Autonomous Aerial Position Tracking System

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Objectives

The objective was to create a system to track an object aerially. Safety and reliability were prioritized over speed, and clarity and usability were emphasized.
Some goals for this project were:

1. User configurable tracking position
2. Simple, intuitive setup
3. Accurate tracking position
4. Steady state error less than 2 meters
5. Convergence time of 5-10 seconds
6. Battery life longer than 30 minutes

Introduction

The autonomous aerial position tracking system is a drone mounted control system that aims to track another potentially aerial object. A system like this could be implemented in various civilian and/ or military applications, for example a camera equipped drone to follow and film a target. The goal is for a drone to follow a target equipped with some required equipment at a fixed distance specified by the user. The drone should quickly respond to changes and should respond to changes in latitude, longitude, and altitude.

Results

Measurement	Mean	Std deviation
Steady state error	1.53m	0.52m
Convergence time	4.5s	2.0s
Response time	1.5s	1.0s
Hardware battery life	55min	3min
Flight time	23min	4min

Table 1: Critical system measurements

We obtained our measurements by comparing GPS readings with a custom script. We used a sample size of 15 trials for each measurement. The system performs admirably, with relatively low steady state error almost at the limit of the GPS precision. Response time is also decent, but convergence time is relatively slow. Tuning the P-controller to converge faster resulted in instability so this was a design choice to favor stability over speed.

Qualitatively, the system tracks different objects quite well, and handles different formations easily. The system can be tuned for different applications by selecting different values for P within the Graphical User Interface.

Figure 1: System in action

Hardware and Approach

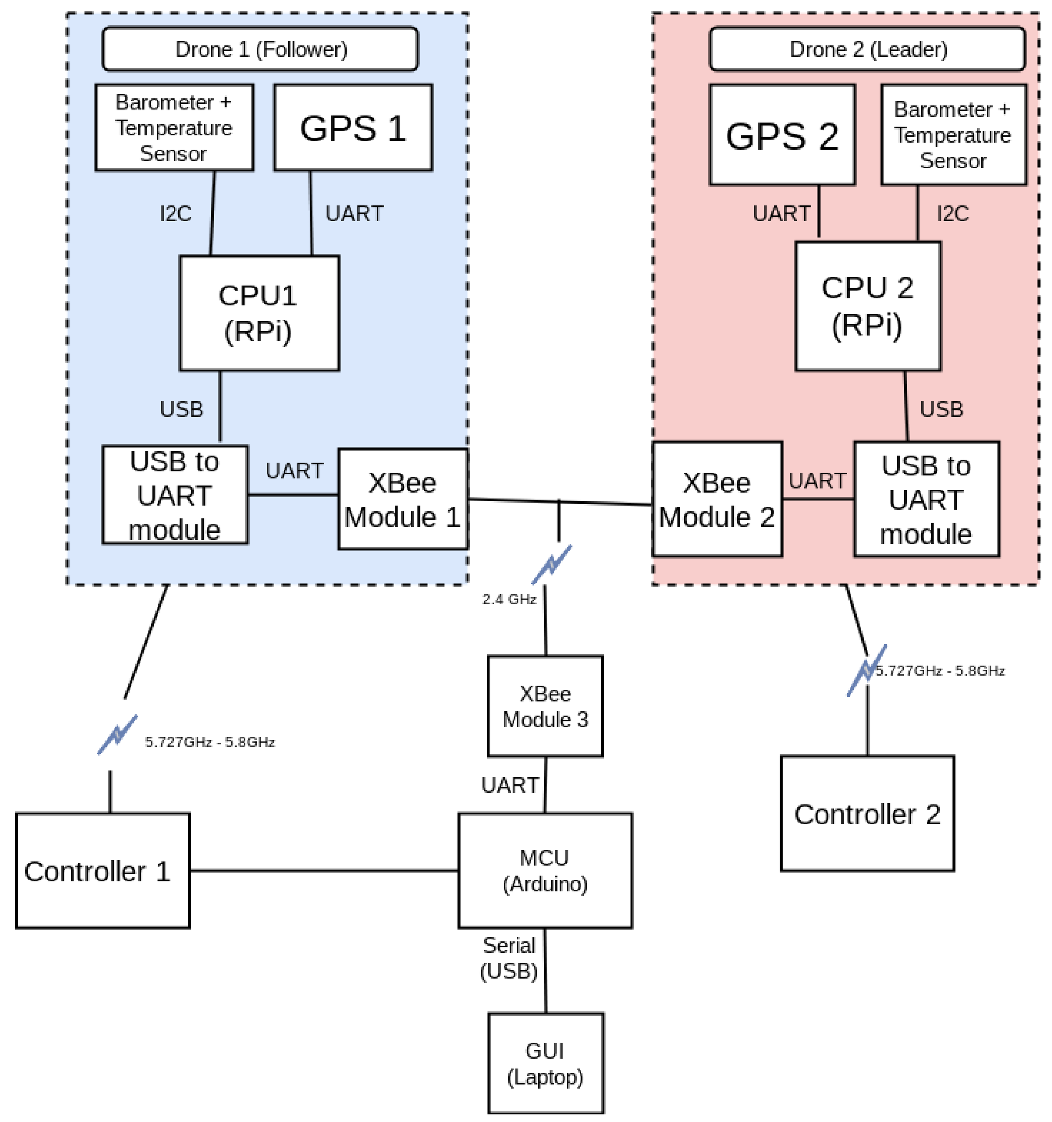
The following materials were needed to complete the project:

