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Conservation of Energy through Wearable Devices

Energy Conservers Team:

Mohammad Altarfa (Momo)

Raymond Holgate

Mohammed Alzaher

Client - Samkruth Aluru

Presented by Mohammed Alzaher

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Introduction

Our project:

Our team, Energy Conservers, has been tasked with using technology to allow a user the ability to read the current conditions of a room and give them the ability to regulate the energy consumption.

Team members:

- Mohammad Altarfa (Momo) : Team leader and room comfort sensing team
- Raymond Holgate : Energy efficiency calculating team
- Mohammed Alzaher: Application designer

Presented by Mohammed Alzaher

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Project motivation, why does your Client need/ want this widget/solution

Project Motivation:

- Due to the increased demand of buildings in today's society, as buildings are used a safezone to comfort multiple of our needs.
- Climate change calls for the effective utilization of energy, buildings are considered to be one of the greatest energy consumers (about 40%).
- Therefore, the project goal to conserve and effectively utilize building energy usage.

Why does the Client need/ want this solution?

This project will aim to study the effects of building energy use and develop ways to reduce the footprint of the building's energy consumption by allowing a user to access the energy data and to make changes to the energy system.

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Project approach

Requirements:

- Data logging of 5 variables picked by the client to be used in comfort/energy efficiency subsystems
- Machine learning of Fanger's PMV formula to calculate the room's comfort index.
- Testing the circuit for indoor comfort for monitoring data to enable machine learning capabilities in the energy efficiency subsystem, we were able to create an energy efficiency calculating subsystem.
- Using the monitored data we adapt machine learning to create a model for energy/comfort index analysis.

Constraints:

- Limited starting material/data.
- Time to acquire monitored data (by testing the circuit in a room at the engineering building) due to school going online.
- Lack of control of an actual thermostat to see the project come to life.

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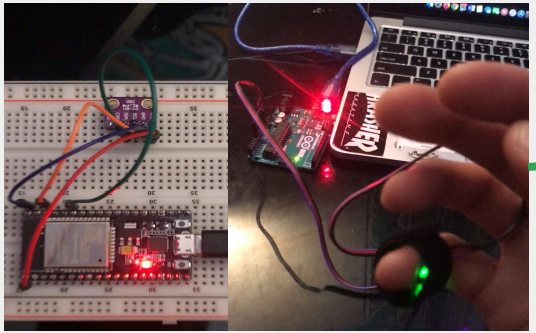
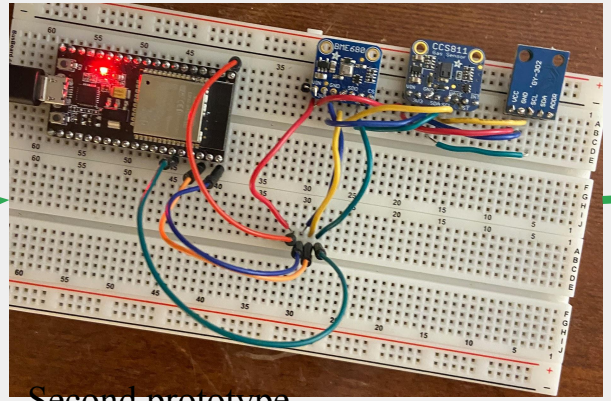
Previous prototypes

Progression of built circuit:

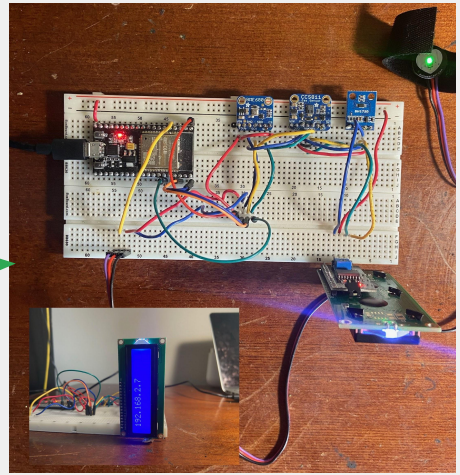
1. Started with a BME280 connected to the esp32 to measure 2 variables. And a parallel running Arduino Uno to host the BPM sensor data. **(First prototype: last semester)**
2. Moved to the BME680 and connected the CCS811 for CO2 measurements and the BH1750 for light measurements. **(Second prototype: January this semester)**
3. Added the BPM pulse sensor for activity level measurements and the lcd screen for the user to access the webpage. **(Final design: early February this semester)**



