Drone Tracker

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Introduction

Problem Statement

To combat a rising trend of unsafe usage of Unmanned Aerial Systems or "Drones" on the TTU Campus, a need for a tracking system has been identified by campus police. The objective was to develop a system capable of using a drone's remote ID signal to track and take a picture of the drone or operator while in use.

What is Remote ID?

The Remote ID (RID) signal is emitted from specified drones and it contains data packages holding information such as the drone's serial number, drone and controller location, and velocity.

Constraints Overview

The system must be able to capture, store, and transmit the captured RID signal and image data to the database. The system must also clearly display this data to the appropriate users.

Design

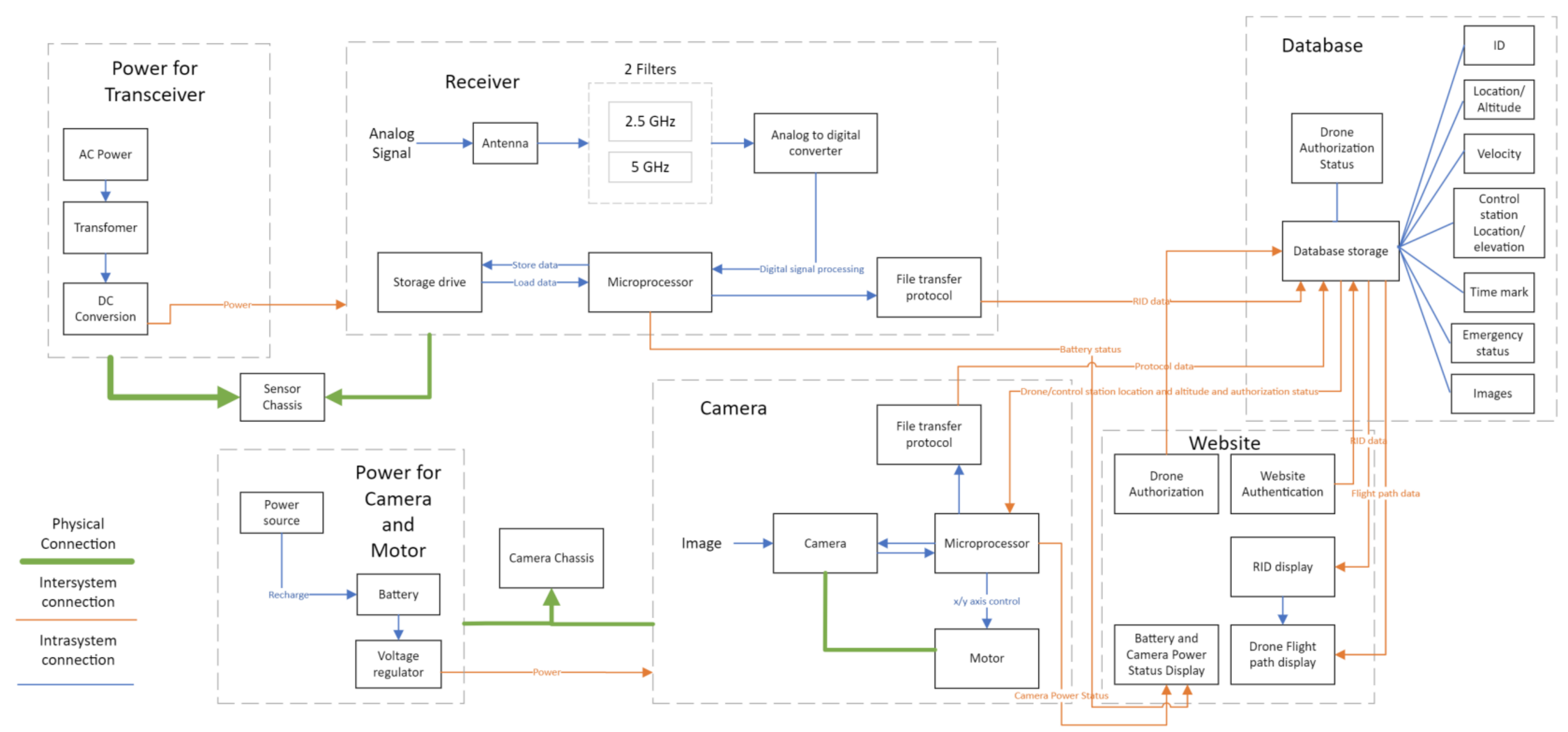


Figure 1. Block Diagram of System

Power: The receiver power system utilizes a battery charged by solar power while the camera power system utilizes a 50 Watt power supply.

