wrong in the family, there is a trick to maintain family harmony, which is to turn a blind eye to some things, closed eyes, difficult to get confused.*

Yihao: Do you have a smart phone that can run application programs?

Chuanwen: *Yes, I have a smart phone with several application program.*

Yihao: Do you use your phone's Apps? If so, how frequent is that?

Chuanwen: *Yes, I use several social apps in my smart phone regularly. I have accounts in Wechat and Tiktok. I follow some of apps but I still want to learn more to know how to use these efficiently and easily.*

Dayi Zhang

(Relatives-Primary Auidence) - Survey

Yihao: Except your parents, do you have any other elderly relatives such as uncle or aunt?

Dayi: *I do, but they all live in Mainland, China. We live far away from each other.*

Yihao: Do you live with your elderly parents?

Dayi: *Yes. My husband and I live with my mother and father. My husband's father and mother live in China now.*

Yihao: If you do not live with your elderly parents, how far do you live from them?

Dayi: *I don't live with my parents.*

Yihao: If you do not live with your elderly parents, how often do you visit them?

Dayi: *Everyday*

Yihao: Have you considered putting your elderly parents to live in a care/nursing home?

Dayi: *Never*

Yihao: Do your elderly people in your family own mobile phones?

Dayi: *Not every elderly could understand smartphones. Like my mom, she has a smart phone, but she barely uses it because she is unable to check words, sentences and pictures etc on her phone. In China, there is a particular device designated for elderly, which is very popular. The words are usually bigger in the device. I have ever bought a tracking device for my parents, letting them to carry on their body while going for a walk around the neighborhood, but it seemed like the internet connection was poor, it was not working as well as it could.*

Yihao: Have you known any of physical unusual activities that your loved ones ever performed at home? (E.g. falling down, changes in gait)

Dayi: *Yes, my father has an Alzheimer. Sometimes he couldn't remember certain things so that causes*

him anxiety and angry.

Yihao: Do you have access to tools and resources to help you plan and/or access care for your elderly relatives?If so, which one of resources/tools is the most useful? (E.g. digital tools, general medical care)

Dayi: *Yes, I have ever used a blood pressure monitor for my parents.*

Yihao: Are you familiar with any digital technologies? Please be specific.

Dayi: *Yes, I am familiar with blood pressure monitor, blood sugar texting and home monitor system. For home monitor system, I bought it in China because my father has an Alzheimer. I brought it to Canada and it didn't perform well as I expected. Once my father got lost while he is walking around our neighborhood in Canada. He was carrying the tracking device that I gave to him when he left home. However, the tracking device was supported with 2G, which means there was no high internet connection speed as 4G did. The tracking device on his body has GPS, which was off for some reasons. Yesterday, one of my friends told me that there was an ageing man who got lost too, the policy sent out helicopter to search but never found that person. For my father, there were only two cops sitting in the car awaiting if he would appear. I felt unfairly. He would probably get lost if nobody has ever called the police, He walked five kilometers into the industrial zone by accident. That was dangerous. He was terrified when he tried to recall the story. He told me he only walked 500 meters when I asked him, obviously he had no ideas that his brain could no longer control his body.*

Mingyu Li

(Relatives-Primary Auidence) - Survey

Yihao: Except your parents, do you have any other elderly relatives such as uncle or aunt?

Mingyu: *Yes.*

Yihao: Do you live with your elderly parents?

Mingyu: *No.*

Yihao: If you do not live with your elderly parents, how far do you live from them?

Mingyu: *My parents live about 2 blocks away from our family.*

Yihao: If you do not live with your elderly parents, how often do you visit them?

Mingyu: *Everyday*

Yihao: Have you considered putting your elderly parents to live in a care/nursing home?

Mingyu: *I am planning to...*

Yihao: Do your elderly people in your family own mobile phones?

Mingyu: *Yes.*

Yihao: Have you known any of physical unusual activities that your loved ones ever performed at home? (E.g. falling down, changes in gait)

Mingyu: *Not Applicable.*

Yihao: Do you have access to tools and resources to help you plan and/or access care for your elderly relatives?If so, which one of resources/tools is the most useful? (E.g. digital tools, general medical care)

Mingyu: *Online research and personal care providers give us information.*

Yihao: Are you familiar with any digital technologies? Please be specific.

Mingyu: *Tv, camera, radio, phone, car, computer.*

Yan Zhang

(Relatives-Primary Auidence) - Survey

Yihao: Except your parents, do you have any other elderly relatives such as uncle or aunt?

Yan: *Yes. I have an uncle (your granduncle) who loves in Jilin province, China.*

Yihao: Do you live with your elderly parents?

Yan: *No, I don't.*

Yihao: If you do not live with your elderly parents, how far do you live from them?

Yan: *Your grandparents are living in Beijing, China, I live in Tianjin, China now. The driving distance is about 3 hours from where I live to their place.*

Yihao: If you do not live with your elderly parents, how often do you visit them?

Yan: *I visit them once per week.*

Yihao: Have you considered putting your elderly parents to live in a care/nursing home?

Yan: *Yes, I did, but it was not me having them to do. Because I have an unfilial brother (your uncle) who doesn't care taking any responsibility to his family, and I and currentlypersonally have no time to take care of your grandparents because of my ongoing projects. About one and half years ago, your grandparents volunteered to live in a nursing home in order to not put pressure on me. They are very kind.*

Yihao: Do your elderly people in your family own mobile phones?

