

Abstract

Masters of Engineering Degree (Mechanical)

Project Title:

Intelligent Occupancy Sensing for Heat Control in Academic Offices

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This project examines the potential energy and cost savings that can be provided by implementing intelligent occupancy sensing to control the heating system for academic (single professor) offices. Space conditioning and ventilation make up 53% of energy use in commercial buildings, so there is good reason to pursue methods that will reduce this demand. While occupancy sensing is primarily used for lighting control, it presents an additional challenge when applied to heating systems. To keep occupants comfortable, the room must be heated before the occupant arrives to ensure the temperature has reached the desired level by the time the occupant enters. In order to address this issue, our occupancy sensing system contains an intelligent component that determines not only where the occupant is, but also where they will be in the future. Our multi-sensor intelligent system is comprised of a radio frequency receiver and transmitter, passive infrared (PIR) motion sensor, Outlook calendar interpretation, and a K-Nearest Neighbors machine learning algorithm to not only determine when the professor is in his or her office, but when they are likely to arrive. In order to determine how much earlier than arrival we would need to predict, we performed physical experiments on an office in Upson Hall and used ANSYS FLUENT to model the recovery time of a room numerically in order to evaluate different heat recovery equipment. We found that if our system was implemented in a building such as Cornell University's Upson Hall, for example, this system could potentially save 176,525 kWh of heat or \$18,852 per year. The predictive machine learning algorithm provides 1% error in predicting the occupancy of the professor, 80% of which was generated in the first week of data processing, making the error after the first week of prediction only 0.2%. Though this project specifically focuses on single-professor offices in Upson Hall, it has the potential to be utilized in nearly any building on a campus with single professor offices, or be easily modified to suit the needs of other types of spaces such as dorm rooms or classrooms.