Wireless Sensor Networks for Early Wildfire Detection

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Abstract

The increase in the size and severity of wildfires over the last fifty years necessitates wildfire detection strategies to detect and respond to wildfires early to minimize damage to land and property. An important aspect of designing a wildfire detection system is being able to accurately monitor a large outdoor area for any signs of wildfire, and quickly respond to any detected emergency. This poster describes a wildfire detection implementation that utilizes a wireless sensor network that can cover a high-risk area to monitor for signs of wildfire, such as temperature and smoke.

Wireless Sensor Network

A wireless sensor network consisting of "nodes" provides the wildfire detection portion of this project. The nodes, equipped with a variety of sensors, monitor in real-time for any signs of wildfire. ZigBee protocol is used to communicate over a large distance. ZigBee was chosen for its low power consumption and a long operating range of 200ft per node. This makes it ideal for implementation in an outdoor environment. The layout of the wireless sensor network is a star formation.

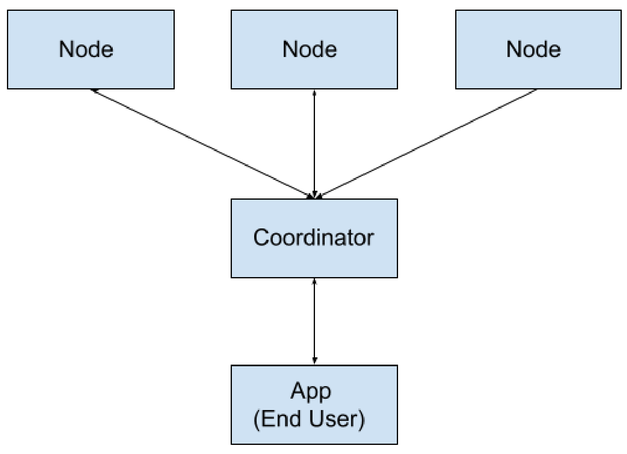

Fig. 1. Diagram for layout of wireless sensor network. An arbitrary number of nodes can be used in the final design.

Each node is equipped with temperature, humidity, and smoke and gas sensors to monitor for signs of wildfire. When certain thresholds (set by the end user) are exceeded, the node sends a signal over the ZigBee wireless network to a coordinator node, set up on the rover. This notifies the end user through the custom app developed, and the autonomous rover then travels to the GPS coordinates of the node to provide further information and verification on the potential wildfire.

App

The custom Android app developed allows the user to view the sensor information from the nodes in real-time and gives the ability to take over the rover. The app communicates with the rover via Bluetooth. By using the functions already built into the phone we can use the phone's Bluetooth, sim card, as well as other sensors to help reduce programming for the app. A command is sent to the rover telling it which information to send, or which direction to go. The rover then sends the desired information back to the app. The app uses a slider to pick which sensor information to select, and switch to active the different functions on the rover such as IR camera, taking a picture, and manual override. The app also includes a home button to send the rover back to its starting spot, and a call button to contact emergency services quickly when a wildfire is detected. This allows the entire system to be monitored and controlled by the end user.

Rover

The rover is designed to give dual verification to prevent false positives in case a sensor fails. Once a node's temperature or smoke sensor reaches the threshold for a likely wildfire (predetermined by the end user), it sends an alert to the rover which then autonomously travels to the node that sent the notification. If multiple alerts are sent to the rover, the rover travels to the sensor in a first come first served basis. A priority implementation for the node also works. For example, if one node is closer to a city then it should have a higher priority than nodes that are deep in the forest. If the nodes that have sent the notifications have the same priority the rover would determine which node was closer and travel to that node.

A Bluetooth module on the rover provides direct communication to the Android app. The rover also processes all the information received from the nodes and sends the information via Bluetooth to the app in real-time. The rover is equipped with cameras that can capture information, take pictures or video and send it directly to the app so that the end user is able to monitor the condition of the wildfire.

