CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

S0912

Project Title

Using Optical Flow Modeling Methods and Sensor Fusion to Create a Novel Low-Cost Autonomous Emergency First Responder

Abstract

Objectives/Goals

Inefficient emergency response causes an average of 100,000 deaths per year worldwide. Autonomous flying robots have tremendous potential to enhance emergency rescue operations. Currently, flying robots are highly limited in their capabilities because they need manual control and are too large, slow, and expensive.

The objective of this engineering project is to create a low-cost, light-weight, and robust robotic drone that can autonomously navigate through hazardous environments efficiently to locate targets (e.g. source of a fire or chemical leak).

Methods/Materials

The Parrot AR Drone 2.0, a relatively low-cost platform that is compatible with inexpensive hardware, was chosen to build the flying robot. Two temperature sensors, two gas sensors, a micro-controller, and a single-board ARM-based embedded system were added to the drone to quickly process vision algorithms and sensor information in real-time. Autonomous navigation is proposed through visual image processing and monocular mapping using Lucas-Kanade optical flow modeling and sensory fusion of gas and temperature sensors to plot obstacles in an environment. The obstacle avoidance monocular mapping algorithm takes a two-dimensional image and uses it to create a three-dimensional map of the drone's environment to identify where the obstacles are located relative to the drone's position. The target location navigation algorithm monitors gas and temperature readings along with visual information to track targets.

Results

The robotic drone was successfully able to map its environment and avoid obstacles while quickly locating targets. Difficulties in obstacle avoidance computer vision algorithms to run on low-power computer were faced and solved using methods like the RANSAC model. The cost excluding the drone was under $100.

Conclusions/Discussion

This project successfully demonstrates the efficacy of electronic sensor fusion with optical flow modeling algorithms to validate a proof-of-concept prototype system that is powerful and cost-effective in autonomous sensing and navigation, with immediate applications in emergency response. Making a variety of sensors that are interchangeable will allow the system to help in different types of disasters such as storms, floods, or nuclear radiation hazard. This project has the potential to help first responders save thousands of lives annually in an emergency response situation after a natural disaster.

Summary Statement

My project is a proof-of-concept method to use sensory fusion and monocular mapping-based computer vision algorithms to create low-cost emergency rescue drones to autonomously navigate in hazardous environments after a natural disaster.

Help Received

UncannyCV, a company that creates computer vision libraries that are optimized for the ARM processor, allowed me to use their vision library for the purposes of this research.