- Drone and Controller
- Raspberry Pi 3 Model B
- XBee Modules
- GPS/IMU Module and Antenna

We used P controller to control the follower drone. We chose P controller as it worked perfectly with our system to decrease its steady state error. Our initial thought was to use PI controller but with the increase in run time of the system the error kept on accumulating, resulting in inaccurate results. While P controller on the other hand eliminated this problem, proving the better option for the project

System Block Diagram

The way our system works is buy having a Raspberry Pi on the drones that is connected to a GPS/IMU module. The data is then sent over an XBee to the another XBee on the base station. The base station consists of an Arduino connected to a laptop that has the GUI on it.



Conclusion

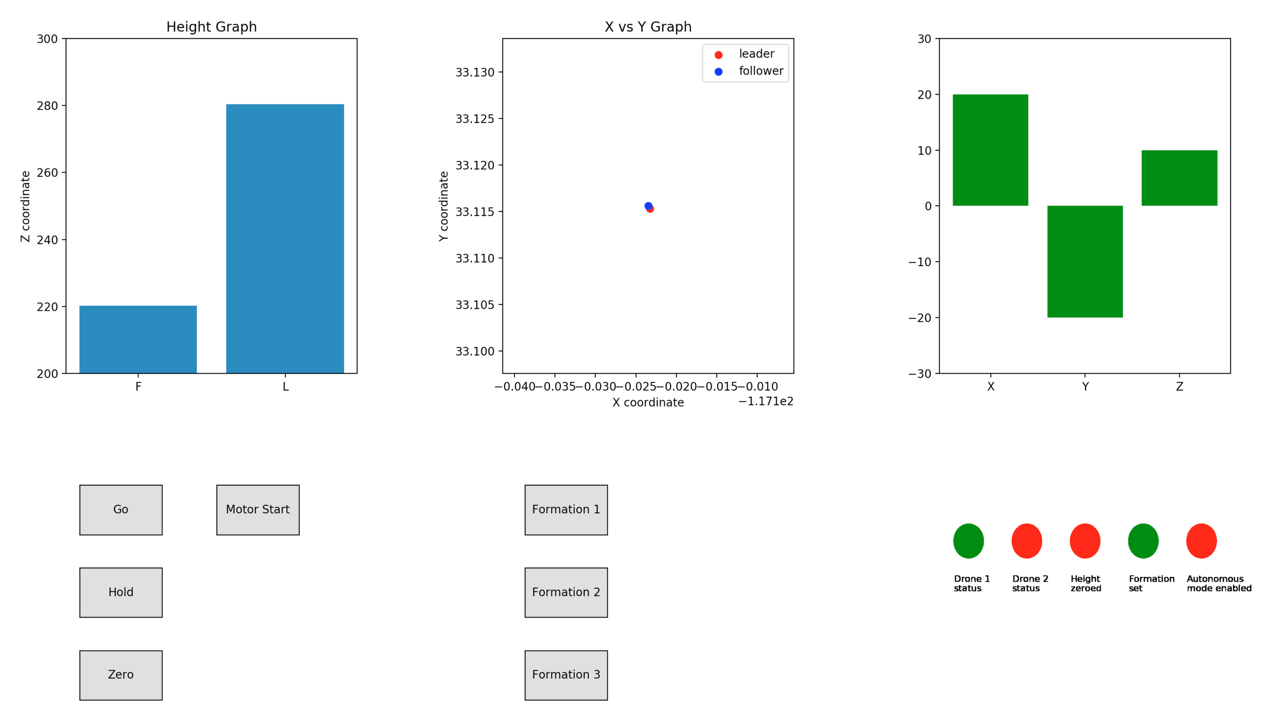


Figure 2: Graphical User Interface

We were able to meet the overall goals and objectives of the project. In the resulting product we had all the parts working to our expectations, within the desired error range. The system is semi-modular, meaning the leader's hardware can be mounted on cars, people, drones, etc. and the follower drone will follow it. It is also easily tunable, and through the simple graphical user interface users can configure parameters like the P-controller gain and the desired following position. The system has a long battery life, is safe, robust, and has the potential for use in numerous recreational, artistic, and militaristic applications.

References

[1] Mark Williams. Ozzmaker main website, http://ozzmaker.com/, 2013.

[2] Ron Konezny. Xbee/xbee-pro s2c zigbee. pages 30–300.

Future Work

Implement **Kalman Filter** to make the tracking of the follower drone more accurate and reduce its overshooting when direction of the leader drone is suddenly changed.

Increase the **GPS module frequency** to 5Hz so data can be sent more often and more calculations can be done per second to update the location more frequently

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