Dwight Look College of ENGINEERING
TEXAS A&M UNIVERSITY

Team 51: Radio Mobile Foxbot
Final Presentation

Brady Lagrone
Sophia Panagiotopoulos
Miguel Segura

Sponsor: Kevin Nowka
TA: Fahrettin Ay

Project Summary

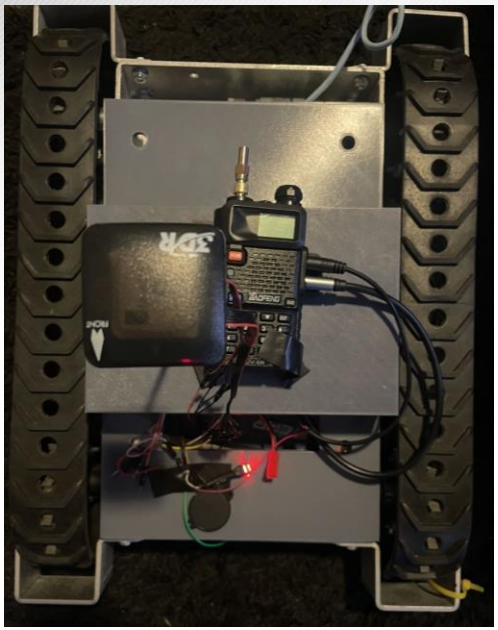
Purpose:

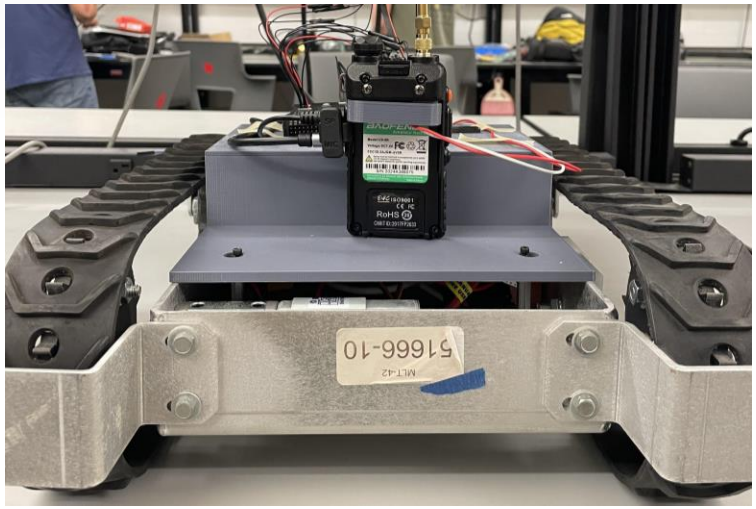
- Amateur Radio Directional Finding (ADRF) is a sport in which an individual tries to locate a hidden transmitting device. Our goal is to “hide” from an adversary Houndbot, who will be trying to locate our robot. Additionally, our robot will increase the potential of ARDF training and aid in the engineering of directional antennas.

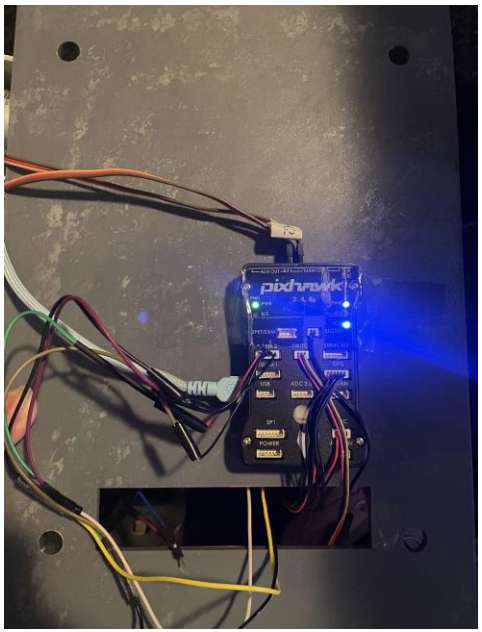
Proposal:

- We have created a radio system coupled with a mobile robot that receives DTMF signals and preforms various functions based on the decoded signal.

