CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)	Project Number
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Project Title

An Early Warning AI-powered Portable System to Reduce Workload and Inspect Environmental Damage after Natural Disasters

Abstract

Objectives

My goal is to develop an early warning AI-powered portable system that can monitor environmental damage during natural disasters. Both air and water quality need to be monitored with the aim of providing early intelligence to incident commanders to plan search and rescue operations. Additionally, intelligence on physical stress of front-line environment protectors will guide incident commanders on optimal resource planning.

Methods

A multi-spectral sensing system to monitor air and water quality that can operate in dangerous environments for safer and accessible rescue operations was developed. The prototype has 1) search and inspection multi-sensor drone, 2) AI-powered intelligent base station, 3) a low-cost portable spectral water quality inspection system and 4) rescue system based on robotic crawler and hand. The search module has 4 drone-mounted sensors: gas sensors, thermal camera, GPS sensor, a visual camera, and wireless communicator. The gas sensor monitors smoke situations while thermal camera detects hidden hot objects. Spectral water quality monitoring system analyzes water samples and quickly analyzes turbidity levels indicating potential pollutants such as salt and bacterial contaminant levels. The AI-powered intelligent base station is based on Nvidia Jetson TX2 and powered by open-source object recognition and localization AI algorithms (imagenet and detectnet). It receives target images and GPS from the search system. The GPS results of target location are sent to the robot for retrieval. The retrieval robot has 3 sensors: ultrasound sensors for obstacle avoidance, LIDAR for fine gripper control and PixyMon camera for texture-based target matching.

Results

The prototype has four key functioning modules: Search and inspection drone with multi-spectral sensors; AI-powered intelligent base station; Portable water quality spectral analyzer; and Rescue retrieval system based on robotic crawler and hand. The search module has four drone mounted sensors i.e. gas sensor to evaluate the environment, thermal camera to detect hidden objects, iPhone5 unlocked sensors like GPS and visual camera, and a wireless communicator. Gas sensor monitors rescue operation viability while visual and thermal cameras detect search targets. AI-powered intelligent base station receives target images and GPS from search system and automatically searches for target. Open-sourced AI algorithm imagenet was used to identify targets with 60-95% confidence, while another AI algorithm detectnet was used to localize target. Target image and GPS location were transmitted to robotic retriever. The prototype robotic crawler could carry loads of up to 2 kg and navigates by comparing the GPS location of the target with the current

Summary Statement

I have developed and tested an early warning AI-powered system to help firefighters and others in the first-line of environment protection to reduce their workload, inspect the environmental damage after natural disasters and plan actions.

Help Received

All experiments were done in home environment and in my garage lab. I appreciate the financial resources provided by my parents to procure experimental devices. I appreciate the time and feedback provided by officers of Sunnyvale Fire Department, Sunnyvale, California.