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Human Occupancy: A Non-Invasive Solution

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ELECTRICAL AND COMPUTER



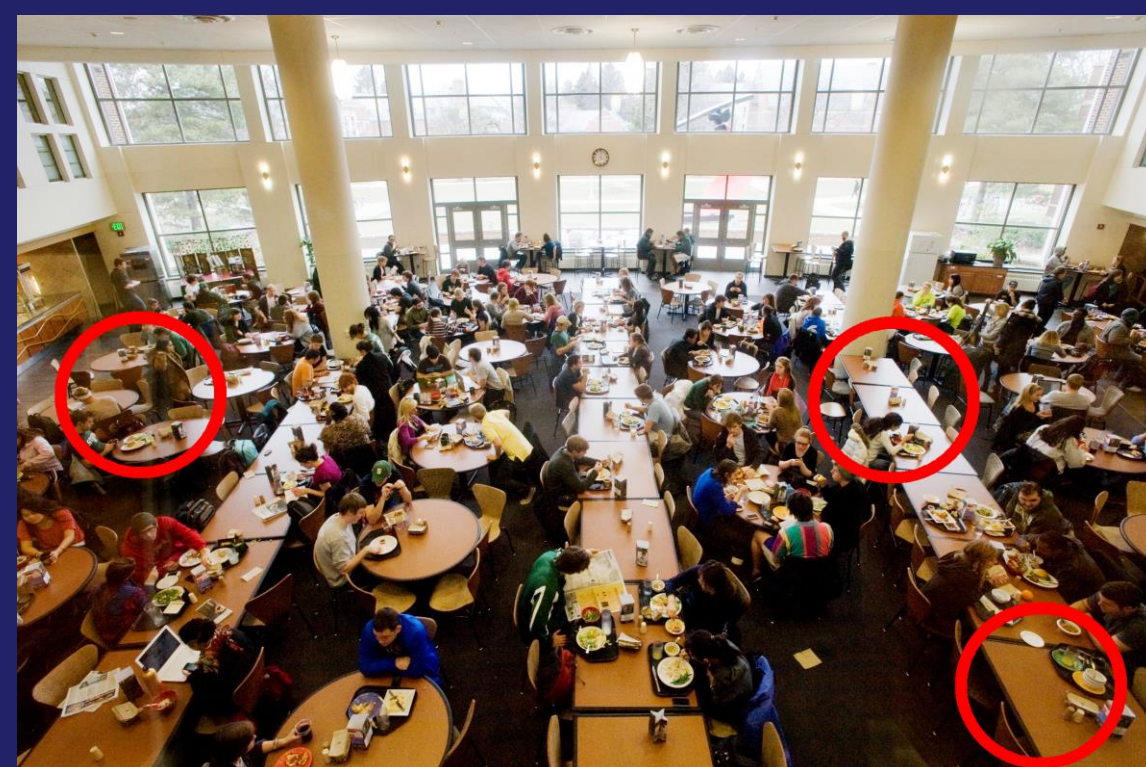
Human Occupancy

A Non-Invasive Solution

CAPSTONE DESIGN
EXPO 2016

Motivation

- There is currently little information on the level of human presence in most buildings.
- Difficulties occur when attempting to find an available space within a given location.