Receiver: Detects the RID signal in the 2.4 GHz Wi-Fi and Bluetooth band with an Arduino Nano ESP32. Transmits with an ESP8266.

Database: Runs on a Raspberry Pi 5 and uses MariaDB for the structure.

Website: Hosted on a Raspberry Pi 5, with HTML framework. Javascript and Google's Maps Javascript API used for additional features.

Camera Hardware: Uses a dual servo control system capable of near 360° visual coverage. Controlled by a Raspberry Pi 4B.

Camera Software: Runs on the Raspberry Pi 4B utilizing a C++ code structure.

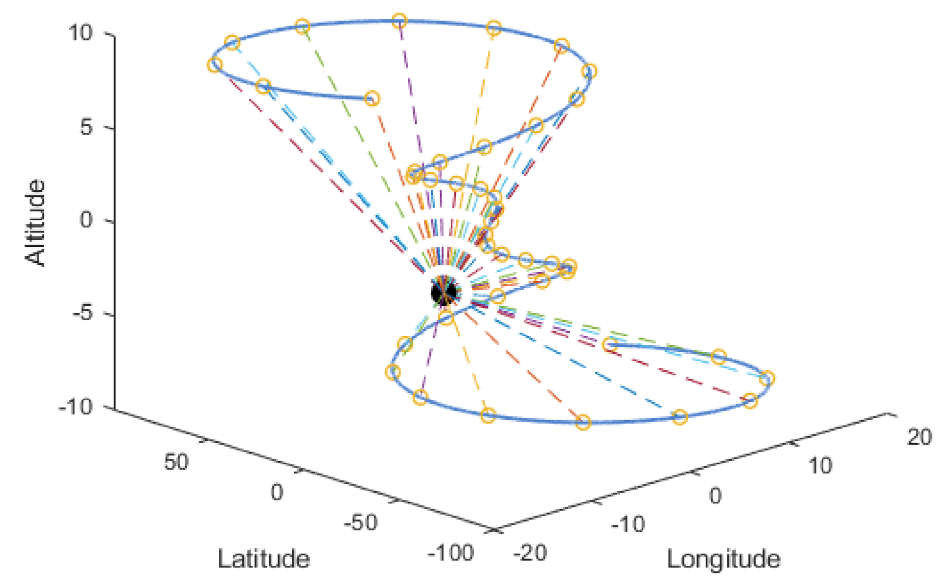
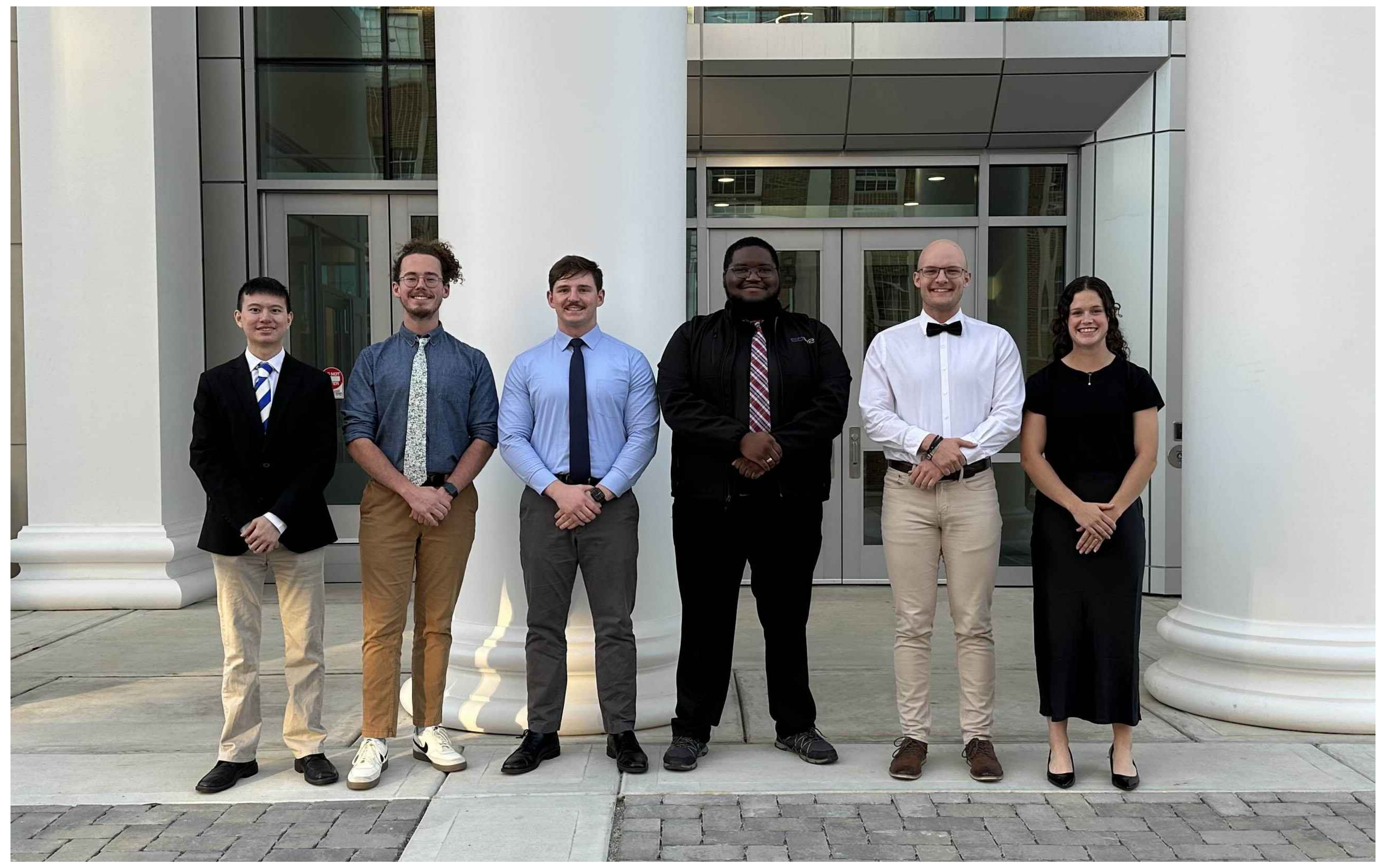


