Poster #: ******

An Analysis of Indoor Air Quality and Particulate Matter Concentrations

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PROJECT OVERVIEW

This project involves developing an open source microcontroller systems to collect environmental pollution data on the University of West Florida campus in Pensacola, Florida (Figure 1).

Why is is Air Pollution Monitoring Important?

- Urban air pollution, which comes primarily from vehicle fuel combustion, is one of the major environmental issues in modern society (Tiwary & Colls 2010, IEA 2016).
- Motor vehicles produce more air pollutants than any other single human activity, and the large quantities of particulate matter (PM) emitted from motor vehicles can cause adverse human health impacts (Torres et al., 2018).
  - Studies show a significant association between mortality from respiratory and cardiovascular diseases, and particulate matter size (D'Amato et al., 2010)
    - Penetration of PM into the lungs is related to particle size and is monitored on two sizes: PM_{10} and $PM_{2.5}$ (Figure 2)

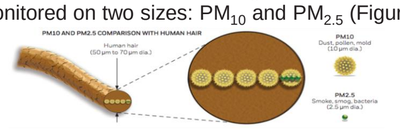

Figure 1: Illustration of the size of PM_{10} and $PM_{2.5}$ compared to a human hair

College campuses, though not as congested as urban centers, experience extensive vehicle traffic at particular locations and during specific times of the day.

- *The specific research objective are to evaluate spatial and temporal spikes in particulate matter (PM-10 & PM-2.5) concentrations on a semi-isolated small college campus*

METHODS

Device

- Particulate Matter data was collected utilizing a Honeywell® HPM Particle Sensor (Figure ?) connected to Raspberry Pi Zero® microcontroller device
  - The HPM sensor operates in 4 key steps: (Figure 2)
    1. Fan induces air intake
    2. Air sample passes through a laser beam where light reflected off the particles is captured and analyzed for particle concentration
    3. Photoelectric converter processes the particle concentration into an output signal
    4. Output signal transmitted to the microcontroller device where it is converted to quantify the density of particulate matter (µg/m^3) for each pollution level (PM-2.5 & PM-10)
- The monitoring device (HPM sensor & Raspberry Pi) will be contained with a 3D printed weatherproof housing and powered via a solar panel power bank.

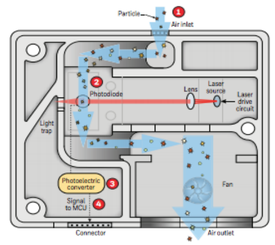

Figure 2: Schematic illustration of HMP sensor operation

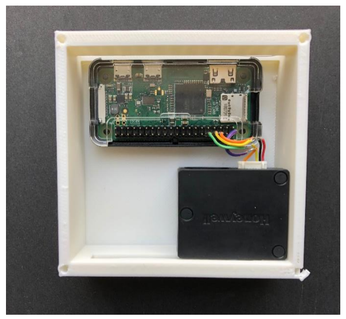

Figure 3: Raspberry Pi 0 and HMP sensor

Figure 4: Indoor sensor 3-D printed housing unit

Data Collection

- Installation of the monitoring devices will begin during the Summer 2019 semester & extend throughout the Fall and Spring terms.
- Data will be logged every 1-second and averaged over 1-minute intervals
- Data will be collected from Raspberry Pi systems through local SSH, with the eventual goal to use mesh networks

Data Analysis

- Data will be analyzed using ArcMap to produce Spatio-Temporal hotspot maps
- Machine learning algorithms will be used for predictive analysis and to isolate trends in the data using the fastai deep learning library

Figure 5: Map of UWF campus and indoor sensor locations

EXPECTED OUTCOMES

In this study, we expect to see spikes in air pollution in the early morning and mid-afternoon as students and faculty are entering and leaving campus. In areas of heavy foot traffic, we should observe an increase in air particulates at times in-between classes. In consistently populated buildings, like the gym, we expect constant PM levels, and we expect fluctuations in buildings used for classes like building 13.

FUTURE WORK

The inexpensive and open source operation of our pollution monitoring device provides a product that is easily scalable depending upon the research objectives. Additional sensors (i.e., CO_2, CO, HC, NO_x) can be added to the monitoring device. We also plan to scale out to monitor these additional pollutants across the city of Pensacola.

For this project we will download the data from the Raspberry Pi devices over a local SSH server. In the future we are looking into building a mesh network, which will create an interconnected networking grid between the sensors and a central server. This has two benefits: 1) it will eliminate the need to physically download the data and allow for real-time monitoring; and 2) the use of a central server allows us to develop an online GIS database, which we can thus make the data available to the public and construct a web GIS platform for data visualization.

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