CS 437: Internet of Things
Final Project Proposal

Overview

We propose to create a network of CO2 sensors with a web interface. Our goal is distributed monitoring of indoor air quality.

Group

One of the motivations of this project is to stretch us beyond what we already know. We have included short professional biographies to illustrate our current skills and how we hope this project extends them.

Eric Schrock (ejs9)

My Computer Engineering curriculum was a mixture of Electrical Engineering and Computer Science in addition to courses on embedded programming and digital logic design. After graduation, I spent four years in the automotive industry working on advanced driver-assistance systems (ADAS). Devin and I now work together on the root of trust (RoT) for secure servers.

I am most comfortable programming bare metal (no OS) embedded C on microcontrollers. I've also played with various sensors and displays. I have very little experience with networking or web development and I anticipate our project challenging me to grow in these areas.

Devin Schmitz (devinms3)

My formal Computer Science background consists of only a few introductory programming courses, algorithms, and data structures, but I have a strong background in applied mathematics and a broad knowledge of the physical sciences. My professional experience is all centered around bare metal embedded C, but I also have a fair knowledge of Linux operating systems and data analysis with numerical Python. I anticipate most everything else involved in the project will be a learning opportunity for me. In particular, I have very little experience with networking and web development, and no experience with javascript.

Motivation

Breathing is one of the most fundamental processes of our lives, but most homes are only equipped with smoke and carbon monoxide detectors, which just warn against critically dangerous levels of air polution. High levels of pollutants like Carbon Dioxide (CO2), particulate matter (PM), and volatile organic compounds (VOCs) can go unnoticed, contributing to drowsiness, illness, and poor cognitive function, among many other potential poor health outcomes[1][2][3].

Large pollutants can be filtered out by a good HVAC or air filtration system, but small asphyxiants such as CO2 and VOCs are best managed with proper air ventilation. However, the exchange of fresh outdoor air for indoor air works against the mission of modern HVAC, door, and window systems, which attempt to maintain a consistent internal climate (in spite of the surrounding environment) by *avoiding* the exchange of indoor and outdoor air.

It is easy to open a window during the spring and fall when the weather is nice, but knowing when it is necessary to open a window for proper air circulation during the cold winter or hot summer can be a challenge. Having a window open all the time wastes energy heating excess fresh air, but fatigue and headache from poor air quality only exacerbates common ailments like seasonal depression.

The first step to balancing this tension is having data. CO2 serves as a good proxy for appropriate air ventilation in general. CO2 is a direct byproduct of respiration and combustion, so indoor levels rise throughout the day as we breath and use gas appliances like stoves, hot water heaters, and furnaces. By monitoring indoor CO2 levels, we can have a better idea of when there is adequate ventilation and when more fresh air exchange is needed.

However, proper air monitoring requires a distributed network. A single sensor, though useful, does not provide a comprehensive picture of the air quality throughout a home (especially in homes with poor overall ventilation). A network of sensors also reduces inaccuracy due to any single faulty sensor reading and keeps the system more robust to sensor failures. Additionally, many existing air monitoring solutions are cost prohibitive to deploy across a home, with individual sensors costing up to $230[4] and coming with a list of extra and unnecessary features like onboard data processing and display.

We propose to address these issues by designing simple, low cost, low energy CO2 sensors that can be deployed throughout a home for real time monitoring of air quality, with a single central hub for processing and displaying the data via a convenient web application on the local area network.

[1] https://ehp.niehs.nih.gov/doi/10.1289/ehp.1510037
[2] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4296077
[3] https://www.niehs.nih.gov/health/topics/agents/air-pollution/index.cfm
[4] https://www.airthings.com//wave-plus

Timeline

- Since we both lack web and networking experience, we set higher time estimates for related milestones
- "CP" stands for "Checkpoint"

Week	Milestones	Hours
6	• Initial design decisions • Parts ordered for initial prototype	4 1
7	• Components individually tested • Initial prototype built	4 2
8	• Local display of CO2 readings • Test plan showing CO2 level variation	3 1
CP 1	**Local CO2 level display**	
9	• Second prototype designed • Parts ordered for second prototype	3 1
10	• New components individually tested • Second prototype assembled and tested	3 2
11	• LAN website displays live CO2 reading	5
CP 2	**LAN access to live data**	
12	• Website shows historical trends	5
13	• Website shows multiple sensors	5
CP 3	**Fully featured website**	
14	• Design documents updated	2
15	• Final report and demo video	4
Hours		45