Project Aero

CSCE 4905/4925 Senior IT Capstone
Fall 2017 - Spring 2018
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Sponsor Organization: Denton Techmill
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Overview

Project Aero is meant to tackle the question of air quality in the city of Denton. There has been a lot of research done on the topic of air quality, specifically in the city of Denton. The city itself is shaped almost like a bowl, which traps pollutants in the city. Moreover, Texas has predominant southeast to northwest winds that carry pollution from the coast, through the coal and gas patches of East and Central Texas, over the Midlothian cement plants, and through many urban areas, straight to the heart of Denton. Project Aero will enable citizens of the city to create an air sensor, contribute it to the network, and help answer the question of how bad the air quality is in the city of Denton.

Currently, there is only one air sensor which is near the Denton Municipal Airport, which collects data hourly. It too, has a front end where the public may view the data, but it is not displayed in an easy to read format. We worked to develop a front end that would enable users to quickly glance at the data and get a complete picture of what the air quality is like in the city. Users can also get historical data from past dates, view a map of all sensors on the network, and view data collected from a specific node. All the data on a PostgreSQL database on a central server, and the front end pulls the data from that database using an API in real time.

Requirements

The main requirements are outlined below:

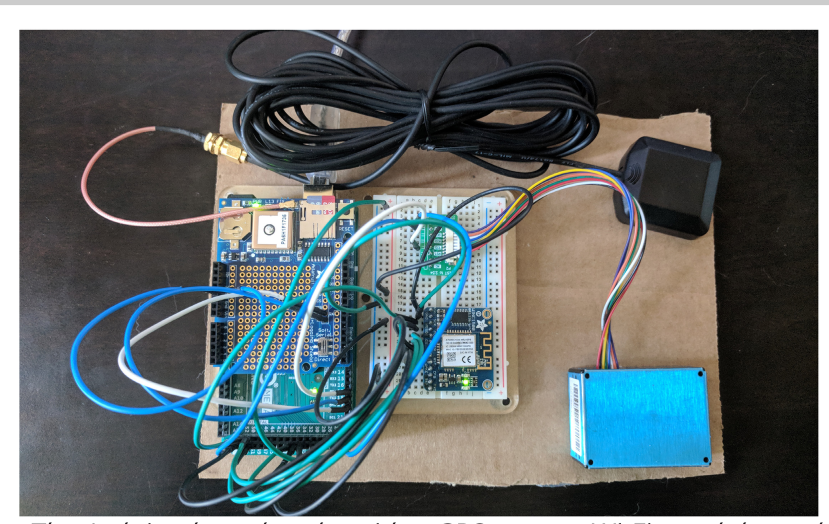
- Database capable of scaling with zero down-time
- Modeling of data in a time series format
- An open API that collects and retrieves network traffic
- Wi-Fi or 3G capable Microcontrollers that can act as network nodes
- Drivers for particular sensors to interface with Microcontrollers
- Web-based "homepage" where anyone can view and interpret datasets
- Human-readable graphs to help provide data analytics
- Open-source practices, with all code available for review and contribution by the team, or anyone else in the Open-Source community

Features

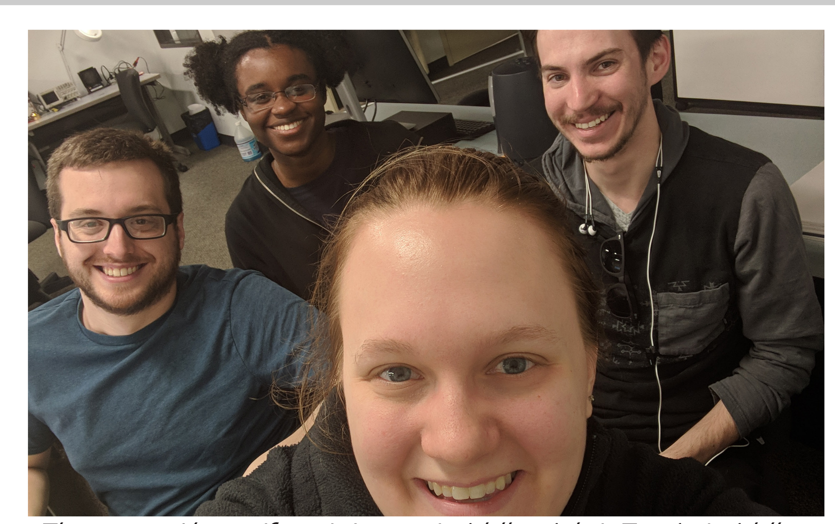
The most unique part of Project Aero is that the data it gets comes from the public. In order to help encourage user input, users have access to a Do-It-Yourself guide to make their own sensors. This gives Project Aero the potential to combine the community aggregate of information to create a full picture for the air quality within Denton and report it to the populace, all created by the people it serves.