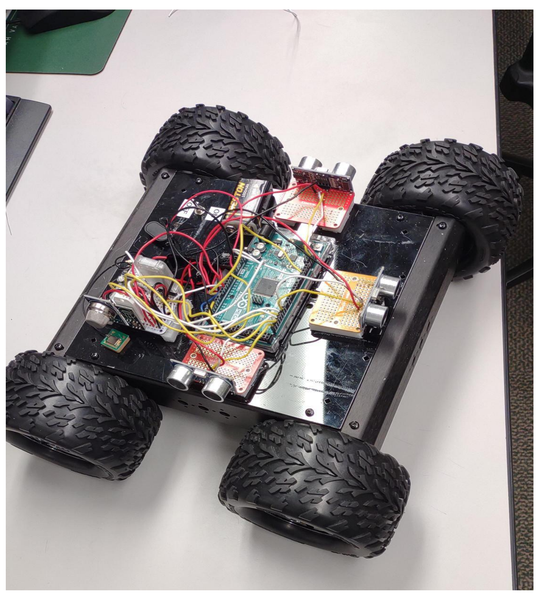

Fig. 2. Designed autonomous rover.

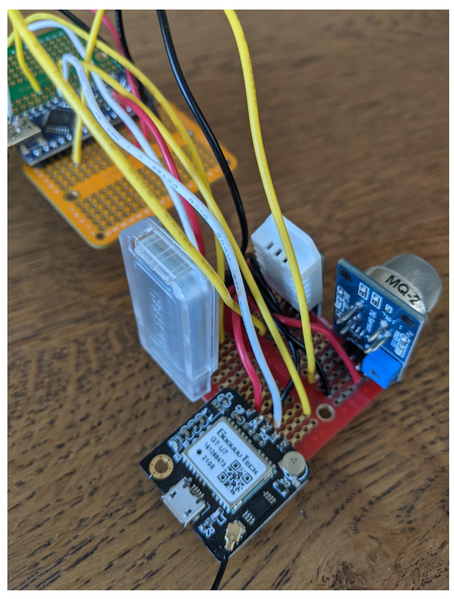

Fig. 2. Designed node.

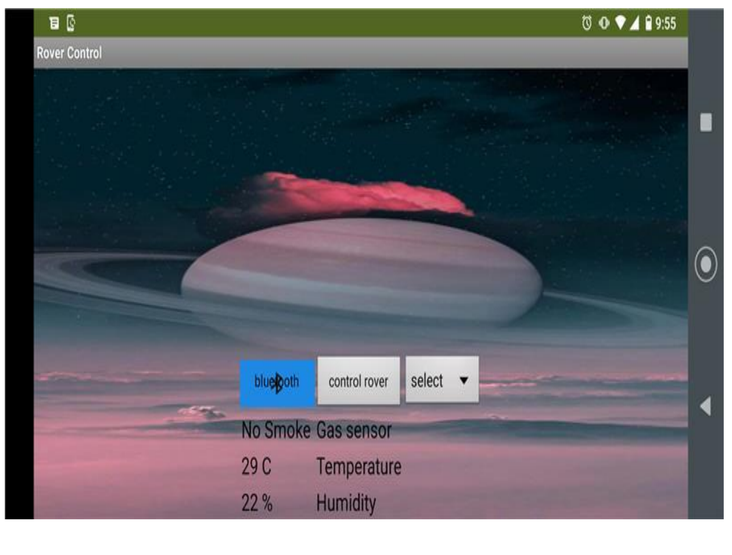

Fig. 3. App displaying sensor information

Conclusion

The designed system works well for identifying and responding to wildfires over a large distance in an outdoor environment. The implementation of the ZigBee wireless sensor network performs well and is easily customizable to any outdoor environment that needs to be monitored for signs of wildfire. Future research and work on this project would entail developing a quadcopter drone instead of a rover for responding to the wildfire, and implementing the designed system in other environments, such as indoor carbon monoxide monitoring.