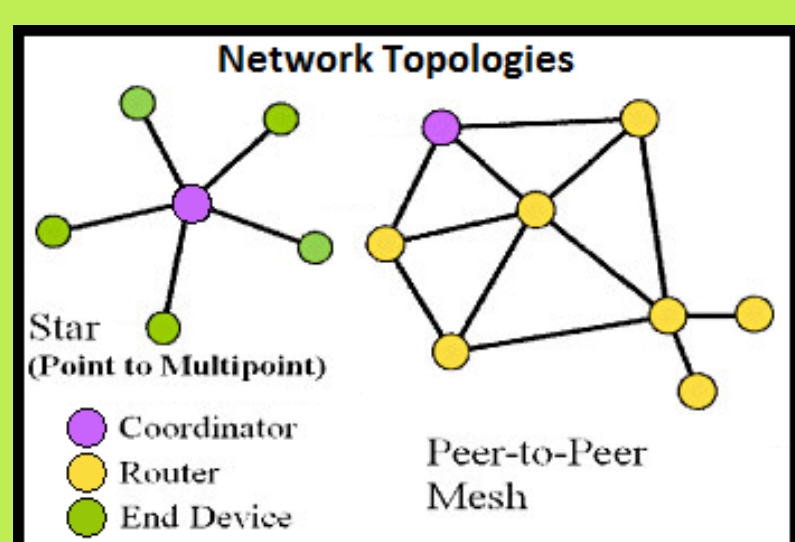


Goals

- Increase quality of life by reducing required time when searching for an available location.
- Maintain privacy for end users—don't track identifying characteristics.
- Provide seamless integration with one's surroundings through innovative distribution of information.
- Spatially optimize business functionalities through statistical analysis given area usage data.
- Small form factor—allow for system hardware to not be cumbersome.
- Independent mesh network to communicate through harsh conditions.

Core Elements

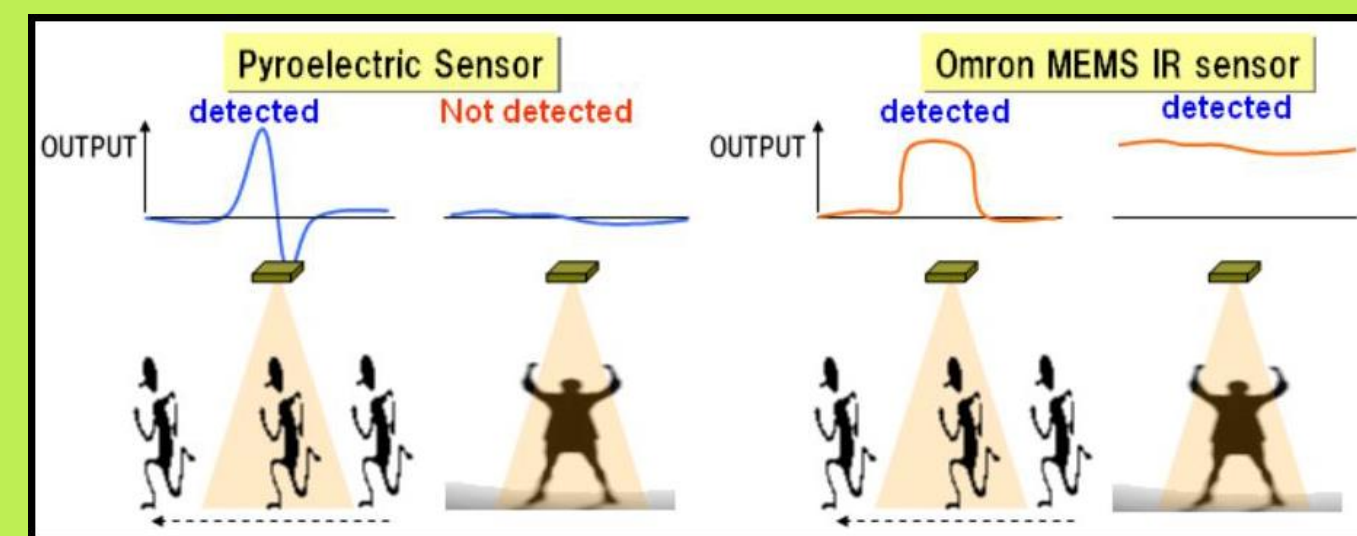
XBee modules are used to create a mesh network. All modules send data back to the master device.



Pyroelectric Infrared (PIR) Sensors are used to detect sudden changes in heat.