Integrated System Diagram





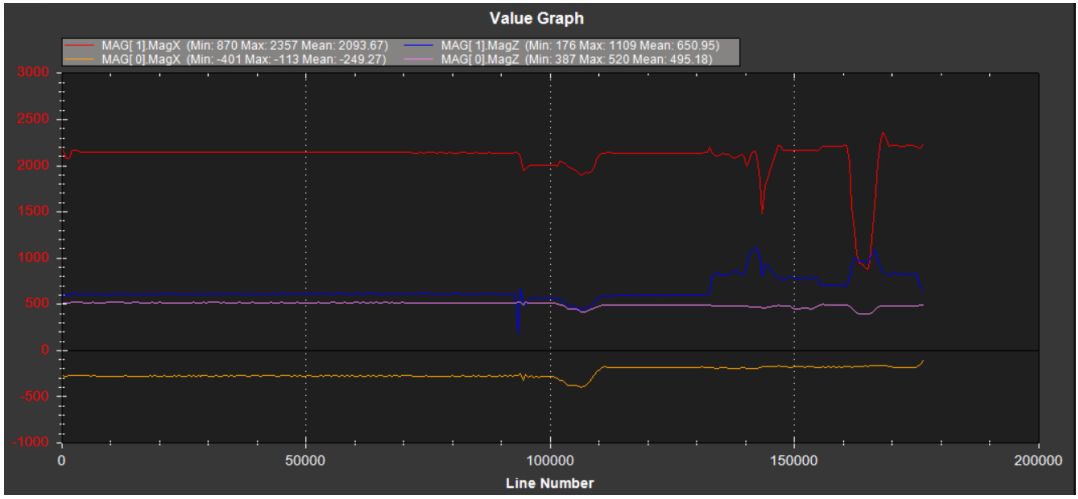


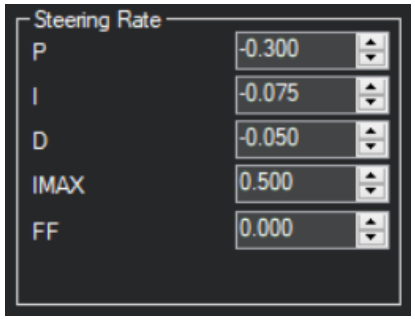
- PCB, Radio, and PixHawk general layout integration
- The 5500mAh battery will be placed below PCB in final design with casing made to hold the other internals that consist of the Radio, UltraSonic Sensors Mounts, and GPS Mount.

PixHawk/Autopilot System

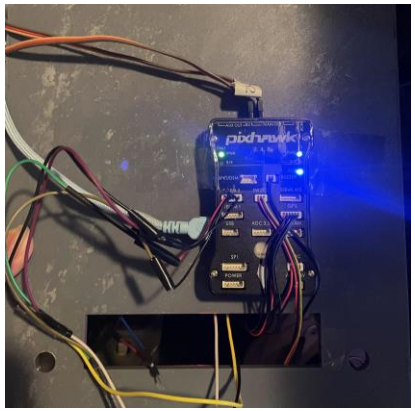
Miguel Segura

PixHawk traverses between waypoints smoothly





Negative offset was required due to immediate saturation for turning points of the rover. Motors would have issues both turning on at the same time due to the error never being met.



- PixHawk mounted directly below GPS module due to it interfering with the external compass.
- External Compass Mag[0] has a much more consistent reading now versus Internal Compass Mag[1].
- S1/S2 of Sabertooth controlled by PixHawk for full autonomous motor control.

