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Light & Temperature Regulating System

GOAL

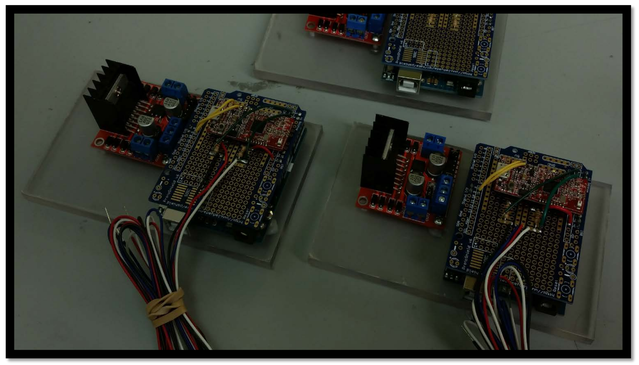
The goal of our project is to create a system that is able to regulate temperature evenly and automatically throughout an entire house by controlling air flow and environmental factors. The overall system will be comprised of several subsystems, each meant to accomplish a certain task and either sense or control temperature. Air flow and sunlight are the largest factors that control temperature in a home, so the system will focus on these elements. The system will also provide the end user with features to help increase control over the temperature in his or her home via an easy to program thermostat. Finally, our system because it will limit the sunlight in the room we have created a Light control system to accommodate for that.

Engineering Requirements

1. The system should preserve the integrity of the A/C unit
2. The system should be able to keep room temperature within 2º C
3. The system should be able to hold different temperatures in different rooms
4. The control system should respond accordingly to set a room's temperature to ±6c from its ambient temperature unless this is beyond the A/C unit's capabilities
5. The system should have the current thermostats' features (hold, fan on/auto/off, hysteresis, temperature scheduling, vacation feature, outside temperature consideration, gas/electric heaters)
6. The system should be able to open and close and blinds/curtains
7. The system should keep balanced luminosity within 5 lux
8. The in-room hub has to be either battery powered for at least a month or be powered from the house 110VAC line
9. The software will have a maximum of 3 menus depth

Design Concept

1. Have temperature sensing in every room
2. Control air flow to every room automatically
3. Control sunlight via blinds automatically
4. Create an easy-to-use interface with many options such as mobile app
5. Programmable features like "vacation mode" and feature control



In-Room Hub

The in-room hub is responsible for collecting data from the thermal and light sensors and relaying this information to the thermostat as well as receiving responses from the thermostat to be used to control the motorized registers in the room.

We accomplished this using an BLE-Mini (Bluetooth module) for communication, an Arduino Uno (microprocessor) to handle the logic, and an L298N H-Bridge to drive the motors on our registers.

Scale Model

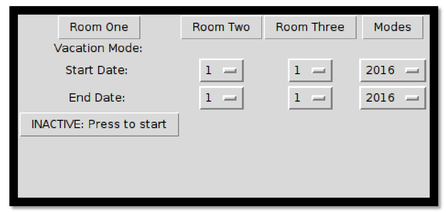
In order to keep this project in a reasonable scope, we decided to implement our system on a scale model rather than a full-sized house. This made completing the project within two semesters feasible.

The rooms that are being regulated are simulated using white storage bins and have been modified and mounted with motorized registers on the top and side. In order to provide the system with air flow, the rooms are connected to a PVC duct system with a fume extractor to serve as an input. We have also mounted a heating element to the removable lid of the storage bin.

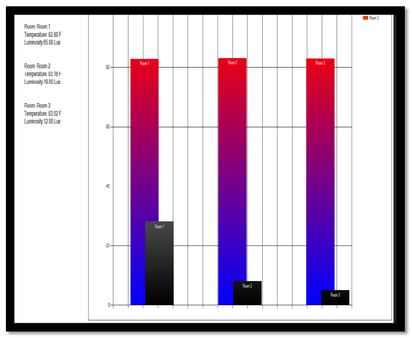
Raspberry Pi Thermostat

The original implementation was uses a Raspberry Pi 3 and utilizes a touchscreen for the interface. The Raspberry Pi implementation was developed solely in Python. Unfortunately, this contributed to the difficulty in establishing Bluetooth communication. Ultimately this proved to be too difficult to implement on the Raspberry Pi so we were not able to use it in the test of the full system.

The UI however is fully operational and includes all of the features that would come standard in a thermostat (Fan Control, AC Mode) as well as settings that we wanted to include in our project (Vacation Mode, Weekly Schedule)



Desktop Thermostat



In light of the difficulties with Bluetooth communication we also decided to develop a desktop application. The desktop application was developed in C# and makes use of Windows Forms libraries for the UI and Windows 8.1 Mobile libraries for Bluetooth communication.

The desktop application offers real-time data and graphical displays for all of the sensors in each room. It also includes all of the standard features of a thermostat as well as the additional features we wanted to include in our project.

Results

To test the performance of our system we energized the heating elements in each room and allowed the rooms to obtain a temperature of above 90º F before activating the control system. After setting a target temperature for each room, we switch the AC mode of our thermostat to cool which activates the thermal control system. At this time we also set a target luminosity value for each room which activates the light control system.

With a target temperature of 85º F and a target luminosity of 90 lux, our system not only obtained these goals but also maintained the values for each room. This was paramount since each room reacts differently.

Acknowledgements

John Scalzo, Dr. Guoxiang Gu, Chrisopher O'Loughlin, Jean-Louis Cozic

TEAM 5: DANIEL MILES, JOHN SGOURAKIS, JON TALLMAN, MCKENZIE BROWN