Yan: *Your grandma doesn't but your grandpa does. He bought a Huawei smart phone which cost him 1,500 RMB.*

Yihao: Have you known any of physical unusual activities that your loved ones ever performed at home? (E.g. falling down, changes in gait)

Yan: *Your grandma had hemiplegia 3 years ago so she couldn't move around by herself. I heared that your hemiplegia even makes your grandma more difficult to grab objects by herself, and she has a poor balance such as walking, breathing and moving one side of her body etc.*

Yihao: Do you have access to tools and resources to help you plan and/or access care for your elderly relatives?If so, which one of resources/tools is the most useful? (E.g. digital tools, general medical care)

Yan: *No, I don't because I hired a daily caregiver who could take care of everything of your grandparents.*

Yihao: Are you familiar with any digital technologies? Please be specific.

Yan: *I am not a tech person. I only use Wechat to keep in touch with everyone. Your grandparents use it to. We always make video chat.*

Li Zhang

(Relatives-Primary Auidence) - Survey

Yihao: Except your parents, do you have any other elderly relatives such as uncle or aunt?

Li: No, *I don't.*

Yihao: Do you live with your elderly parents?

Li: *No, I don't.*

Yihao: If you do not live with your elderly parents, how far do you live from them?

Li: *For about 2.5 hours long from Tianjin to Beijing. They live in Beijing.*

Yihao: If you do not live with your elderly parents, how often do you visit them?

Li: *I go visit them once per week, sometimes I stay with them for about one week when I am free.*

Yihao: Have you considered putting your elderly parents to live in a care/nursing home?

Li: *They are living in a nursing home now.*

Yihao: Do your elderly people in your family own mobile phones?

Li: *Your grandpa owns a smart phone, your grandpa doesn't.*

Yihao: Have you known any of physical unusual activities that your loved ones ever performed at home? (E.g. falling down, changes in gait)

Li: *Your grandma sometimes cried in the night and her body was moved involuntarily.*

Yihao: Do you have access to tools and resources to help you plan and/or access care for your elderly relatives?If so, which one of resources/tools is the most useful? (E.g. digital tools, general medical care)

Li: *No, I don't.*

Yihao: Are you familiar with any digital technologies? Please be specific.

Li: *I don't get what you mean. I always take some photo shots to your grandparents.*

Hong Zhang

(Relatives-Primary Auidence) - Survey

Yihao: Except your parents, do you have any other elderly relatives such as uncle or aunt?

Hong: *Yes, my mother has 7 sisters, two of them were passed away. Your grandpa has two borthers who live on Shandong province, China.*

Yihao: Do you live with your elderly parents?

Hong: *No, I don't.*

Yihao: If you do not live with your elderly parents, how far do you live from them?

Hong: *About 25-30 minutes away from my place to their apartment.*

Yihao: If you do not live with your elderly parents, how often do you visit them?

Hong: *I go to see them 3 times a week.*

Yihao: Have you considered putting your elderly parents to live in a care/nursing home?

Hong: *No, never!*

Yihao: Do your elderly people in your family own mobile phones?

Hong: *My father does have one but he never use it. My mother does not.*

Yihao: Have you known any of physical unusual activities that your loved ones ever performed at home? (E.g. falling down, changes in gait)

Hong: *My mother is in a wheelchair, and she is not able to take care of herself because she has chronic kidney disease and Alzheimer's disease. My father walks with her crutch, which does not help a lot for his balance sometimes and we were really worried about his safety, but he was adamant that he could handle everything and he told us that he didn't want us to worry about him too much. However, he often fell and I remember one time he broke his right arm. I understand that because he was a solider, he pretends to be strong with his personality at all times.*

Yihao: Do you have access to tools and resources to help you plan and/or access care for your

elderly relatives?If so, which one of resources/tools is the most useful? (E.g. digital tools, general medical care)

Hong: *No, I don't. We hired a caregiver for them.*

Yihao: Are you familiar with any digital technologies? Please be specific.

Hong: *I don't use any technologies for taking care of my parents.*

Bin Zhang

(Relatives-Primary Auidence) - Survey

Yihao: Except your parents, do you have any other elderly relatives such as uncle or aunt?

Bin: *Yes, my mother has 7 sisters, two of them were passed away.*

Yihao: Do you live with your elderly parents?

Bin: *No, I don't. But I live close to them.*

Yihao: If you do not live with your elderly parents, how far do you live from them?

Bin: *3 blocks away.*

Yihao: If you do not live with your elderly parents, how often do you visit them?

Bin: *I don't visit them frequently.*

Yihao: Have you considered putting your elderly parents to live in a care/nursing home?

Bin: *No.*

Yihao: Do your elderly people in your family own mobile phones?

Bin: *I think my father has one.*

Yihao: Have you known any of physical unusual activities that your loved ones ever performed at home? (E.g. falling down, changes in gait)

Bin: *My father has issues to balance his body because he had a sugery 3 years before.*

Yihao: Do you have access to tools and resources to help you plan and/or access care for your elderly relatives?If so, which one of resources/tools is the most useful? (E.g. digital tools, general medical care)

Bin: *The caregiver really helps because we don't have much time.*

Yihao: Are you familiar with any digital technologies? Please be specific.

Bin: *I don't.*

Yichao Jin

(Artificial Intelligence (AI) Expert) - Expert Interview

Yihao: Could you describe your professional background?

Yichao: *I am currently working for an AI company in downtown, Shanghai and I am a product manager. I am AI expert but I am a product and tech guy who's passionate about creating intuitive UX's! Except my current company, I also experienced from leading product and tech across multiple startups within app/web-development, AI, so most of time I am a tech entrepreneur. For the most part I am keeping track and leading the product development and allocating tasks and team members. My job duty also consists of having a full market overview of our competitors, making sure deadlines are met, avoiding bottlenecks, talking and understanding the tech part of the development, present and talk to investors and stakeholders, making roadmap and scheduling, and also helping out the team whenever needed, including daily and weekly status meetings. Unless you have full control and others start to interfere, sometimes even without you knowing, some of my projects can quickly become chaos and we loose overview and control.*

Yihao: How do you see Artificial Intelligence (A)I and Improving Human Decision-Making can identify better ways for humans and machines to work together to solve important problems? And why?