First prototype



Second prototype



Final design

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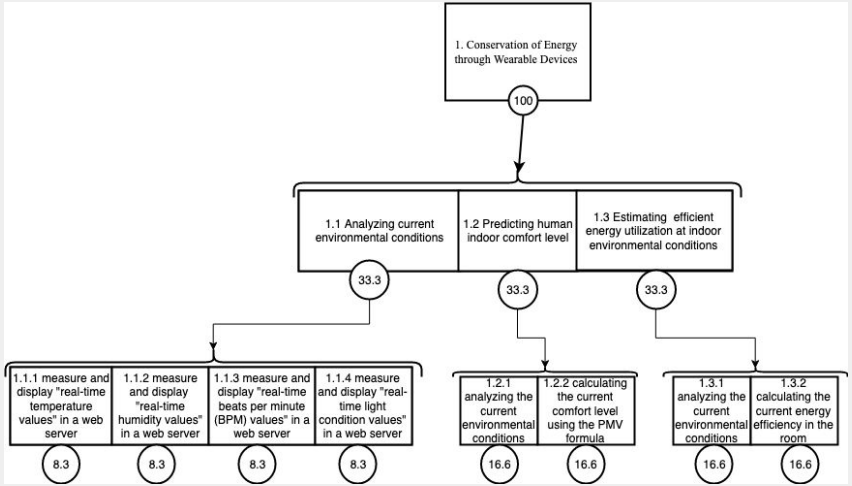
Subsystem breakdown

- Based on the research carried out last semester, we have noticed that Momo is finding more papers related to human indoor comfort and Ray is finding papers related to energy efficiency. We have decided to spit up the teams as such, with Momo incharge of the indoor comfort subsystem (1.2) and Ray incharge of the energy efficiency subsystem (1.3).
- We have also assign Mohammed Alzaher to be incharge of the GUI (which was suppose to be an app)of this project. Another thing to mention is that we have included an additional joint index subsystem which should be (1.4), and that Momo was incharge of the data logging subsystem (1.1).



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Timeline and responsibilities of Mohammad Altarfa (Momo)

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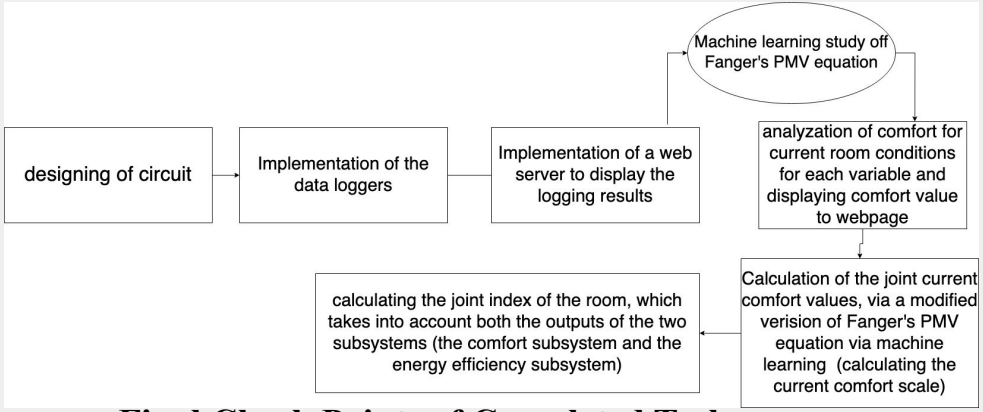
- **Responsibilities:**
  - In charge of the room comfort calculating subsystem in this project, the data logging subsystem off this project.
- **Tasks of my responsibilities:**
  - Measuring and logging current indoor environmental conditions.
  - Analyzation of current indoor environmental conditions and measuring their comfort value.
  - Concluding if the room is comfortable or not based on the analyzation of current conditions. Through the machine learning of Fanger's PMV formula to calculate indoor room comfort.

- **Timeline**:



- **Final Check Points of Completed Tasks**:
  - Measured and logged 5 variables in realtime. (Temperature, Humidity, light, Co2, BPM)
  - Analyzed the comfort index of each of the variables.
  - Using a machine learning study of a modified version of Fanger's PMV formula, concluded if the room is comfortable or not, continuously in a closed loop.
  - Set-up of a joint index sub system to merge the two subsystems.

