Early Wildfire Detection Using a Raspberry Pi Smoke Sensor

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Introduction

On average, about 67,000 wildfires occur every year and burn about 7.0 million acres

Wildfires Effects:

- Climate Change: Increase carbon dioxide within the atmosphere leads to increasing temperature.
- Pollution: More contaminants in the air, worsening air quality index.
- Public Health: Pollution leads to increase health issues, like cancer, heart and respiratory diseases.
- Biodiversity: Wildfires destroy all flora and fauna in their path, displacing animals that are able to escape.
- Economic Resources: Economic loss due to destruction of natural resources, cost of fire fighting, and rehabilitating affected areas.

Current Wildfire Detection/Prevention Flaws

- Satellites cannot detect early stages of wildfires
- Optical systems may cause false alarms and are very expensive
- Learning about how existing wildfire detection systems are not sufficient enough in preventing or controlling wildfires, it gave us the inspiration in creating a possible solution to this grand challenge.

Our objective:

To combat our grand challenge, we are creating a smoke detector sensor that has a stable power source, able to transmit a message through Raspberry pi, and capable of detecting a wildfire when it occurs. We hope by developing this smoke detection system, we can help notify the authorities at a quicker rate in order to prevent wildfires.

Methods

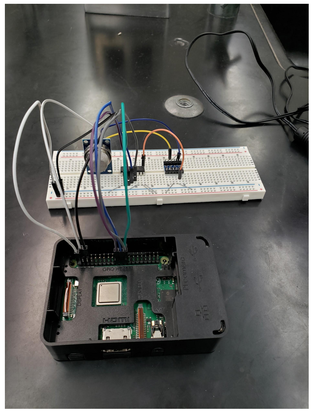
Power: We soldered the wires to nine volt solar panels and connected them in parallel using crimps. The parallel circuit will enable us to charge the device with direct currents. Given more time, we would have connected the solar panels to power our project. We picked solar panels since they were cheaper and provided just enough power to not over charge the system.

Transmission: To transmit a signal from the smoke sensor to the proper authorities, we chose to use a Raspberry Pi. We programmed the Raspberry Pi to send an email when it recieves an input from the smoke sensor (code available at: https://github.com/TobyJChappell/GCI). We then set up a crontab to run the script on boot so that we would only need power in order to run (therefore our project does not need a monitor or keyboard to work).

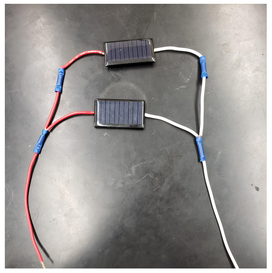
Detection: In order to detect smoke, we wired a MQ-2 Smoke Sensor to the Raspberry Pi. By connecting the sensor to the Raspberry Pi's GPIO (general-purpose input/output) pins, the Raspberry Pi is notified when a fire is detected and allowed to take the necessary actions.

Acknowledgements

- Dr. Anne Sonnenchien: Provided a basis for the original project idea and design consultant.
- Dr. Charlene McCord: Helped us set up a meeting with an expert in solar energy.
- Dr Robert de Bruijn: Worked with us on decision to use a Raspberry Pi for transmission.
- Dr. Aaron Harrison: Provided support to begin work on smoke detection.

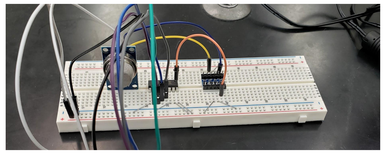


Raspberry pi connected to the breadboard with the MQ2 sensor.



9V Solar panels that are connected in parallel with wire crimps.

Raspberry Pi Model 3

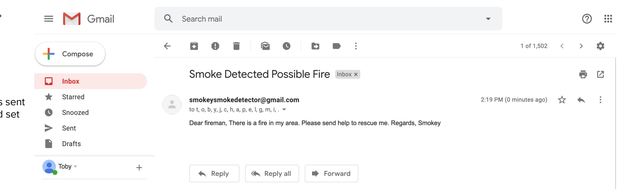


This is a breadboard with the MQ2 smoke sensor.

Results

While we were not able to test our project design since we did not have time to complete it, we were able to test and build most of our project. For one, we were able to send an email from our smoke detector using Google's SMTP server (Figure X.X). Additionally, we were able to build our solar panel circuit (Figure X.X), which would be used to power our project. Lastly, we connected the MQ-2 Smoke Sensor and Raspberry Pi on a breadboard (Figure X.X). Assuming we had time to finish our project, we would enclose our project so that it would be a single unit. Furthermore, we would use the ion-concentration chamber and test the sensor's ability to identify and measure the concentration of ions in the smoke detected. In the future, we plan to connect the raspberry pi to the solar panel circuit so that the system can work remotely from a plug.

The image on the right shows an email that was sent by the raspberry pi to the gmail account we had set up.



Conclusion

- Working prototype demo, which enable us to solidify future plans/goals: To connect the raspberry pi to the solar panel circuit so that the system can work remotely from a plug. This will allow the use of this project domestically.
- Our project has the potential to save lives for people who live in habitats where there is a larger chance of wildfire that could disrupt their homes.
- When the Australian wildfire took over storm in the world, the impacts were devastating. We wanted to find a way where we can help alleviate that so we decided to use Raspberry Pi since we wanted to develop a messaging system to alert wildfire authorities faster to help reduce the amount of damage done to neighboring communities.
- We predict that this product will breach that gap to help the communities all around the world to increase the safety of animals/civilians.
- Below is a budget table for what we spent for the duration of our project; green items listed as free courtesy from the Chapman Makerspace

Items	Price
Raspberry Pi 3 Model B	$24.99
Solderless Breadboard	$5.54
MQ2 Gas Sensor	$4.49
Jumper Wire Pack	$6.99
Solar Panels (8v)	$7.89
5V to 3.3V Logic Level Converter	$5.55
Analog-Digital Converter (8 Ports)	$5.82
Total Price	$61.27

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