Yichao: *Human beings have a competitive advantage in decision-making compared to machines. The choices made by a machine cannot be accepted by a human even if the decision is optimal. The computer may not be influenced by its actions, however the choices it creates will have an effect on humans. I believe that humans are likely to accept decisions made by members of the society, meaning they are not ready to follow the decisions made by a machine. Machine learning is a machine undertaking that lacks supervision and debate owing to the assumption that the machine doesn't have a person involved and people are not equipped to comprehend it entirely, rendering it less credible than human-led decision-making. In fact, this is the reason why humans question how the machine makes a decision. Undeniably, the algorithm of decision-making is questionable. The ability to have a global outlook makes humans to play critical roles in the process of decision-making while controlling the actions of AI in the final decision. If the machine fails, the designer will unplug it off. There is less trust in the power of machines because the current AI is prone to mistakes without human last control. Since humans are*

responsible still accountable of the choices they make, they still have an essential role to play in decision-making. The decision owner describes the rules of engagement and directs a decision maker, which can be a machine or humans in a concept called rule-based decisioning because execution is done according to the rules. For instance, the human is always in charge since rules are defined by knowledge elicited by a business information analyst.

Until it is clear that nobody has experienced a machine make a clear-cut decision and a combination of machines Artificial Intelligence (AI) with humans is a significant step to reach the optimal decision-making. With time we will be forced to change our opinion about AI because machines will gain legitimacy and become independent in decision-making. Thinking to be in charge or playing a critical role in decision-making will be eased taking away the human ego. The importance of partnership is to enable us humans to know who is in charge of the decision-making process. We cannot accept to process of decision-making to be fully given to machines, but maybe to a certain extent because there is no global view in machines. Machines do not integrate a synthesis function since they are designed and directed to handle a precise problem. Looking at the overall picture makes human beings better because they consider an evaluation of several factors in the process of decision-making. Some factors, such as feelings and ethics cannot be evaluated by a machine before making a decision. Understanding all the data patterns result from the explanation to the last detail because there will be no black boxes. Through the process of collaboration, the important task will be asking the machine correct questions. Due to expected changes in various circumstances, AI needs to adjust by having continuous tweaks. These circumstances include the market as well as rules and regulations, and in future, humans will be replaced by AI in repetitive and non-rewording tasks. The capacity and ability to analyze and evaluate huge amount of data through ML make Artificial Intelligence (AI) to have a consistent advantage. Undeniably, a precise model can be achieved when human beings mandate a machine to evaluate and analyze a huge number of cases since we can be limited to our experiences and memories, shifting the precision of decision-making. Decision-making and company laws require a completely integrated decision-making service focused on the rules laid down. In particular, the concept would entail the combination of a number of sub-models of algorithms to build a powerful AI, where each model has a specialization in decision-making for a specific mission. All the outputs will be synthesized because each model will give their decisions to a single algorithm model which will take the final decision. I believe that after the rules are extensively evaluated and validated, human beings can now be responsible of directing machines. In either ways humans will have to know and understand the decision made by a machine. To follow the right methodology, humans will have to

ensure provision of right data statistics to have a correct pattern.

Yihao: How many years have you been involved in the field of Human Body Recognition technology in AI?

Yichao: *I have been working on AI for years. I graduated from computer science engineering so everything between you know hardware and software I can very well actually take care of that and at the same time I want to take in professional business training.*

Yihao: Have you ever experienced any projects with the integration between Interaction Design and Human Body Recognition technology? If so, please describe.

Yichao: *Yes, as I said my current company is a start-up company that does AI business. The company's name is called Customize. It is the first AIot integrated cloud platform in Asia. The business model is very simple. We change our customers based on the number of cameras, months and AI models. The first competitive advantage is our AI innovation team. Our team differs from other teams. Our AI engineers are competent but also innovative. They utilize their AI knowledge and skills to innovate systems and apply them in complex instruction sites. The second competitive advantage is our AI algorithm. Our algorithm has been developed and modified since 2016 which is specifically for the construction industry. The third competitive edge is our extensive database. Because covid-19 is changing the way we work, and the construction industry is no exception to the problems posed by Covid. Construction requires a lot of workers on the site, sometimes the works very close together, which is a huge problem when it comes to social distancing and keeping workers healthy. Covid cases are growing every day too. So we think how can let construction stay on course and how to keep workers stay safe. By implementing AI and other technology into our company, we can ensure that their projects is on schedule and those workers are staying safe. We use HBD AI technology to achieve our goal and change the way how security can be ensured in construction course. AI and IoT can send social distancing alerts anywhere on the site to anyone at anytime, so we make sure ensuring workers stay the designated six feed apart. We realise that AI can also help with normal regulations like helmets and new regulations like face masks, using facial recognition to ensure everyone has both. By implementing these technologies we can you help ensure that workers are staying safe, and their project is on schedule and hopefully help stop the spread of Covid until we can get back to normal.*

Yihao: Could you provide a general knowledge of how Human Body Recognition/Object

Identification technology works?

Yichao: *Let's talk about facial recognition. So there are actually employ around seven facial expression s and those are meticulous so this is one thing about emotions but emotions is a superset I go deep in detail with it and be cool with the frowning face, you know the normal poker face, in my previous project we have smelling of laughing on the COS emoji. There are certain aspects between a rule, like your emotions the minute, so certain emotions are super said and it's pretty good to actually take them but then there certain things as well that you need to incorporate as a detailed explanation, so I actually saw a lot of people I didn't sort of analysis like what's going on these days and then one thing I'm trained like, this poker lips think it's been crazy. On the other hand, as you know we have experienced a lot of ways with facial recognition in the society, but I think Canada, America or other Western countries have restrictions on this. Some phones use facial recognition to grant access like iPhone and some governments like our government and USA, we are using such technology on database like drivers' licenses for so many reasons.*

Yihao: Do you think that the IoT can provide an advancement for smart caregiving applications and systems, which are equipped with sensors and mobile devices?

