ELECOMP CAPSTONE SUMMIT
FRIDAY, MAY 10, 2019

THE UNIVERSITY OF RHODE ISLAND

THINK BIG WE DO℠

Digital Particulate Sensor for Room Alert

AVTECH™

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Project Motivation

Room Alert provides business continuity by notifying staff if environment extremes threaten their computers, facilities and other assets. Thirty percent (30%) of unexpected downtime for a small to mid-sized business is caused by environment factors. In the USA alone, that means that millions of businesses are impacted every year. Room Alert helps to monitor, alert, and ultimately prevent this downtime. Dust and other airborne particulates can have a significant impact on other environment conditions and a facility as a whole. Not only can high levels of particulates impact workers' health, it can also cause premature wear on equipment, rapid filter clogs, and can even indicate that smoke or smoldering materials are present. Adding an intelligent particulate sensor that can detect that particulates are present will add significant value to Room Alert users and will provide new insights that could help reduce downtime and equipment damage.

Key Accomplishments

Schematic and PCB layout:
The schematic was created on a program called DipTrace. All the chips and components had to be made in the program and saved under a project library. These parts were created to spec and routed to match our breadboarded prototype. The next step was to convert the schematic into a PCB. We received the exact sizing for the PCB from AVTECH, and from there we had to layout our components. AVTECH gave us the PCB sizing because they wanted our final project to physically look like there line of accessories. The components were all laid out and then routed through the top and bottom side of our two layer board. The PCB was has mounting holes that are used to connect the entire unit together. The top and base of the enclosure line up perfectly with the mounting holes allowing for everything to screw together nicely. Our blower and sensor then connect and stabilize to the mounting holes on the PCB.

Implementing Smoothing Algorithm:
After some research, an algorithmic way to obtain clean outputs is by using a smoothing algorithm. This method takes in a certain amount of values and averages them all together into one data output. During our tests with Arduino, the algorithm was a success and showed us clean outputs from our particulate sensor. This algorithm made an easy transition over to a our PIC Chip which guaranteed us that we will have reliable data on the output of our final project.

MPLAB Code to give Output Data from Particulate Sensor:
We used MPLAB Code Configurator (MCC), which is an API that automatically generates code to our liking. We managed to set our input/output pins and the frequency so the chip can be capable in transmitting/receiving data. Our main file is where the smoothing algorithm and pulsing was implemented. When the chip is powered, it gives us voltage values coming from the sensor ranging 0-5 volts which are changing with the level of particulate.

Storing Data To a Text File:
We researched ways to store our current values into a text file, and we found that XLSX was the correct Python API function to use. Since Python is more broad, we were able to store values to a text file automatically using this method. Comma Separated Value(.CSV) file, was primarily used to store our data. Once the data was saved, we can then import it to Excel to graph our data points. This way we can visually see what our data looks like and also comparing it to our old data points. This was an extremely useful tool when testing and comparing the different prototype configurations.

Testing Units:
Large Bins filled with dust and particulate were used for simulating a warehouse environment. The sensors and fans/blowers were placed inside the units, and then data was recorded to test how accurate the sensors were. The data came back very accurate and proved to us that the our prototype unit worked properly. The same test were taken once our enclosure came in. This was to see if the enclosure allowed the dust to filter through as easily as the prototype. The test passed again for the enclosure proving to us that the final product worked efficiently. The simulation bins played a big role with finalizing every component used in the our project.

Final Enclosure:
The enclosure for our project was made to match a similar sensor packaging AVTECH already has. We altered AVTECHs cad files to fit our components, but kept the same look and feel of their pervious design. We had help from a mechanical engineer to make these corrections to the cad files and 3D print the final enclosure. There are mounts for screws to lock the top and bottom pieces together and slots to allow particulate to flow through the intake and exhaust on our blower/sensor package. The enclosure came out perfect and fits right in with AVTECHs senor lineup.

Anticipated Best Outcome

The anticipated best outcome is a fully-functional engineering prototype; composed of an electrical schematic, circuit board design, and a bill of materials that can be used to manufacture the product. All components and design choices should consider the eventual CE & FCC certification desired for this product. Averaging the data over time and holding peaks for 3 seconds is to ensure Room Alert has time to recognize the high particulate levels when scanning loops may take 2-3 seconds. A mechanical enclosure design should also be included, and ideally would be tested with multiple variations that optimize air flow and particulate detection.