PixHawk/Autopilot Results

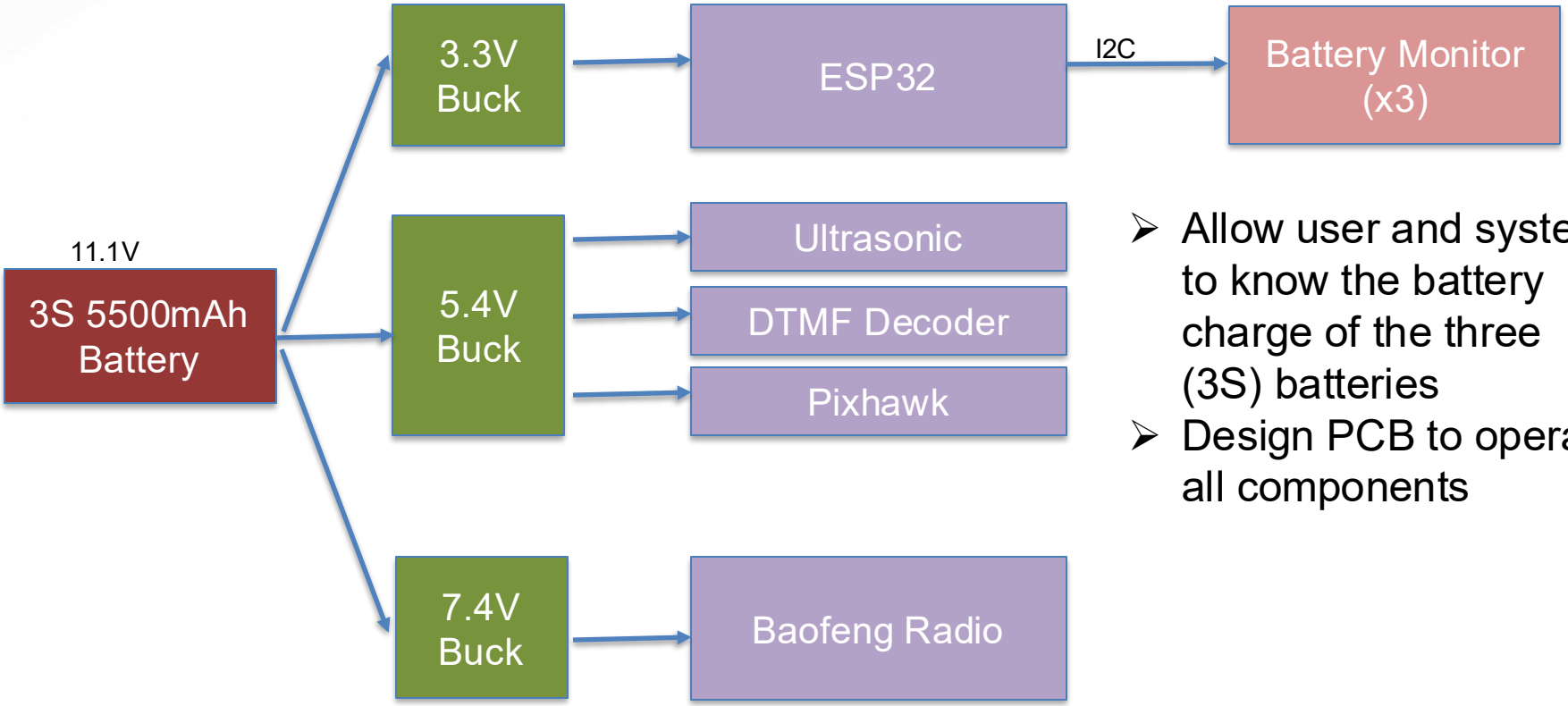
Miguel Segura

Tests Performed	Met
Linear Path to 1 Waypoint?	Yes
Offset home location, rover relocates itself and accomplishes Mission Plan?	Yes
Rover is able to follow through multiple waypoints?	Yes
Off-Road Mission Plan?	Yes