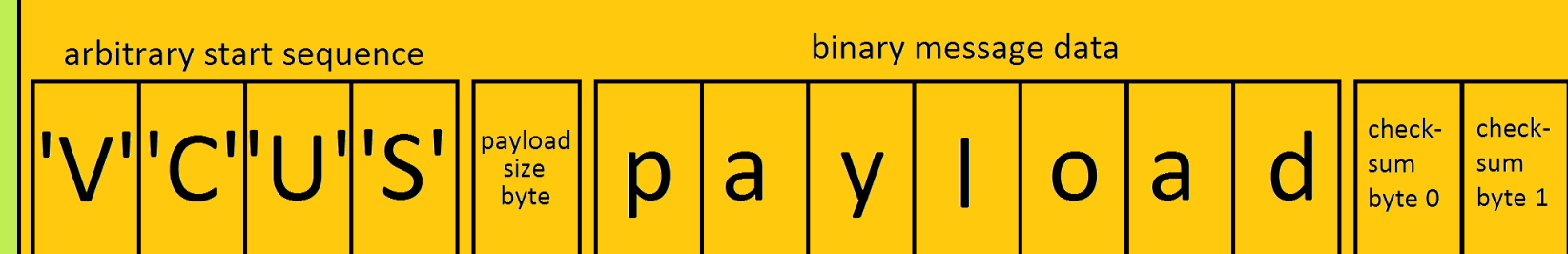


Omron D6T thermal sensors are used to capture data for an approximate area of 144ft².



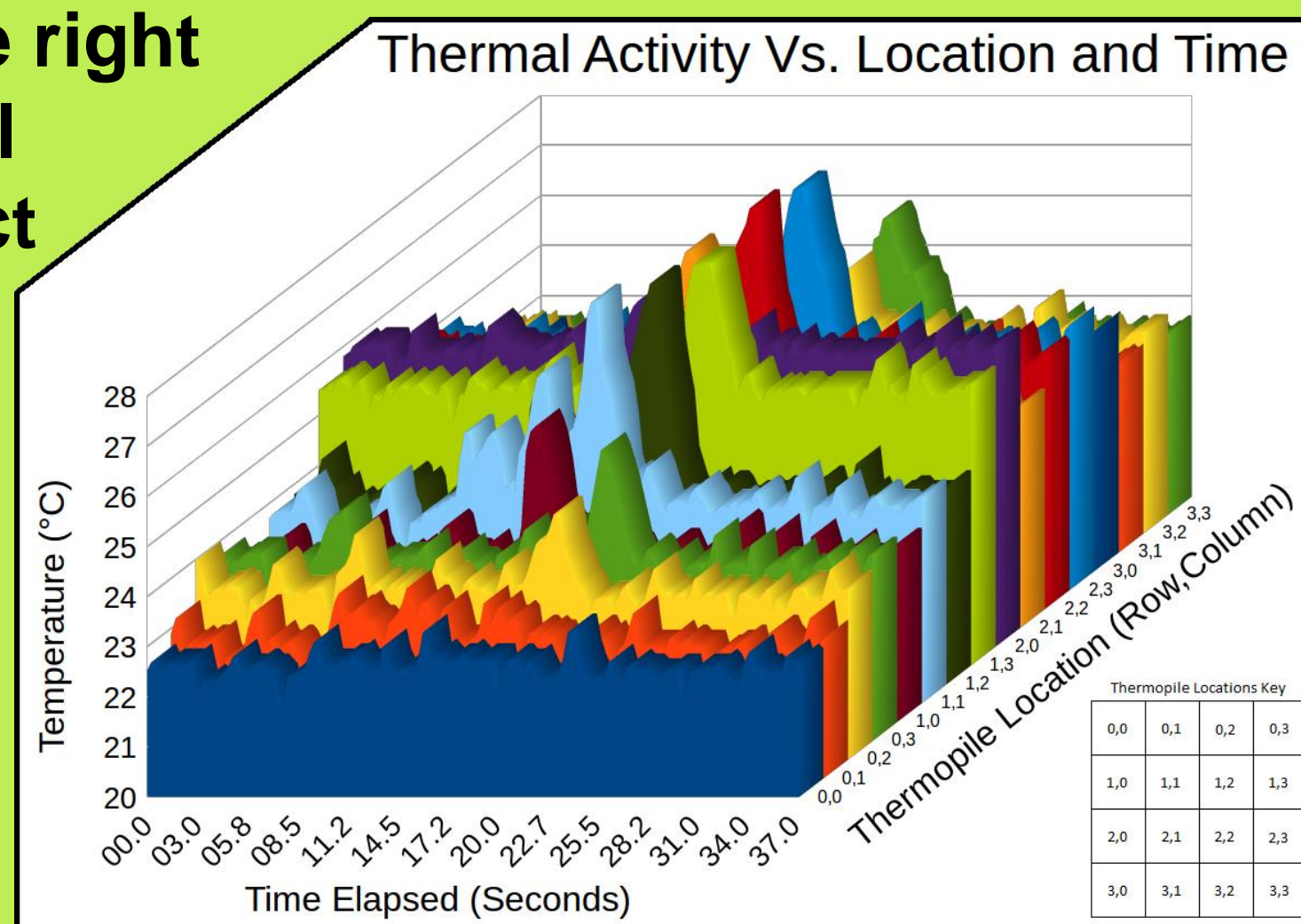
ATmega328P (slave) microcontrollers are used to interface communication and sensor data. They serve as the heart of each Area Occupancy Detection Module (AODM).

