Development of a Rapid Prototyped Hand Exoskeleton for use in Patient Rehabilitation

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INTRODUCTION

- The human hand is vital for interactions within the environment. Ailments such as paralysis, nerve damage and stroke can result in the partial or even complete loss of function of this integral physical structure (Iqbal, 2015). Hand exoskeleton technologies have made it possible for more efficient patient rehabilitation (Heo, 2012).
- With the use of rapid prototyping (or 3D printing), hand exoskeletons can be made easily accessible in the future, beyond exclusively clinical applications.

***Figure 1**: Sample finger links and rings assembly for exoskeleton displayed on a bionic hand.*

PURPOSE

Design and develop a hand exoskeleton prototype using in-lab manufacturing techniques with off-the-shelf electrical components allowing five different grasp patterns.

METHOD

- Research into anatomy and degrees of freedom of the hand was conducted to obtain measurements of fingers for the ring, link, band and electrical containment components.
- The measurements were then applied to models of the components designed on SolidWorks.

Figure 2

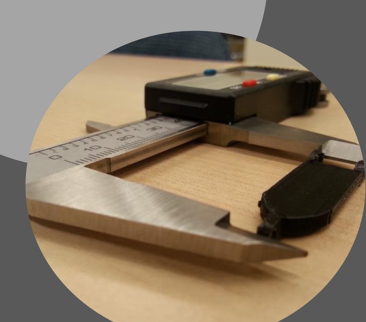

***Figure 2 & 3**: A Vernier Caliper was used to measure out dimensions of the components.*

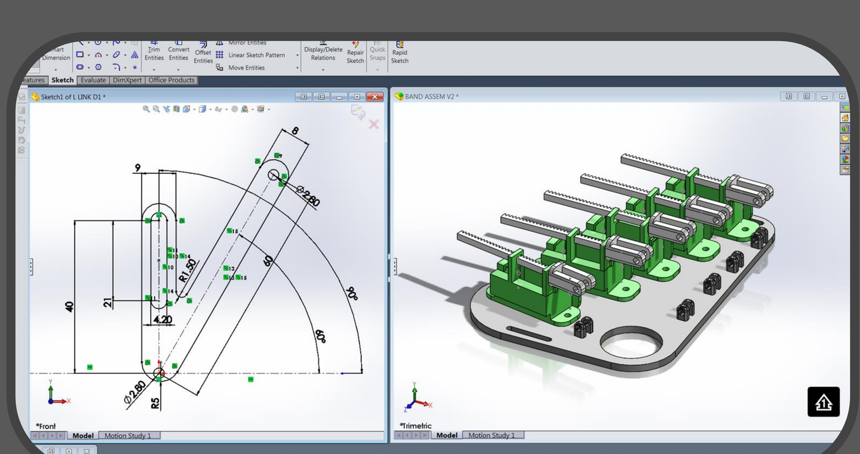

***Figure 4**: A SolidWorks sketch of an L-shaped link (left). A SolidWorks assembly of the band components (right).*

- Separate part files of all components were combined to form assemblies of each finger, as well as an assembly for the entire band portion. This allowed for a preview of how the components would fit together once assembled.
- All of the parts were then 3D printed. Rafts and supports (extra material) were added to the printing files to ensure that the components, once printed, retained structural accuracy.