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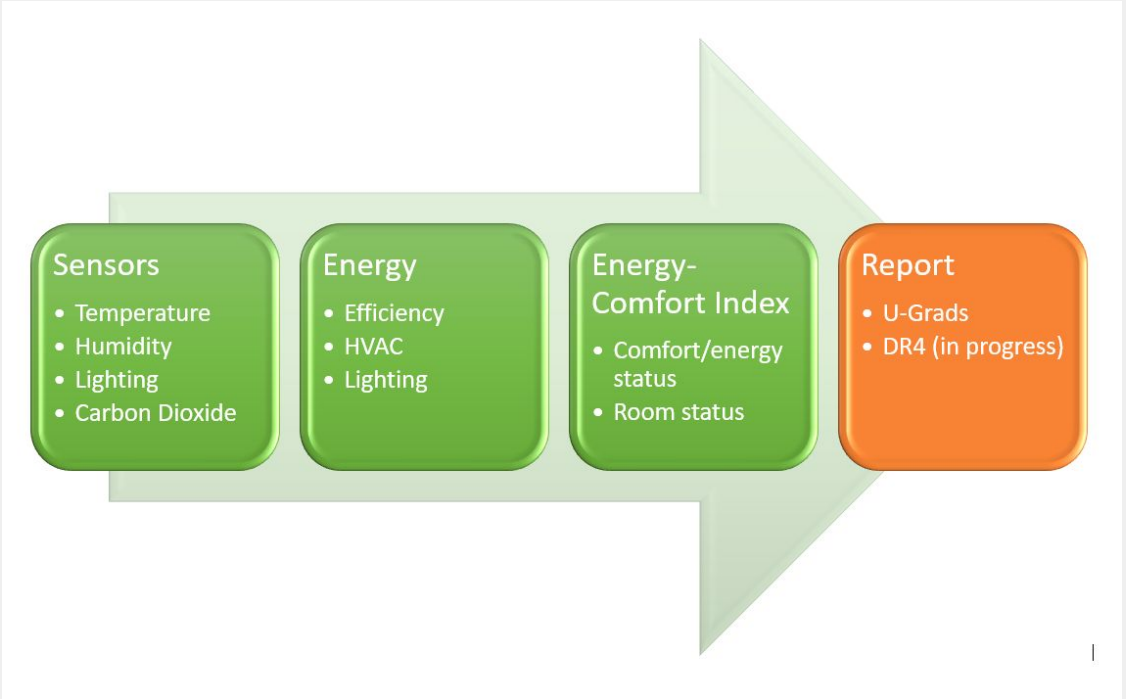
Timeline and responsibilities of Raymond Holgate

- **Energy efficiency:**
  - Setting ideal temperature levels.
  - Setting ideal lighting settings.
  - Estimating cost of setting environment outside of ideal settings.
- **Energy-Comfort index:**
  - Combined rating.
  - Assigned values for any conditions outside of ideal ranges.
  - User would have knowledge to adjust aspects of energy usage to attain optimal index.
  - User recommendations available to improve room conditions (in progress).
- **Final Steps:**
  - U-Grads presentation (completed).
  - DR4 report (in progress).



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Timeline and responsibilities of Mohammed Alzaher

I am responsible to create an application that allow the user to check the room comfort level and to provide the best ways to conserve energy.

Duties:

- The platform of the application.
- The coding part.
- Transferring the data from the web server.

Timeline:

Past situation: some obstacles regarding to the building way of application and the publisher rights to install the application on the store.

Final situation: we ended up to allow the user to check all the variables reading by using IP address that lead to the webpage server.

Presented by Mohammed Alzaher

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Challenges

- **Problems:**
  - Ability to link outside temperature to our model.
  - Ability to code input HVAC temperature from user.
  - Setting parameters for all conditions & producing correct outputs.
- **Resolutions:**
  - Designed our code to change variable in the code itself.
  - Debugged our code to simulate many conditions.
  - Added user friendly outputs to describe room conditions (i.e. text descriptions).
- **Online Transition:**
  - No in person meetings & ability to build device as desired.

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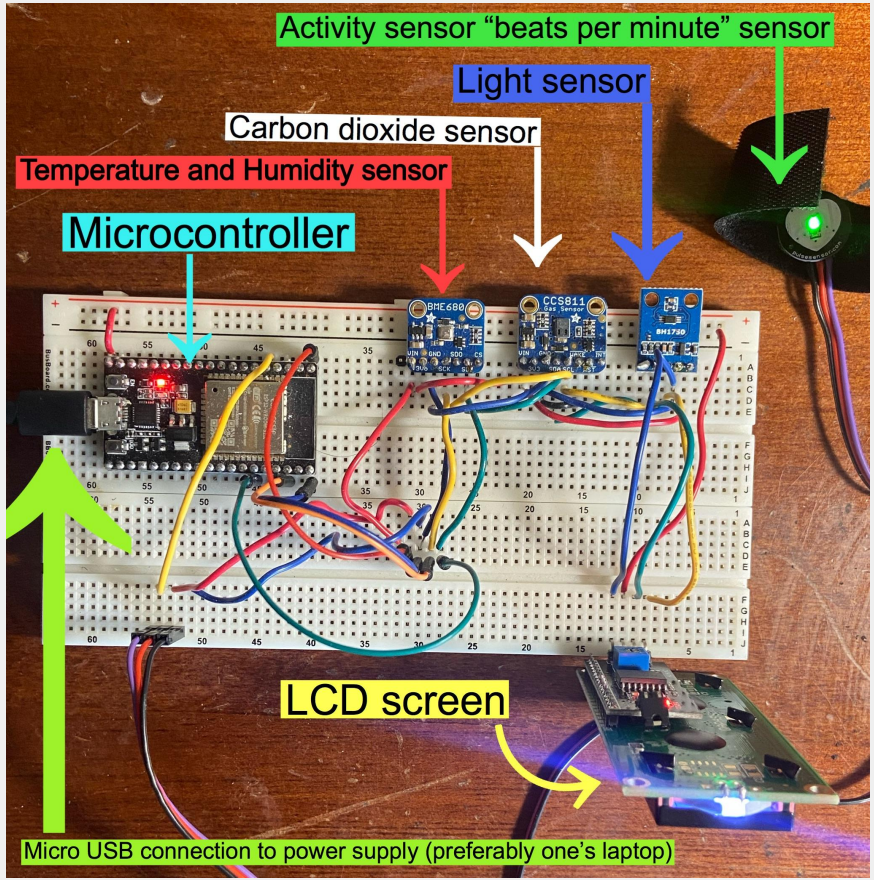
Final product