Figure 2. Camera pointing angle simulation. Used to confirm the feasibility of the pointing angle equations for an arbitrary UAS path around the camera (black dot)



From Left to Right: JieJun Stowell, Abraham Perkins, Austin Williams, Aaron Stewart, Sterling Sloan, Meredith Nye

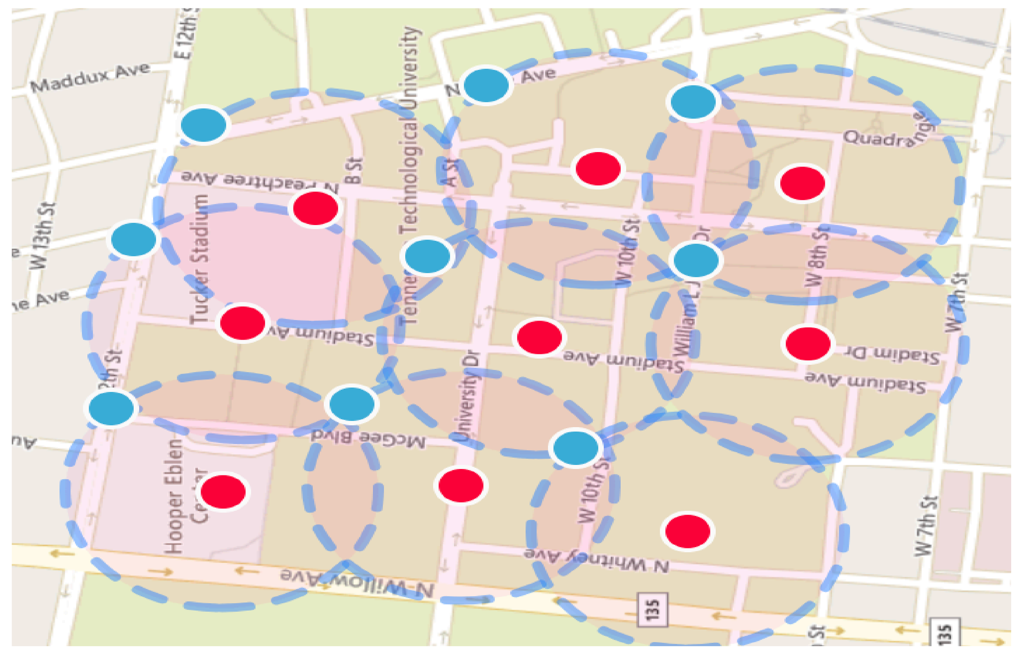


Figure 4. Originally this project proposed that the full contiguous Tennessee Tech campus would be under surveillance. This map of 9 receivers showcases this plan.

The team decided to roll back on the full implementation of nine receiver stations to reduce cost, but should a future capstone group continue the project. Each station costs around 40 dollars, and would be easily integrated.

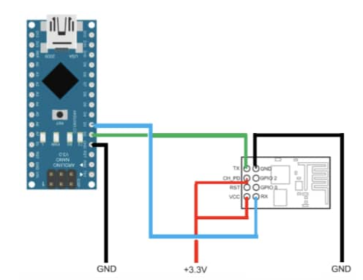


Figure 5. The Arduino Nano soldering schematic

Experimentation

Upon beginning this testing regiment, we found that our receiver was behaving unexpectedly. We modified our process and instead used the receiver as a transmitter to send "test packets" to the database. In doing so, we were able to test the rest of the system and verify that it worked as intended. This process was repeated multiple times, until finally we were certain that our system demonstrated the required functionality – given a signal is actually acquired.

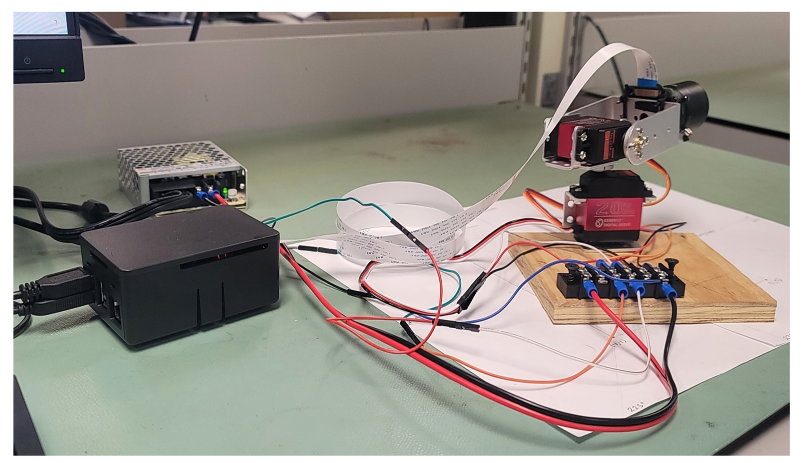
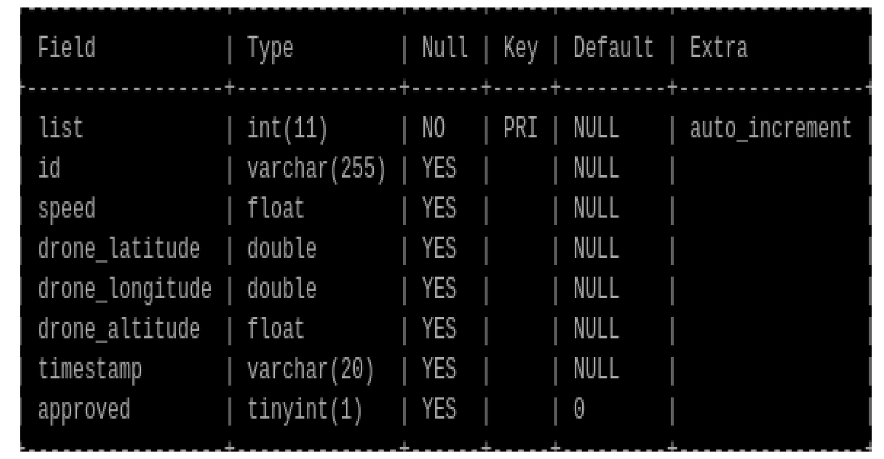