Yichao: *We think of new ways to approach healthcare because really today healthcare is kind of stagnant, it's kind of stuck in the old way of thinking and by going through some customer examples and some scenarios I hope to kinda change the mentality. I do believe that innovation can help ageing people avoid unsafe factors at home. I think Lot is able to connect everything to transmit data. For example, mobile phones, TV or cars and so many more of other devices. I think there are some featured benefits to highlight. First, people can use their apps to do anything today, with apps available to anyone with a smart device, doctors, caregivers, families can all stay connected from each other. The technology offers users with up to date information on their people who need care.*

Yihao: Does AI have useful applications in the field of caregiving?

Yichao: *In my knowledge, I never used it before but I've ever heard a lot about it. If you browse your Apple Store for USA, there are lots I believe. But in China, we are behind a bit for digital healthcare technology from the West.*

Yihao: What is the future impact of IoT on the ageing people and caregivers alike? How to protect users from certain potential risks in data privacy?

Yichao: *The family caregivers are most concerned about safety related things, like did dad take his medicine today, did grandma fall or get out of bed and these are people who have a lot to think about. They just got done raising their own kids and now they're being sucked back into caring for their parents when are they going tohave time to live their own lives. Most family caregivers today live over 100 miles away from the ones that they care for which is different from previous generations.These are people who want help and they want support, they don't want to feel guilty that they didn't do enough but they also just cannot afford the cost of professional care. Caregivers across the country are getting burned out plain and simple. Now the seniors on the other hand even though their eyesight is getting worse there they have arthritis their hearing is bad. They aren't so concerned about the risks. They face but they do feel the strain of psychological challenges. They can feel lonely but they don't want to be a burden on their family one of my friends shared his story with me that her father had fallen in the kitchen and he had his emergency button right there with him but him refused to press it and it was days until somebody actually found him on the floor he didn't want to be he was embarrassed about the situation and he just didn't want to be a burden on the rest of his family. There is an expectation of care and this is an idea that technology will adapt to us and you know we will be able to pull in all of this structured and unstructured data, but there's also, this real issue of privacy and concern and this really will bring up new business models I think the whole idea of computing on the edge will become more prevalent in the future. We're not going to want everything in the cloud, we want to own our data because right now all the companies on your data and they monetize it but what if you keep your records and you keep your data and you share it with who needs to know? I think that's key when you build out this type of solution who needs to know what you know if you want to prevent elder fraud.*

Lee Bing

(Human-Computer Interaction) - Expert Interview

Yihao: Could you describe your professional background?

Lee: *I am an UI/UX designer. I am living and working in Shenzhen, China now. I worked in Seattle last year as a full-time UI designer at Expedia group after graduating from U. I've been working in the design sphere for about four years and I have experience in creating mobile applications websites loggers and other brand attributes. I try to design not only from the visual side but also from market insight.*

Yihao: What is your role at Expedia Group?

Lee: *I build web-based platforms as a User Experience (UX) designer for travelling services professionals. My role and job description entail overseeing larger design teams to ensure they effective and efficient. Hands-on experience design is a good example of a leader and also to keep my skills in shape. Currently, I'm working in a capacity to enhance the migration of manual business processes to digital solution which will be cost and time effective for the interest of traveling services professionals.*

Yihao: How has your role evolved? What can you project about the future?

Lee: *For over three years, I have gained comprehensive experience in the field of user experience. Initially, there was little about service design, user, and customer experience. At the very beginning, the primary focus was on the aspect of user interface (UI). The evolution of user experience came gradually to become a holistic approach with tools and methodologies that I learned aggressively. The field has become interesting because being among the UX professionals, we bring strategic value to the table. While in school, I had an opportunity to build an organization based on UX and consider how I can fit it into an enterprise corporation. That is when I gained experience about interacting systems, teams, and individuals. As more organizations and enterprises invest in digital transformation, the evolution of experience design continues to rise. Advance in technology as well as emerging trends prompts us the UX to focus on concepts such as Virtual Reality (VR), Artificial Intelligence (AI), blockchain, and voice, among others. Therefore, as service professionals, we need to adjust our skills and experience to be able to work effectively in these new fields where methodologies and tools are still in their infancies. Personally, I believe that these changes make the field of experience design broad and more exciting.*

Yihao: What is common between user experience and experience design?

Lee: *There are various definitions of UX, including an interaction of a user with a system, service, or a product. Other definitions provide that all aspects of the interaction between end-user with products and services of the company encompass user experience. This is the definition by Jacob Nielsen and Don Norman. I think the definition is better when we use human experience because user experience is all about people or employees in the ecosystem experience. As a result, experience design is a mechanism to enhance human experience in a particular ecosystem. For example, the interaction between digital systems, physical space, dentist, assistant machines, and patients can be categorized as an exam in a dental ecosystem. Since it takes various aspects to enhance a process, experience design subdivided into many sub-disciplines.*

Yihao: How does service design work well?

Lee: *Service design aims to connect interactions between people or systems using touchpoints. As a result, it concepts creates a two-way understanding of the systems and people involved in the business process and their interactions. I can give you an example, I recently mapped out a publishing process that involved numerous aspects such as creating, reviewing, editing, approving for publication, marketing, compliance, and sales while communicating with customers. It is clear that this process is detailed since it involves distinct systems, individuals, and teams that need to play their roles in harmony. Different teams have issues and inefficiencies that are invisible and the efficiency of the methods of design will uncover and address such issues. Importantly, a service blueprint is essential in sharing an understanding of the identified issues across the members of the teams, making it easy to execute a discussion and plan for improvements.*

Yihao: Why is important to design beyond the product?

