Introduction

This project seeks to implement and learn from a wifi-connected network of sensors, which will be statically placed in buildings across campus. We plan to use these sensors to detect and extrapolate fine-grained information about how temperature and light vary within and between buildings. We are interested in measuring temperature to determine whether Yale is utilizing indoor spaces efficiently, and we are interested in light levels for both the above and for light levels’ correlation with mental health. We hope to also evaluate the power consumption of our sensors and use light levels to ascertain whether future implementations of this project can be solar-powered.

This project will be limited by physical constraints, including building boundaries and a finite number of devices. We hope to build a working and extendable system that will allow us to collect sufficient and interesting data within these constraints and provide valuable feedback on energy usage in buildings to Yale and its students.

Project Details

This project consists of two main parts.

Part I involves initial set-up and testing within one building. We aim to establish a network of wifi-connected sensors across the 6 floors of AKW. These sensors will be powered using wall sockets and detect temperature and light in various parts of AKW. On each floor, we will place 5-10 sensors. The sensors on each floor will be connected to a centralized hub through Bluetooth, which will then upload information online to our database using wifi. The information will be collected and uploaded every five minutes. We will test and adjust the collection and upload rates accordingly.

Part II entails analyzing data as well as expanding upon the data obtained from Part I to make our sensor detection more efficient. We will work on an algorithm to infer a continuous distribution of light and temperature within individual rooms. We will also begin writing software for Yale administrators/students to use in evaluating energy usage efficiency within buildings.

Division of Work and Deliverables

Christina: Design and test circuits/pcb for individual sensors. Set up central wifi hub and test sensor network. Determine power efficiency of sensors. Determine whether light levels are suitable for solar-powered sensors.

Lily: Design algorithm to infer a continuous distribution of light and temperature within rooms. Software for using information from sensor data to determine new energy usage policies.
Christina & Lily: 3D model visualizing light and temperature data over time.

Stretch Goals

If the system defined above has been completed before the deadline, we hope to move on to Part III. Part III would be development of a 3D model of AKW (that can be expanded to other buildings) that visualizes the obtained light and temperature data over time. In addition, if we determine that light levels in some areas are sufficient, we may develop solar-powered PCBs to replace the corresponding sensors.

Timeline

01/14/2019 - 02/05/2019 (~3 wks) - Ideation period.
02/07/2019 - Submission of Project Proposal
02/11/2019 - 02/18/2019 (1 wk) - Read literature and meet with Yale Operations / Yale Carbon Charge individuals. Order parts and assemble sensor prototype.
02/18/2019 - 03/01/2019 (1.5 wks) - Begin Part I. Design network, choose sensor locations, and get approval for project from AKW people.
03/01/2019 - 03/07/2019 (~1 wk) - Design PCB and get it printed.
03/08/2019 - 03/25/2019 (1 wk) - Install devices in AKW. Begin data collection.
03/25/2019 - 04/05/2019 (1.5 wks) - Begin Part II. Analyze data and adjust network if needed.
04/06/2019 - 04/20/2019 (2 wks) - Complete distribution algorithm and visualization software.
04/20/2019 - 04/25/2019 (~1 wk) - Prepare final report.
04/26/2019 - Submission of Abstract, Project Code, and Final Report