Autonomous Target Scoring Drone

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Objectives

The goal of this project is to create a drone system that can automate accuracy verification at U.S. Navy bomb ranges. Components of this system is a quad-copter that has been modified to be able to fly to a GPS coordinates autonomously, and an interactive GUI that allows the user to interact with the system. The desired functionality of this system is as follows:

1. User enters target GPS coordinates into our interactive GUI
2. Drone autonomously travels to target and takes a picture of the target
3. Our computer vision software calculates a score for the hits on the target
4. User tells the drone to come home or enters new coordinate

Introduction

The motivation for this project is to increase efficiency and safety of target practice by preventing personnel from having to travel on to the bomb range to score artillery shots. While designing this system, some things that we focused on was creating a system that is easy to use, flexible and reproducible. While this system is meant for military training, the framework that we have created can be easily modified for other applications such as active duty bomb damage assessment and search and rescue efforts.

Figure 1: System Overview

Results for Target Scoring and GUI

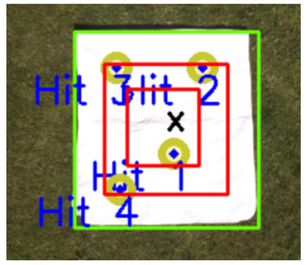

Figure 2: Computer vision result

By using our image processing algorithm we are able to score circular hits on square targets in many configurations.

Accuracy of Computer Vision	~80%
Image processing speed	~8-10 seconds
Maximum number of projectiles detected	7-10
Works with different colors	Yes

Figure 3: Computer vision specifications

Interactive GUI features:

- Image of target
- GPS coordinate input fields
- Score Output
- Fully functional text editor for taking notes about session
- Drone status

Figure 4: Interactive Graphical User Interface

Materials & Methods

The following hardware components were used to accomplish this task:

- Autel X-Star Premium Drone
- Raspberry Pi Zero W
- Wireless Network Router
- Adafruit Ultimate GPS
- Arduino Uno

These techniques were used for system integration:

- WLAN for data transmission from drone
- Serial communication for transmission from PC to MCU
- PWM into controller interface to send motor action commands back to drone

Autonomous Flight Control

Our autonomous flight control system has the benefit of simplicity, modular design, and customizability. In its current state, it's designed to either be flying to the desired GPS coordinates at a constant speed or not flying at all.

Future designs could incorporate proportional (or proportional-integral) control, a magnetometer for heading correction, an accelerometer for altitude control. The program as it is now could be used as a state in a state machine that included additional states for IMU calibration, autonomous takeoff, autonomous landing, and more.

Flight Time 25 minutes
Max Speed 15 m/s
Max Range 100 m

Conclusion

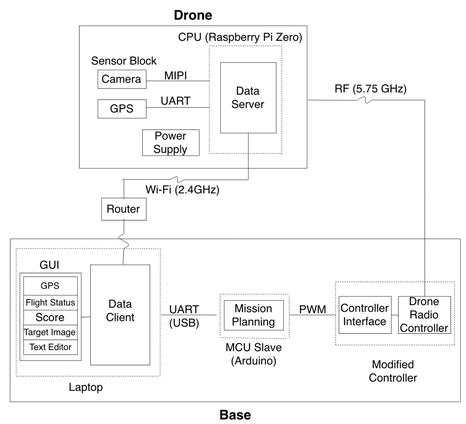

Figure 5: System Block Diagram

What was accomplished in this project:

- A computer-vision based target scoring program that could easily be integrated into any other system that demands target scoring.
- A semi-autonomous flight control system designed to be modular, flexible, expandable, and customizable.
- A reliable communication system for sending data directly from one device to another using a combination of TCP/IP and serial communication protocols.

Relevant Topics

- Computer Vision
- Autonomous Vehicles
- Software Design

Future Development

The beauty of this system is the many ways it could be improved or altered to fit different situations. Ways to improve the project include making it fully autonomous from start to finish, integrating a live video feed into the GUI, adding the option to enter multiple targets at a time, or even utilizing Autel's recently released SDK to drastically reduce the necessity of external hardware.

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