Network Communication Protocol



All network traffic utilizes a unique protocol designed to eliminate corruption of data. Active collision prevention is also implemented.

Statistical data is stored locally for plotting purposes. The figure to the right displays thermal data with respect to time and location. This data is from a person walking past an Omron D6T sensor.

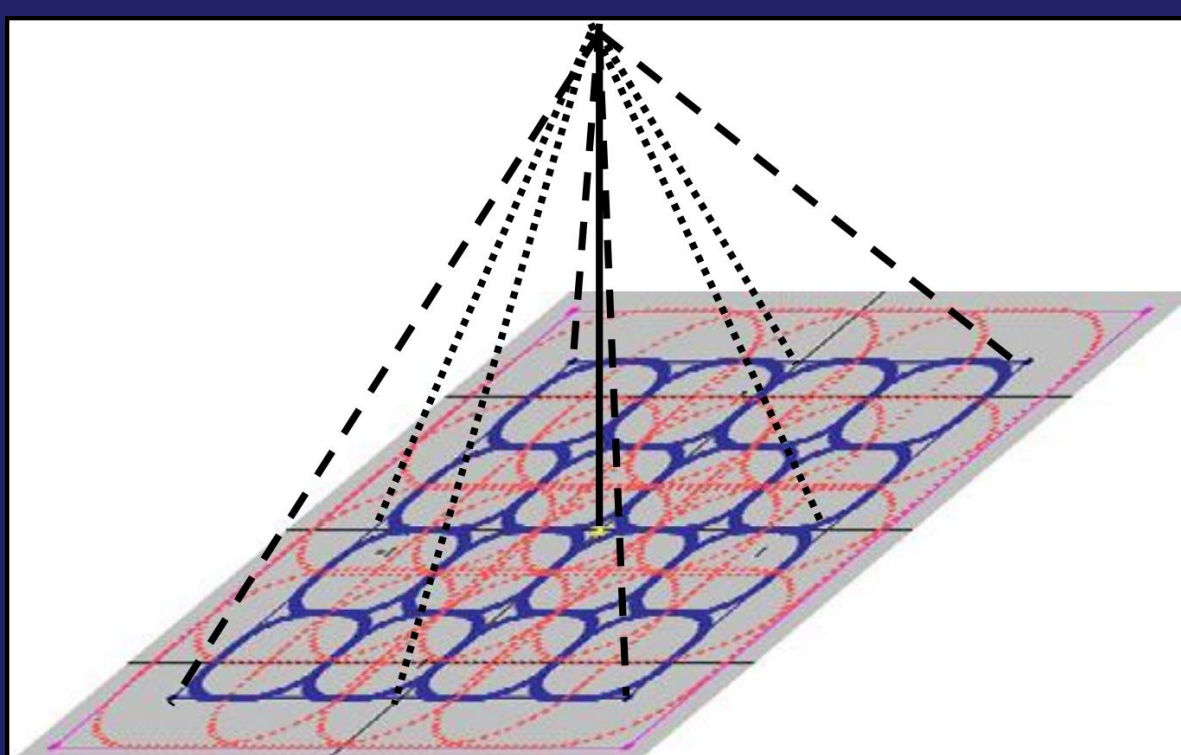
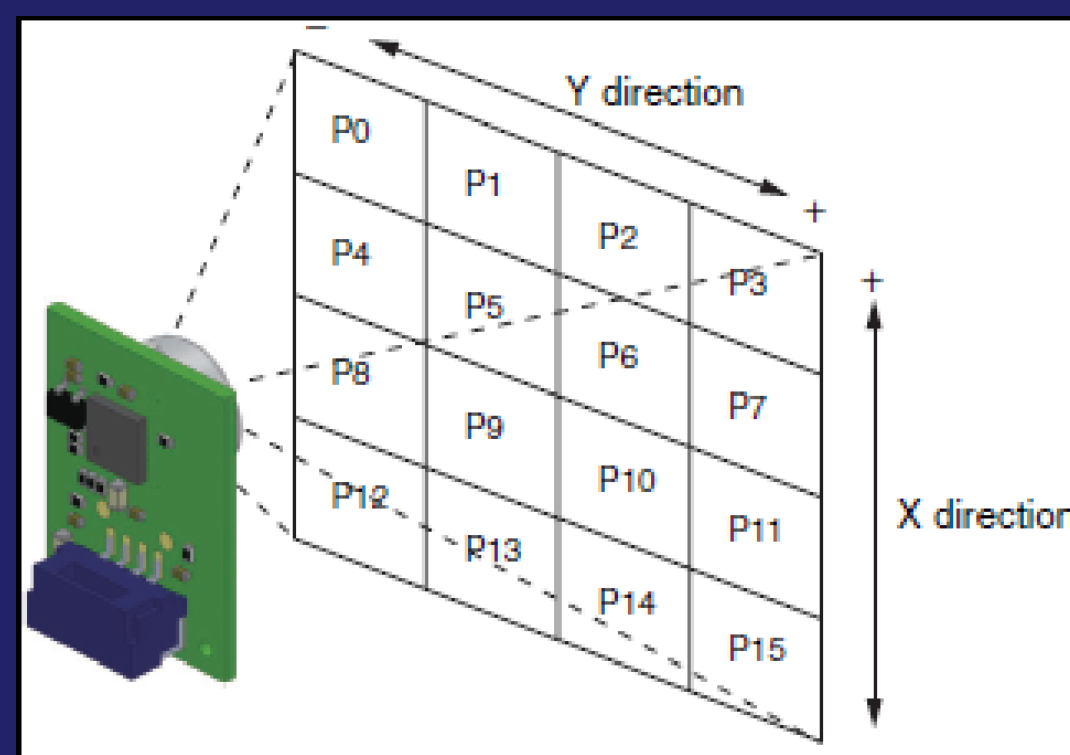


Raspberry Pi 2 Model B (master) embedded system is used as the central hub of the Human Occupancy Detection System. Qt

Creator is a C++ framework that allows for the creation of graphical user interfaces. It also enables serial communication between devices. In order to make development as fluid as possible, Qt executables are placed on the Raspberry Pi via cross compilation from a PC to the device over the local network.

Design Overview

- The system is comprised of a single Raspberry Pi and a network of ATmega328P microcontrollers.
- XBee modules with DigiMesh firmware reliably handle sending and receiving of data amongst microcontrollers.
- Each ATmega328P handles I2C transactions between an Omron thermal sensor as well as a digital reading from a Pyroelectric sensor. Acquired data is then broadcast using serial communication and a 2.4 GHz XBee module.
- All data is collected on the Raspberry Pi, from which it is displayed, and saved into a timestamped file for future analysis.



Acknowledgements

We would like to personally thank all of the faculty at VCU for molding us to be the engineers we are today. In particular, Dr. Cabral for his wisdom, Dr. Xiao for his enthusiasm, Dr. Filippas for “being the man,” and Dr. Klenke for always relating school to industry. This also would not have been possible without our awesome grad TA, Matthew Leccadito.



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