Power Subsystem

Brady Lagrone

- Distribute power requirements to MCU, ultrasonic sensors, DTMF Decoder, Baofeng radio, Pixhawk, and Ultrasonic sensors
- Enable Foxbot PCB to be powered via battery to allow 2 hours of untethered operation



- Allow user and system to know the battery charge of the three (3S) batteries
- Design PCB to operate all components

Power Subsystem Specifications

Brady Lagrone

Specifications	Voltage Output (V)			I(out)
	Min	Nom	Max	
11.1V to 3.3V step down converter	3	3.3	3.6	1.25 A
11.1V to 5.4V step down converter	5	5.4	5.6	0.4125 A
11.1V to 7.4V step down converter	7	7.4	8	2.225 A

Power Subsystem Results

Brady Lagrone

Test	Met
Provide sufficient power to ESP32, Pixhawk, Baofeng Radio, Ultrasonic Sensors, DTMF Decoder	Yes
Operate with input voltage range 9.6 to 12.6(11.1 nominal)	Yes
Power the Foxbot System for two hours	Yes
Measure how much charge is available in batteries	Yes

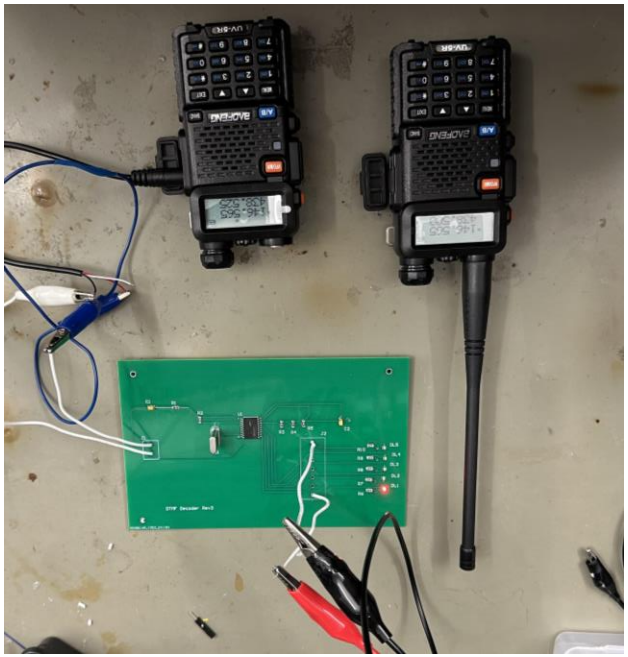
Dwight Look College of ENGINEERING
TEXAS A&M UNIVERSITY

Radio Communication

Sophia Panagiotopoulos

The user will be able to communicate to the rover through Baofeng UV 5r radios and DTMF tones. These are tones that are made by combining a high and low frequency, for a unique frequency corresponding to each number on a keypad.

FFT shows the frequency response of the signal received by the transmitting radio. This tone sent was a 1 which corresponds to 697 Hz and 1209 Hz, the two peaks in purple



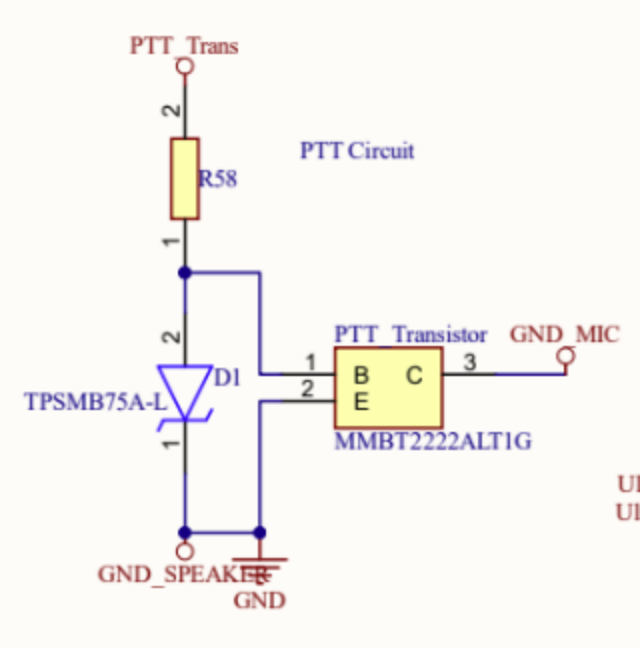
The decoder can correctly identify the tone that is sent. This shows the lowest bit going high indicating that a 1 will be sent to the ESP

