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Building a machine learning-based intelligent HVAC system to minimize infection spread

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ABSTRACT

Heating, Ventilation and Air Conditioning (HVAC) systems are fundamental to most buildings. These systems control the airflow and microclimate conditions to create a safe and comfortable environment for occupants. However, these systems lack adaptability and require parameters to be manually controlled. This poses an issue with the current spread of infectious diseases in indoor environments. Then, a system is required to intelligently monitor and change the conditions to reduce the spread of viruses and create a safer environment. A control system is needed to assess the environmental parameters actively and independently make the necessary adjustments. To accomplish the goal of creating an intelligent system, a machine learning method is employed to build a neural network model based on data sets of indoor room conditions that will teach the HVAC controller how to change the system settings to create the most suitable environment. This will be achieved through computer simulations created using Python to simulate the HVAC system. The neural network is created under supervised learning that adjusts the proportional–integral–derivative (PID) controller parameters. The input data into this model are the room variables: temperature, humidity, and detection of infection from a COVID alarm. The alarm is an external input into the simulation; this alarm is produced by a computer vision algorithm that analyzes frames produced by an infrared camera that monitors the human body temperature and can detect fever. If such events occur, the alarm will be triggered and send a warning signal to the controller. In this research, dynamic equations of temperature and humidity variables are taken from existing literature which explains how they behave inside rooms based on the factors that affect floor areas, room volumes and occupants. In response to these inputs, the model will instruct the PID controller to adjust the flow rates and recirculation of air implemented by the HVAC system and maintain the environmental variables in the range that are outlined by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). For example, these guidelines suggest maintaining relative humidity between 40% and 60% in infected areas that can reduce the half-life decay time of the virus. The simulation results will show that the proposed machine learning method can create an intelligent system that will independently monitor the input factors and make the required adjustments to reduce or limit the spread of the infection to create a safe indoor environment in our facilities.

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