Lee: *The concept considers the interest of the client or the user to create and support human experience. It ensures that the discussion does not concentrate on the features of the product but the positive outcomes from the jobs being done. We have to avoid the assumption that everyone has a similar definition and understanding of the term 'product' because it is pretty vague. As I mentioned earlier, it is a challenge to provide the definition of a product based on where it starts and how it ends in publishing. The experience of human beings gain on a daily basis in not thought in terms of products. For instance, clients booking an airplane is thought to be interacting with our digital touch point and do not think about our products. The mental models of individuals are essential in creating the experience that*

can be used to design features of a product. Since companies need to appeal to several slices of the business, you cannot only rely on products but also on the key needs. A single slice will provide revenue for the organization but unlikely to satisfy the core needs or overall experience. Therefore, actors in the ecosystem are important when taking a holistic view of their experience to avoid situations that do not satisfy their core needs. These can be achieved by establishing efficient and intuitive tools that can successfully help to serve the user."

Yihao: Could you describe your capstone project completed during your master degree? (e.g what problems does it solve? what goals can it be achieved?)

Lee: *I designed an app called Elepho. It is a new system that facilitates the quality of contact between childcare services and parents. This software keeps parents well-informed, thus allowing the role of daycare teachers more manageable at the same time. I noticed that most adults have difficulty adjusting to their busy lives and experience the loss of time with children and friends, and the perceptions and concerns of parents regarding daycare facilities are diverse and change with the development of the children.*

Yihao: What research methods did you use in building a cohesion between using the knowledge/ perspectives/concepts of AI and Human-Computer Interaction?

Lee: *I conducted secondary research for literature review. This performed my research on blog posts, and forum discussions. Then I did primary research. I conducted an online survey and recruited through Facebook groups, daycare email lists, and online forums. The survey got 46 responses in total. I also conducted semi-structured interviews with 5 parents and 3 daycare teachers. Now when the research was ready, the problem was defined, I analyzed data and summarized research findings. I summarized users' needs and generated 2 personas. Brainstorming/Ideation was also important part of my research plan. I brainstormed on design opportunities, and sketched out possible ideas. Then, I invited users and discussed potential concepts, conducted a competitive analysis to further narrow down previous concepts and synthesized and selected the final concept. I performed research on the Media Richness theory and use it to exam different ideas, I developed information flows to generate the wireframes, low-fi and high-fi prototypes and tested with 3 parents and 1 teacher, and made changes accordingly. After all, I developed the visual system, physical models for other components. These were reflected on the design process.*

Lili Liu

(Adults and Family Caregivers) - Expert Interview

Yihao: Could you describe your professional background?

Lili: *I am an occupational therapist, researcher and academic administrator.*

Yihao: In your past research or real-life story, do you have any ageing participants who have disabilities? If so, what types of disability did they suffer from? And, how their lives were affected by their disability?

Lili: *Yes, I have worked with older adults with physical and cognitive disabilities. Those with physical disabilities experience challenges with accessibility and access to services. Those with cognitive disabilities experience challenges with social support, wayfinding and risks of going missing. They all experience issues related to autonomy and social support. For some elderly people in poor health, they mainly rely on their families to take care of themselves, their support for their children is greatly reduced, and they can no longer take on more responsibility for their children in terms of physical and financial resources. Consequently, for those children making personal sacrifices on taking care of their parents could possibility loss some of their freedom or their freedom is fully dismissed. The socialization ability of my participant vanished totally, she is unable to abandon her elderly mother in the hands of anyone. As they could not find a caregiver to take care of her, they had to let her go. However, for most healthy elderly people, taking care of household chores and grandchildren is a common form of giving back to their children.*

Yihao: If you did have your older adult participants with certain physical or mental disabilities, what kinds of supports and services do you think they need to improve their lives? Could you share at least one story for me?

Lili: *Most seek services and supports to help them enjoy their daily lives to the greatest extent possible. Family facing trouble to take care of their ageing parents may consider convincing their parents to live at care home. However, seeing additional individuals becoming caregivers, with no option; there are no more families residing adjacent, maybe they are the remaining family and the elderly individual is not willing to enroll in a convalescent home, or it is not affordable. Consequently, self-care for the elderly becomes important, this relates to self-care, hobbies or social connection with family and friends. The important thing is to identify what activities are meaningful to each person and then to find the*

ideal support to help them fulfill their wishes. These services/supports can be met through volunteers, neighbours, professionals or unlicensed service providers.

Yihao: What brings family together? Responsibility or love?

Lili: *It's really a lot of caring and obligation. For without it a family would not have been It's really a lot of caring and obligation. Joy, for without it a family would not have been viable in the first place. And accountability, because without that, the family wouldn't remain that way. At various stages of life, our affection for our families will be checked, which I can promise from my own personal experience. For example, Giving birth to my kids, they are mine. No inquiry ever came up if I was taking care of them or not. To admit that these kids require greater attention relative to the rest of the kids does not add up to anything. They are my kids; I will carter for their well being because nevertheless it is part of their requirement. Or, a guardian can become ill for decades, the time their kids were little, and the guardian did not for one time have to tell their kids to give them a helping hand. That's where the burden comes to the photo. You have a spiritual duty not to lose trust in the people of your family, to help them out in times of trouble and to love them in everything that you have to give. At the end of all that, if you continue to stick together, you'll know how much you've grown up as a person. Then you are worthy to expand your support to a lot of citizens who need it, and it brings you great pleasure to do so!! ..*

Yihao: Normally what factors/reasons could restrict physical activities in older people in their normal lives?