- **How it meets original specifications:**
  - Energy/comfort index created.
  - Data tracked in real time and in many room conditions.
  - Displays whether conditions are ideal for comfort and energy conservation.

Joint index of (comfort and energy index's) of the room

Variale index	Index Value
Current comfort value of the room	uncomfortable
Current comfort index of the room (Comfort index)	-0.50
Current energy efficiency value of the room	non-energy efficient
Current energy efficiency index of the room (Energy index)	0.66
Joint Index of the room (|comfort index| + energy index = Joint index)	1.16
Final status report of the room	uncomfortable and non-energy efficient



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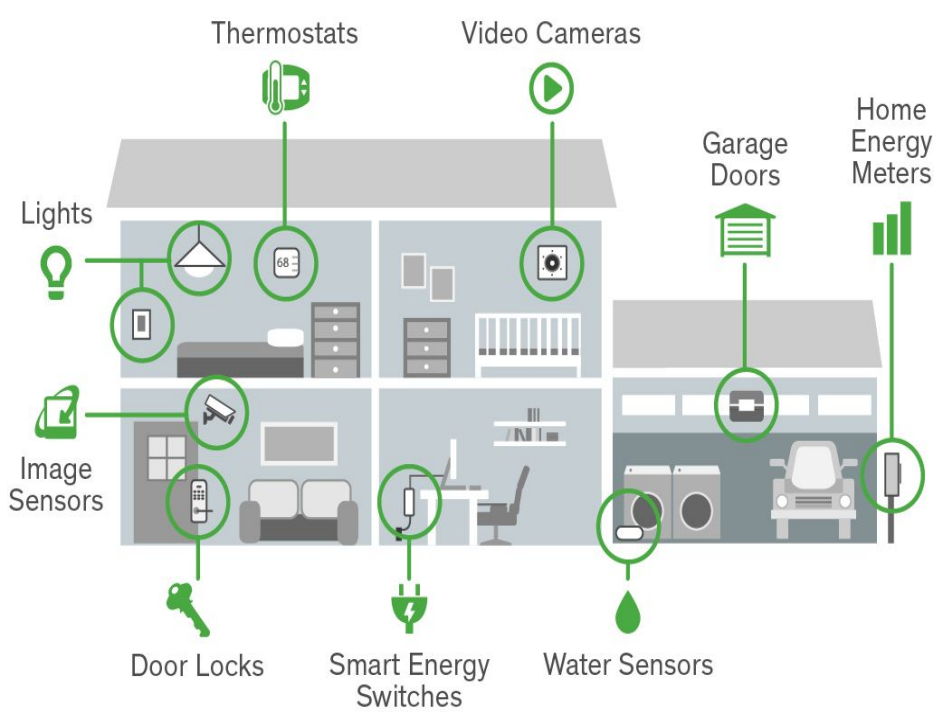
Future work (Hypothesis)

- **Next steps:**
  - Refine comfort-energy model.
  - Add additional sensors.
  - Design & build satellite subsystems:
    - Smart switches.
    - Automatic blinds.
- **Incomplete systems:**
  - Fully incorporated smart phone app.
  - Complete lighting energy analysis.
  - Fully incorporated sensors:
    - Outside temperature.
    - User input for HVAC temperature.



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Conclusion

What was the goal, and how did your team meet that goal?

- The goal was to create a device to analyze optimal room settings to conserve energy while also providing comfortable levels for residents.
- The team has to do good strategies and ways to reach to the goal. Those strategies included the power of teamwork and organize every step until we reached to our goal and have the device worked efficient and accurate.

Thank you