Figure 6. Camera system lab setup for testing

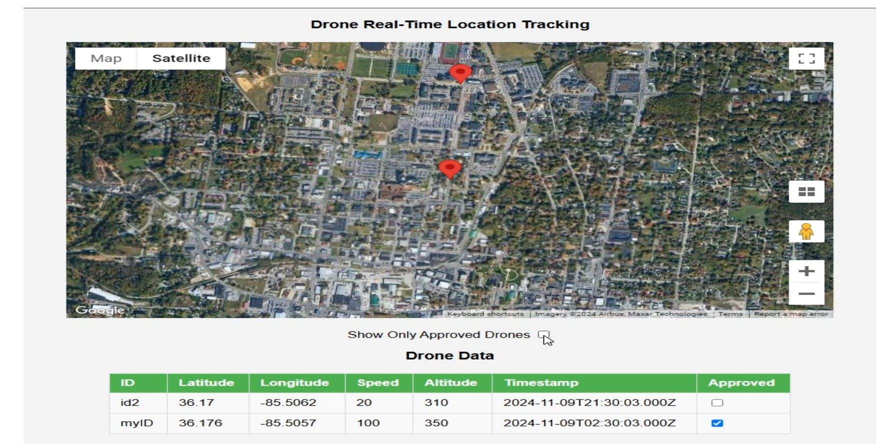
Outcomes

- Upon receiving a Remote ID packet (259 Bytes maximum), our system successfully inserts it into our database and displays the relevant information on a secure website.
- Within 100 milliseconds of signal acquisition, the camera system receives the information from the database and calculates the ideal angle for capturing an image of **either** the drone or the operator – depending on the nearest target.
- Once captured, the image is sent to the database and stored with the appropriate drone information, allowing our stakeholders to view important data related to the depicted drone, while also seeing the drone itself (or the operator).



Field	Type	Null	Key	Default	Extra
list	int(11)	NO	PRI	NULL	auto_increment
id	varchar(255)	YES		NULL	
speed	float	YES		NULL	
drone_latitude	double	YES		NULL	
drone_longitude	double	YES		NULL	
drone_altitude	float	YES		NULL	
timestamp	varchar(20)	YES		NULL	
approved	tinyint(1)	YES		0	

(a) Database Output



(b) Website Output

Figure 7. Database and Website Output

The image above shows the database that stores the data received from the Remote ID signal next to the website that displays that information. For each row in the database, a marker is generated and placed on the Google Maps map. By hovering over a specific marker, you can view detailed information about that drone, such as its ID, speed, and altitude.

Conclusion

The team has created a primarily functional drone tracking system. In addition, an expansion of the existing system to cover all of the contiguous campus has been simplified for a future team. Future improvements can include upgrades to the camera system's assembly, lowering the cost of the receiver's power system, and upgrading the detection radius of the receiver.

Proposed Budget	
Subsystem	Cost
Receiver	$429.48
Camera	$340.04
Power	$716.43
Database	$161.08
Website	$30.00
Total	$1,677.03

Final Budget	
Subsystem	Cost
Receiver	$31.99
Camera	$284.71
Power	$151.25
Database	$175.82
Website	$0.00
Total	$643.77

Acknowledgments

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