Project Outcome

The Anticipated Best Outcome was achieved. We successfully made and prototyped a complete digital particulate sensor for Room Alert.

Figures

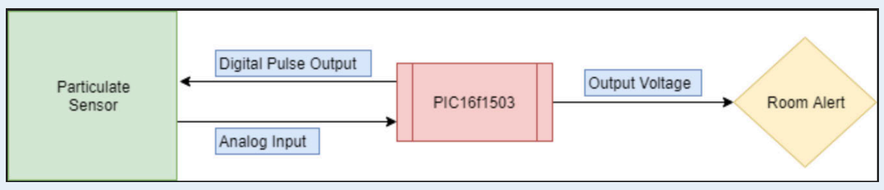

Fig. 1. PIC chip flow chart plan to operate when programming

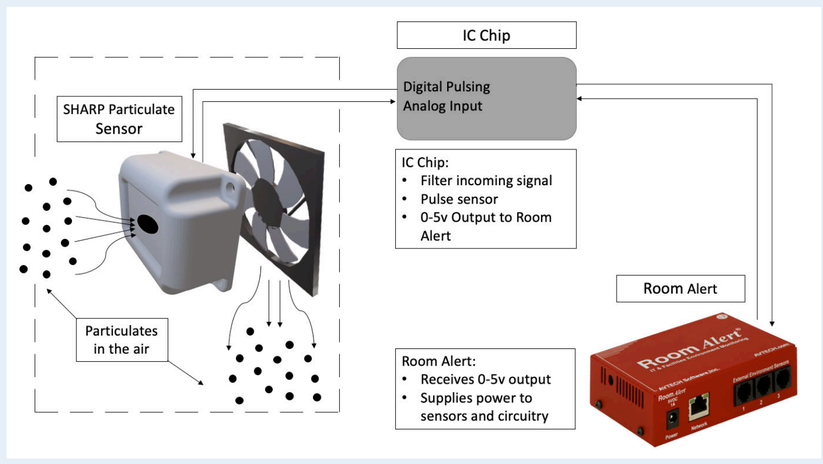

Fig. 2. System block diagram for the hardware, PIC chip and Room Alert

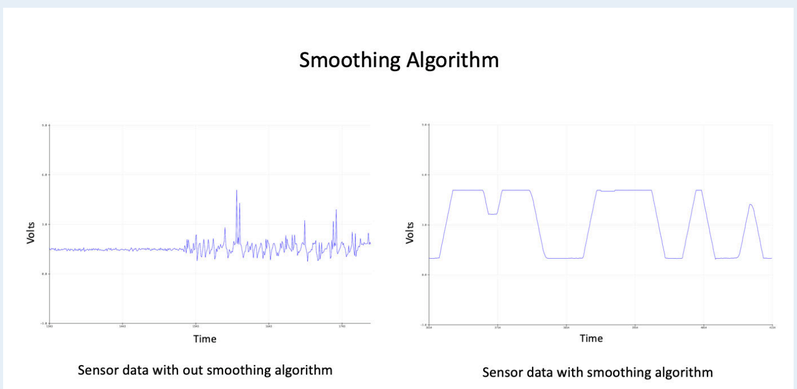

Fig. 3. Output voltage test from PIC chip, displaying before and after

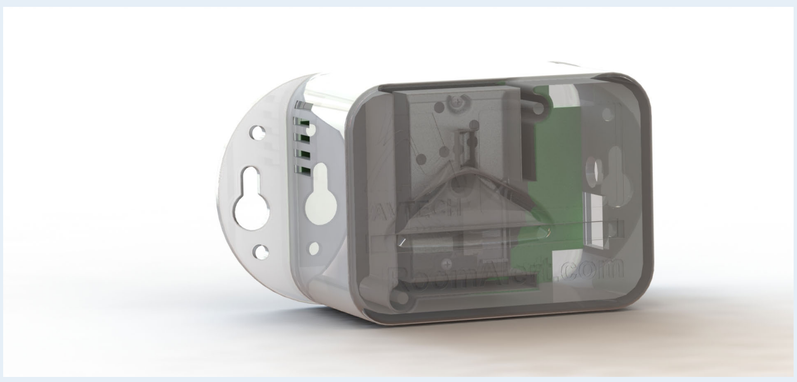

Fig. 4. Final enclosure with the sensor and blower

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