Abstract

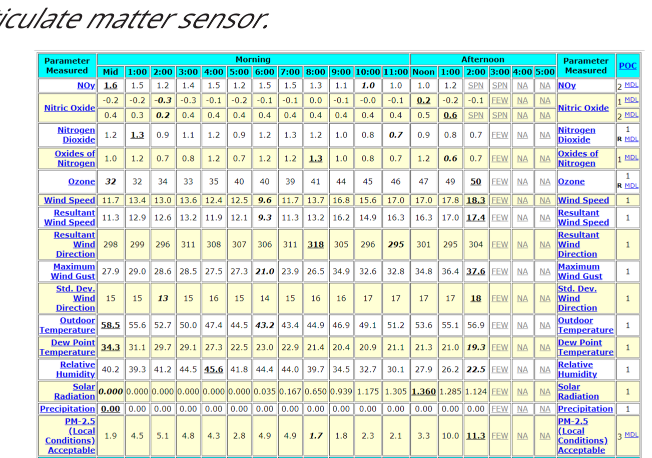
Due to the copious amounts of traffic from various highways, a multitude of large businesses, and two universities, it is quite shocking to find that there is only one air quality sensor in Denton (located at the Denton Municipal Airport). The next closest is over 15 miles away. Given these facts, we don't have an accurate and widespread view of how bad the air quality is in the city. It is the goal of this project to rectify the lack of air quality data. This project will help the citizens of Denton become publicly aware of the air quality, the standards set by the EPA, and take civic action. This project's innovation is derived from the fact that the data collected is publicly available and displayed in a manner that the average citizen can easily digest. Additionally, citizens can elect to create their own sensor and contribute the data collected from it into the publicly accessible database.



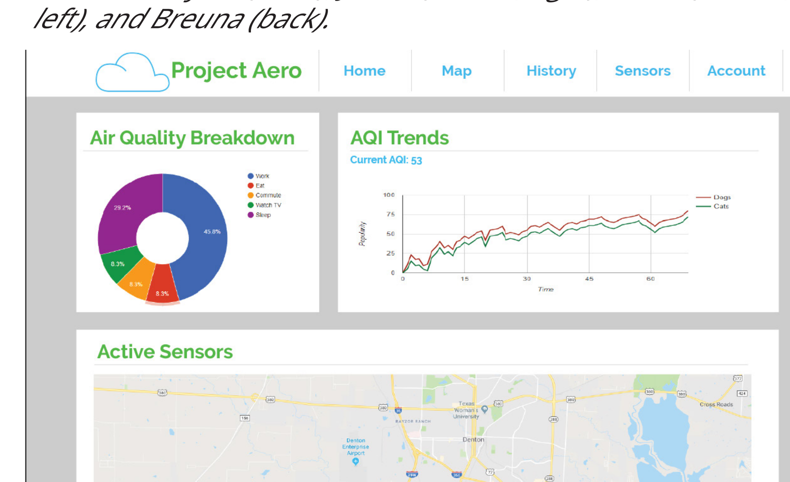
The Arduino based node, with a GPS sensor, Wi-Fi module, and particulate matter sensor.



The team. Alyssa (front), James (middle, right), Travis (middle, left), and Breuna (back).



TCEQ's website with the data from the Denton Sensor.



Our website, with data pulled from TCEQ's website, and our own personal node.

EPA Standards, TCEQ, & Denton

The EPA (Environmental Protection Agency) has implemented national laws in specific regards to the air quality in the United States. TCEQ (Texas Commission on Environmental Quality) has been put in charge of ensuring that the standards set by the EPA are met in the state of Texas.

TCEQ is the organization that is also in charge for providing air quality forecasts, managing about 150 air quality sensors statewide, and for punishing other organizations who do not meet state and federal regulations.

So how is Denton doing in regards to these regulations? In short, not well. There are two types of ozone, some in our atmosphere that protects us from the sun, and some that forms at ground level from vehicles and refineries which react in sunlight. Below is a table of the number of high days, where ozone levels exceeded 71 parts per billion.

Year	Days above 71 PPB
2013	40
2014	15
2015	30
2016	13
2017	16

Source: www.tceq.texas.gov

Challenges

The team faced many varied challenges. Chief among them was the construction of a working sensor controller from the ground up. This involved physically soldering wires to the circuit boards, learning a new proprietary programming language for the controller, and configuring each sensor component so they would all work together.

Another challenge was trying to find the right kind of server setup that could host all of our necessary applications and produce desired functionality. We started out using an Ubuntu Server distribution hosted by UNT on their network. In order to access the server, you had to be on a VPN, which introduced a host of new issues, including getting sensors to connect and deliver data to them. In addition, many compatibility issues as well as problems with web hosting while on the UNT virtual network were experienced.

The biggest lesson learned was that when working with a project of this size with so many new aspects and unexplored territory, it is best to jump into development as early as possible. Doing so would have provided the greatest chance at discovering and solving unforeseen issues that impacted the team's overall project requirements.