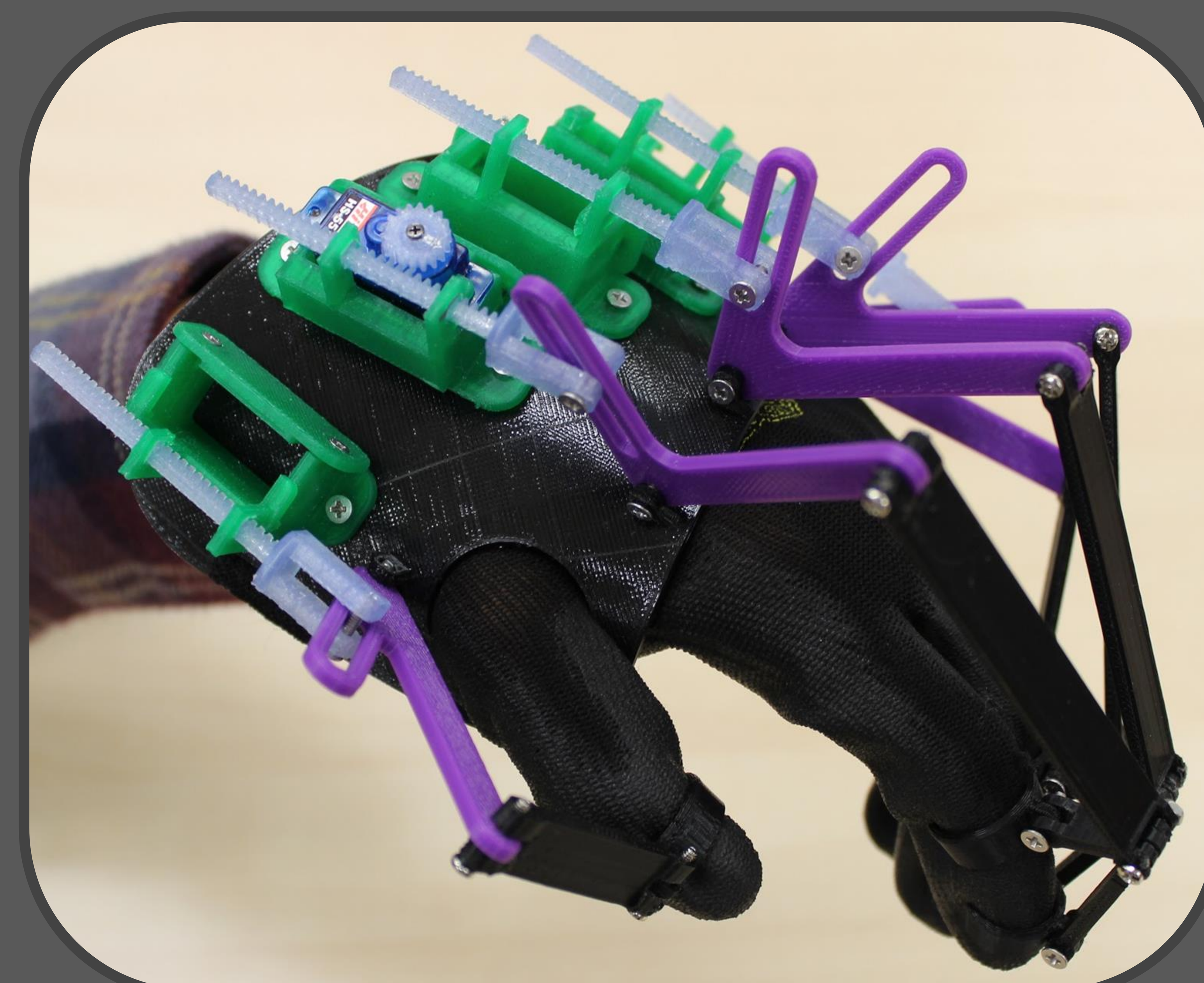

***Figure 9**: The hand exoskeleton*

- Printed parts of the hand exoskeleton were then constructed.
- An electrical system (using Arduino software) was designed so that EMG (elecromyographic) signals from muscles undergoing contraction and relaxation could be used to actuate the servo motors. The motors, in turn, activate one of five grasping patterns in the hand exoskeleton.
- Finally, all electrical and 3D printed components were assembled to create the final design of the hand exoskeleton prototype.

***Figure 5**: 3D printer extruder.*

***Figure 6**: 3D printed finger components*

***Figure 7**: Electrical components of the hand exoskeleton*

RESULTS

- 3D printing and coding simple grasping patterns within electrical elements allow for a hand exoskeleton prototype to be developed easily within the lab.
- Researching designs for the exoskeleton made it possible to explore and develop new ideas for functional and efficient prototypes.

***Figure 8**: The hand exoskeleton - final product*

CONCLUSION

- The successful creation of the hand exoskeleton proves the capability of lab feasible design and construction of such prototypes.
- With the use of similar methods for developing exoskeleton framework, multiple structural and functional options can be tested.
- As the research pertaining to the development of hand exoskeletons is pursued more thoroughly, using simple technologies such as 3D printing, testing and accessibility can be made much less challenging.

Literature Cited

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