Anton Chico Middle School, New Mexico

Amaya Gonzales, Kiara Sanchez, Ava Lucero, Amilee Cordova

Problem Statement:

Wildfires are a serious threat, especially in rural areas where response times are slow.. We need a faster, more reliable way to detect fires early to prevent future destruction. (UNSDG 13)

Objectives:

- **Improve Early Fire Detection** – Deploy a system of smoke detectors in wildfire-prone areas to identify fires as soon as they start and send instant alerts to responders.
- **Reduce Fire Response Time** – Ensure firefighters and forest rangers receive real-time alerts, allowing them to reach and contain fires before they spread out of control.
- **Protect Communities and Resources** – Minimize wildfire damage to homes, farmland, and livestock, reducing the financial and emotional effect on families in affected areas.
- **Enhance Safety and Sustainability** – Support long-term wildfire prevention efforts by providing a proactive solution that reduces environmental destruction and promotes community resilience.

User Requirements:

- **Reliable Smoke Detection –** The system must accurately detect smoke in wildfire-prone areas and avoid false alarms from non-fire sources.
- **Real-Time Alerts –** The smoke detectors must instantly notify firefighters, forest rangers, and emergency responders when smoke is detected.
- **Wide Coverage –** The system should be able to monitor large areas, particularly near campfire sites, forests, and high-risk wildfire zones.
- **Durability and Weather Resistance –** Devices must withstand harsh outdoor conditions, including extreme heat, wind, rain, and debris.
- **Long Battery Life or Sustainable Power Source –** The system should function for extended periods without frequent maintenance, potentially using solar power for sustainability.
- **Integration with Emergency Response Systems –** Alerts should connect seamlessly with fire departments and ranger stations to ensure quick action.
- **Cost-Effective and Scalable** – The solution should be affordable for widespread deployment and easily expandable to cover more at-risk areas over time.

Figure 1: Circuit Diagram:

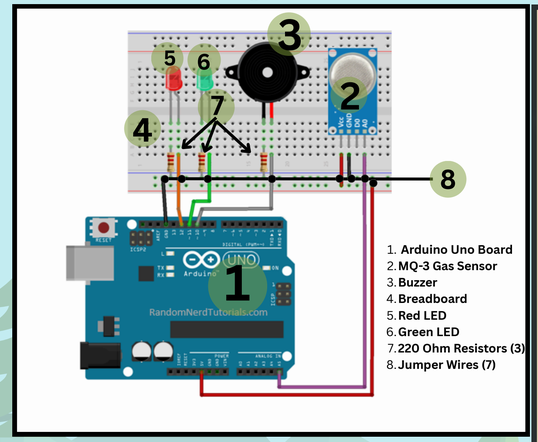

Figure 2: Prototype Detail: Flowchart

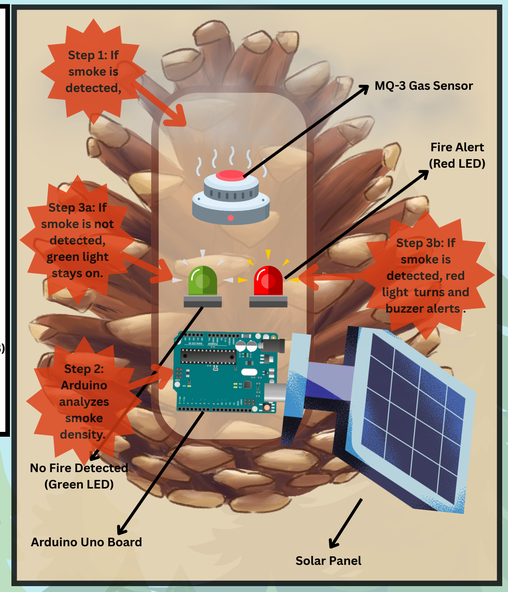

Figure 3: Testing Data (Visual Data 2)

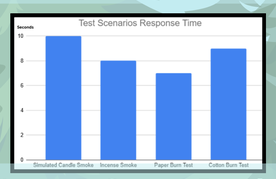

Figure 3: The graph to the right shows that the paper burn had the quickest response time with 7 seconds. The simulated candle smoke took longest to alert (10 seconds).

Figure 5: Survey Results (Visual Data 1)

Figure 5: Shows user survey data from survey administered after prototype was presented to various users.

Figure 4: Design Iterations

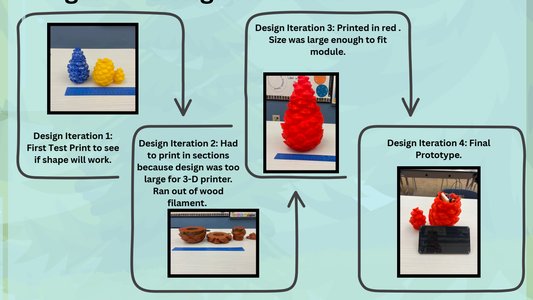

Figure 4: Shows the number of design iterations it took to create the appropriate casing for the smoke detection sensor.

Engineering Design Process

Problem:
Our client Dr. Martinez almost lost his home to the Hermit's Peak fire in 2022.

Brainstorm:
Our team explored different ways to detect fires faster.

Plan:
We designed a prototype that detects the presence of a fire and sends out an alert.

Test:
We tested sensor accuracy to measure how quickly the smoke detector responds to ensure notifications are sent immediately.

Improve:
We impoved our prototype by changing our coding to simulate no fire presence and an alert.

Communicate:
We shared our findings with our users and had them complete a survey to provide feedback.

Results:

We were able to create a prototype that adequately meets the purpose of our project. It took us several tries to find the right code and wiring diagram, and we also had to make different versions of the casing to fit the sensors and wires. In the end, we built a working prototype that solves the problem we set out to fix. Our prototype supports equity by helping firefighters and people in areas with limited resources. By making a low-cost, easy-to-use system, we're making sure that more people can stay safe, even in places where fire services are harder to access.

Conclusion:

Our team believes that the Fire Bandit prototype meets the basic needs of our users, firefighters and forest rangers, by helping them detect wildfires early, especially in high-risk areas like campgrounds and dry forests. The smoke sensor (MQ3) can detect smoke quickly, and the Arduino Uno processes this data and sends signals. The power source, which can be a battery or solar panel, allows it to work in remote places where there may not be electricity.

If we continue this project, we know there are important improvements we can make to better meet user needs. We plan to add a wireless transmitter, like a Wi-Fi or LoRa module, so alerts can be sent in real time to emergency responders. We also want to include a Bluetooth sensor that can send out the GPS location of the fire. This would help firefighters know exactly where to go, saving time and making responses faster and safer. These upgrades will make the system even more useful, especially for areas that don't have access to fast emergency services.