Lili: *Physical environments can present barriers to restrict physical activities. Other barriers include inaccessible technology (e.g., inadequate internet or lack of technology), minimal or difficult to use transportation which prevents them from getting to health appointments, do grocery or pick up medications.*

Yihao: Could you introduce an example illustrating the experience of people who provide support and assistance to an older person or a person with a disability?

Lili: *The Alzheimer Society in each geographic location provides many services to persons living with dementia, to their care partners and also education for the community. Family members can attend support groups and access materials to help them with their experience in caregiving. Persons living with dementia can access services on how to plan their journey living with the condition as it progresses. Currently, these services are also available virtually/online/remotely during COVID 19.*

Yihao: Which services or programs for older adults would you like to see provided or increased in the coming 5 years?

Lili: *This depends on the population(s) and conditions. During COVID 19, it is important for all older adults, regardless of their conditions, to have social support. Outreach programs that allow older adults to safely access social support with volunteers or service providers, in person would be ideal. Safety measures would have to be put in place to ensure that service recipients are safe.*

3.0. User Testing Feedback and Scores

Average Satisfaction Score: **3.3**

	Strongly Disagree				Strongly Agree
I won't have to worry too much about the safety and health of my parents if I use the monitoring app.	☐	☒	☐	☐	☐
I think I would like to use the app frequently.	☐	☐	☒	☐	☐
I would imagine that most users would learn to use this app	☐	☒	☐	☐	☐
I felt very confident using this app.	☐	☒	☐	☐	☐
I think that the elderly's personal privacy is fully taken into account when they are being monitored.	☐	☐	☐	☒	☐
I think the colour application matches the features communicated by different types of situation.	☐	☐	☒	☐	☐
I felt I had to learn how the sign-up process works before moving forward.	☐	☐	☐	☐	☒
I found the sign-up process was complex or confusing.	☐	☐	☐	☒	☐
I think the Night Time Summary is helpful in helping family caregivers to learn their parents' activities.	☐	☐	☒	☐	☐
I could understand in which meaning that each icon represents in the UI.	☐	☒	☐	☐	☐
I think calling 911 is sometimes unnecessary and the function should not be highlighted on the dashboard page.	☐	☐	☐	☐	☒
I believe the way of sending alert notifications to the family caregiver's phone is the most effective.	☐	☐	☐	☐	☒

Table 7. User testing result from participant A

Average Satisfaction Score: **4**

	Strongly Disagree				Strongly Agree
I won't have to worry too much about the safety and health of my parents if I use the monitoring app.	☐	☐	☐	☐	☒
I think I would like to use the app frequently.	☐	☐	☐	☐	☒
I would imagine that most users would learn to use this app	☐	☐	☐	☒	☐
I felt very confident using this app.	☐	☐	☐	☐	☒
I think that the elderly's personal privacy is fully taken into account when they are being monitored.	☐	☐	☐	☐	☒
I think the colour application matches the features communicated by different types of situation.	☐	☐	☐	☒	☐
I felt I had to learn how the sign-up process works before moving forward.	☐	☐	☒	☐	☐
I found the sign-up process was complex or confusing.	☐	☒	☐	☐	☐
I think the Night Time Summary is helpful in helping family caregivers to learn their parents' activities.	☐	☐	☐	☐	☒
I could understand in which meaning that each icon represents in the UI.	☐	☐	☐	☒	☐
I think calling 911 is sometimes unnecessary and the function should not be highlighted on the dashboard page.	☒	☐	☐	☐	☐
I believe the way of sending alert notifications to the family caregiver's phone is the most effective.	☐	☐	☐	☐	☒

Table 8. User testing result from participant B

Average Satisfaction Score: **3.0**

	Strongly Disagree				Strongly Agree
I won't have to worry too much about the safety and health of my parents if I use the monitoring app.	☐	☐	☐	☒	☐
I think I would like to use the app frequently.	☐	☐	☐	☒	☐
I would imagine that most users would learn to use this app	☐	☒	☐	☐	☐
I felt very confident using this app.	☐	☐	☒	☐	☐
I think that the elderly's personal privacy is fully taken into account when they are being monitored.	☐	☐	☐	☐	☒
I think the colour application matches the features communicated by different types of situation.	☐	☒	☐	☐	☐
I felt I had to learn how the sign-up process works before moving forward.	☐	☐	☐	☐	☒
I found the sign-up process was complex or confusing.	☐	☐	☐	☒	☐
I think the Night Time Summary is helpful in helping family caregivers to learn their parents' activities.	☐	☐	☐	☒	☐
I could understand in which meaning that each icon represents in the UI.	☐	☒	☐	☐	☐
I think calling 911 is sometimes unnecessary and the function should not be highlighted on the dashboard page.	☐	☒	☐	☐	☐
I believe the way of sending alert notifications to the family caregiver's phone is the most effective.	☐	☐	☐	☒	☐

Table 9. User testing result from participant C

4.0. Exhibition Documentation

4.1. Final Design Poster

usafe

Designing Usafe: An Analysis System that Tracks Unusual Behavioural Patterns to Support Elderly People Living Safely at Home Alone

Research Background

The research focuses on monitoring and analyzing unusual behavioural patterns of older adults who live alone at home, which will benefit families needing elderly caregiver-services. By integrating advanced technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT), a monitoring mobile application as part of the Usafe system is designed for family caregivers to monitor and analyze their elderly loved ones' daily activities. The ecosystem of the Usafe platform enables the elderly to live independently at home to stay healthy and safe.