Radio Communication Continued

Sophia Panagiotopoulos

Communication between the two radios is enabled by the PTT button. When pressed it puts the radio into 'transmit' mode and puts the other into 'receive' mode.

On the rover, PTT needed to be controlled using the ESP for autonomous two-way communication.



This circuit was added to the integrated PCB so that the user could get data from the rover.

Communication Test Results

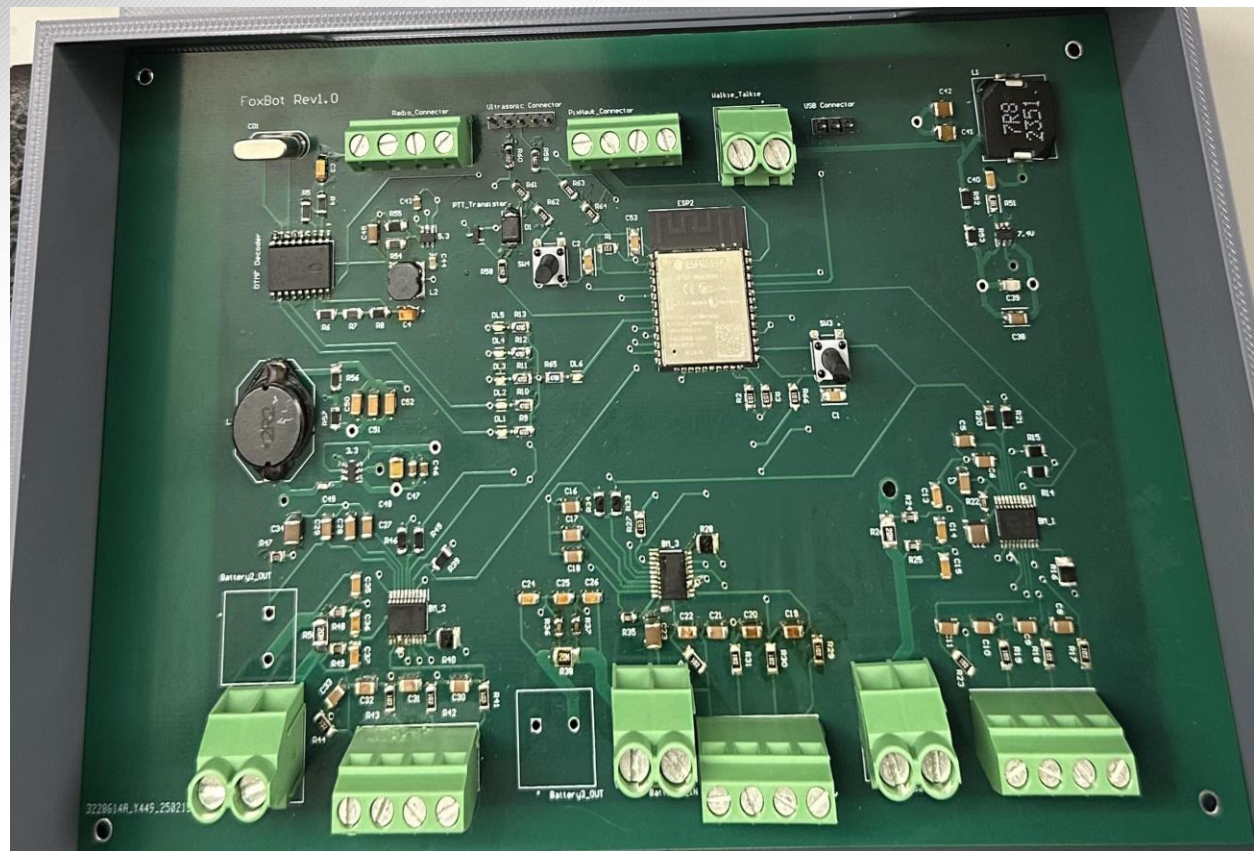
Sophia Panagiotopoulos

Tone Sent	0	1	2	3	4	5	6	7	8	9