Involved Research Methods

Quantitative Data Collection Methods

- *Online Survey for Primary Target Users (Family Caregivers)*

User-Centered Design (UCD) Approaches

- *Storyboard*
- *User Personas*
- *User Journey Maps*
- *User Empathy Maps*
- *Competitor App Analysis*

Quantitative Data Collection Methods

- *Semi-Structured Interviews with Primary Target Users (Family Caregivers)*
- *Semi-Structured Interviews with Secondary Target Users (Elderly)*
- *Semi-Structured Interview with Artificial Intelligence Expert*
- *Semi-Structured Interviews with Human-Computer Interaction Expert and Older Adults & Family Caregiving Expert*

Design Problem

Al-Shaqi, Mourshed, and Rezgui (2016) note that the world's senior citizen population continues to grow, and many elderly people like to live independently without daily support from their family members or caregivers. As a result, they may be more likely to experience a health issue (e.g. falling) and could develop a disability or lose mobility, which has a significant influence on the healthcare sector.

Major Design Opportunities

Preparation and Fast Responses Increase Chances of Living Longer and Better for Ageing People

Family members should pay attention to self-help and first aid for loved ones' health and safety. The rate of disability and death is high in old age, and disease's early symptoms are not always obvious. Often by the time symptoms are discovered, the disease has already become dangerous.

Safety is a Priority for an Ageing Individual Living Independently

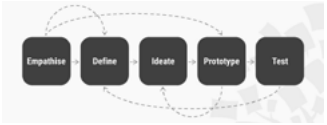
When it comes to the elderly living independently, health and safety should be considered a priority. Family caregivers could do better to minimize injury and distress suffered by their elderly loved ones. There are reasonably easy, rational safety steps that people can take to help keep their elderly parents and other loved ones healthy and safe.

Systematic Data Management Enables Uniformity of Artificial Intelligence (AI) Infrastructure Development (e.g., Human-Body Recognition)

Artificial Intelligence (AI) technology has a wide array of uses in the caregiving service sector. Human-Body Recognition (HBR) provides the technological support that involves an algorithm to track seniors' daily activities. Caregiving informatics is likely to benefit the most from AI technology. Using AI technology, patients can get information about what is ailing them and a possible treatment. The technology provides an opportunity to collect accurate information that enables decision-makers to act as soon as possible. The use of AI in body detection and sensory tracking saves human power and money, and it helps ensure better decision-making.

Design Process

My UX process is divided into 5 stages in the Design Thinking Process provided by Rikke Friis Dam and Teo Yu Siang.



5 stages in the Design Thinking Process (Image by Rikke Friis Dam and Teo Yu Siang)

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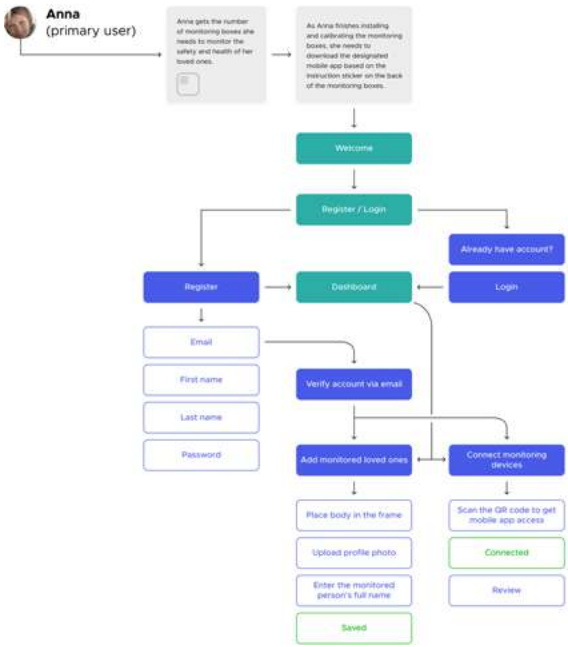
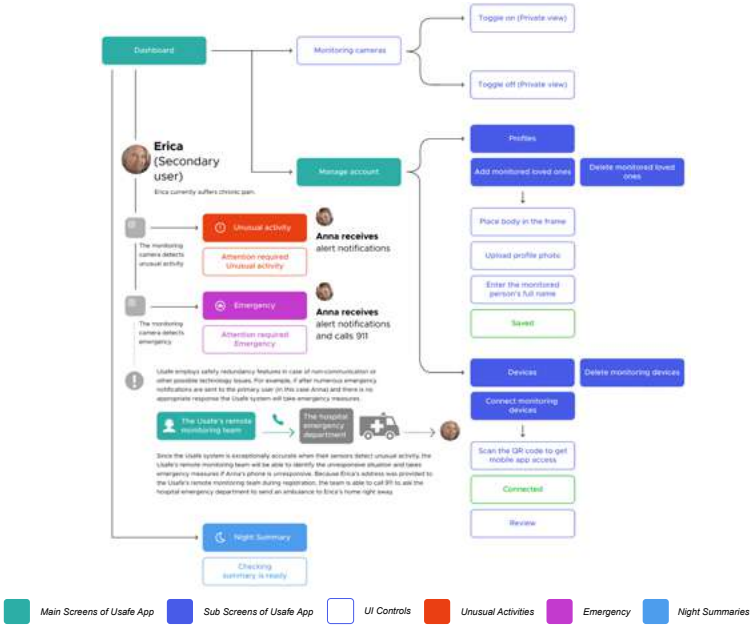
User Personas and Information Architecture

Driven by the target users, I developed the primary user as the family caregiver, and the secondary user as the elderly family member. The main user of the app is the primary user who utilizes the Usafe platform to monitor their loved ones' safety and health.



The second Information Architecture explains how the secondary user, elderly Erica, is saved by the technology. The physical sensory box detects sudden medical issues when Erica stays at home alone. The system sends an emergency alert push notification to the primary user, family caregiver Anna's phone.



Wireframes

A wireframe is for beginning the foundation of visual design, user interface and user experience. The wireframe creates the structure—the backbone—of the entire project layout, making it easier later to build individual parts. In other words, wireframes are low fidelity prototypes and about planning the flow of the user experience rather than the final visual outcomes, which will be addressed later.

Welcome

A brief introductory screen when new users open an app, website, or interactive experience. This screen consists of brand identity and brand name, which is recognized throughout the entire design.

Register / Login

Users land on this screen when the button, Get Started, is hit in the Welcome screen. New users can register an account. A brief video tutorial is provided for them to watch how the login process works step-by-step. Returning users can directly sign in to get to the main dashboard.

Sign-up

Users provide their email address for the next step of account verification, first name, last name, and the password for login.

Account Verification

For data security purposes, the system sends a verification code to the user's provided email address. The user enters the code below to confirm their account. The email address will be the username for future logins.

Entering the Number of Monitored People

Users provide the number of loved ones to monitor so the system can set-up the following screens. If the user wants to learn how the process works, they can watch the tutorial.

Body Scan

Users add their monitored loved ones to the system, using the phone, they perform a body scan by placing their loved ones in the screen frame. The function is implemented by the Memory Allocator of Human Body Detection (HBD) in Artificial Intelligence (AI).

Entering the Number of Monitoring Devices

Users are required to clarify how many monitoring devices they want to set up. The Usafe system needs to know the number so that the set-up can process in the following screens.

Scanning QR Code

Users scan the provided QR code found on the back of each monitoring device to get mobile app access. In the previous screen, if the number of monitoring device is two, then they prepare two devices and scan the QR code twice (repeated for the number of devices).

Confirmation for Connected Devices

Users get a chance to review the camera's quality and learn how to switch between Linear Figures Mode (LFM) and Real Body View Mode (RBVM) by clicking the bold text on the bottom. This ensures the privacy of monitored elderly.

Dashboard

Users keep track of the activities of their monitored loved ones in their homes through the installed monitoring sensory devices. The system pushes alerts to the users' phones for emergency or non-emergency situations. If an emergency happens to any monitored person, calling 911 for the family caregiver is the most direct and feasible solution. The entry for calling 911 is in the upper right corner of the screen.

Night Time Summary

Every night the family caregiver receives a push notification to learn the night time summary for their loved ones. This screen helps the monitored elderly confirm that their routine is going well and helps family caregivers understand if adjustments are needed. Family caregivers can learn about what specific activities their loved ones perform during the day through text information and gradient-coloured data visualization.

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Colour Prototypes

Built-in Sensory Monitoring System

Anna gets multiple Usafe sensory monitoring boxes to track Erica's safety and health, each has built-in sensors and a camera. Each box can be installed on the wall or placed on a table in each room. The device can accurately detect and send notifications to family members in real-time when abnormal behaviours or emergencies are detected.

Built-in Sensory Monitoring System

The installation is quick and easy. Anna needs to confirm that she has Wi-Fi in her mother's residence. As Anna finishes installing and calibrating the monitoring boxes, she needs to download the designated mobile app following the instruction sticker on the back.

Instruction for Usafe

Anna lands on the Welcome Screen. She hits the Get Started button to the next screen.

Register / Login Screen

Anna is asked if this is the first time using the app. If it is she needs to register. If she is a returning user, then she can directly login to the dashboard.

Sign-up Screen

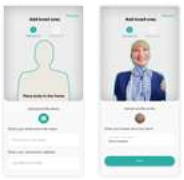
Anna is asked to provide her first and last name, email and password in the sign-up process.

Account Verification

Usafe system sends Anna a verification code for security.

Number of Monitored People

Anna adds her loved ones to the Usafe system.



Body-Scan, Profile Photo and Full Name for the Monitored Person

By providing the elderly's general information including full name and address, Usafe records them in the system. Now Anna is adding her mother, Erica into the Usafe system.

Saved

The two physical sensory boxes are now successfully set up for Anna's mother. Erica is on her cameras now. Anna can switch the live stream camera between Linear Figure Mode (LFM) and Real Body View Mode (RBVM) to protect the personal privacy for her mother.

Confirmation for Connected Devices

Dashboard (Real Body View Mode)

On the dashboard Anna will be able to check her mother's daily activities at different areas of her home.

Dashboard (Liner Figure Mode)

The Linear Figure Mode (LFM) can be turned on or off anytime.

Dashboard (Unusual Behaviour Detected)

When an event happens (here is an Unusual Behaviour), a description is provided on the top of the short video clip to review what is going on and compare next to the "live view" the panel is selected.

Dashboard (Unusual Behaviour Detected)

As this may not be an emergency, the event will send as a regular feed following the first panel as a video clip marked with an "orange dot" for family caregivers to keep tracking their loved ones.

Dashboard (Emergency Detected)

Suppose the situation develops into an emergency. In that case, if the monitored person hasn't recovered, that means this situation turns out to be an emergency, and the lines will turn purple.

Alert Notification

Anna will get an alert notification on her mobile app, and she can call 911 for immediate help.

Predetermined Events from Day and Night Summary

Anna will receive a daily report of her mother at the end of the day. The context of the summary could include eating habits, leaving and monitoring home or falls, walk and sleep patterns, etc. Anna is able to set her preferences for how and when to receive reports and updates within the app. She can decide to receive reports daily or weekly.

Usafe employs safety redundancy features in case of non-communication or other possible technology issues. For example, if after numerous emergency notifications are sent to the primary user (in this case Anna) and there is no appropriate response the Usafe system will take emergency measures. Because Erica's address was provided to the Usafe's remote monitoing team during registration, the team is able to call 911 to ask the hospital emergency department to send an ambulance to Erica's home right away.

4.2. Video Narrative

Video URL:
https://vimeo.com/584771749

Department of Art & Design
University of Alberta, 2021