Accuracy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Distance (yards)	10	20	30	40	50	60	70	80	90	100
Accuracy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

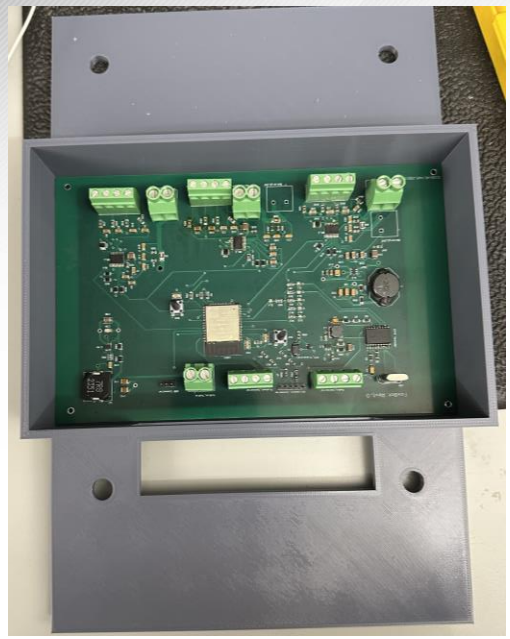
The radios were able to communicate over a broad range of distances while maintaining decoding accuracy.

Integrated PCB



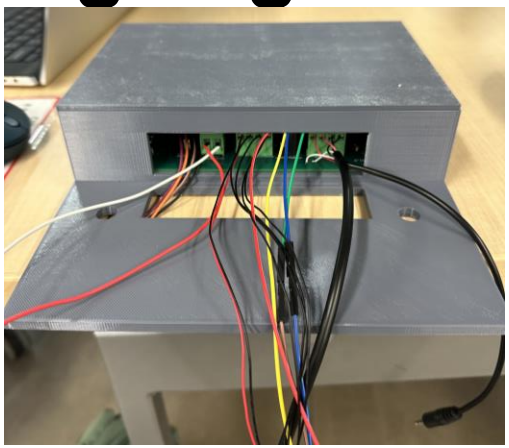
The decoder and power PCBs were combined into an integrated PCB with the addition on the ESP and PTT circuit.

Putting Everything Together

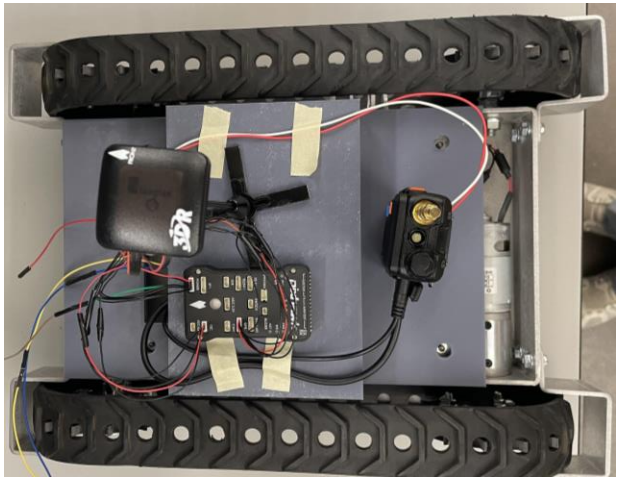


Rover Cover

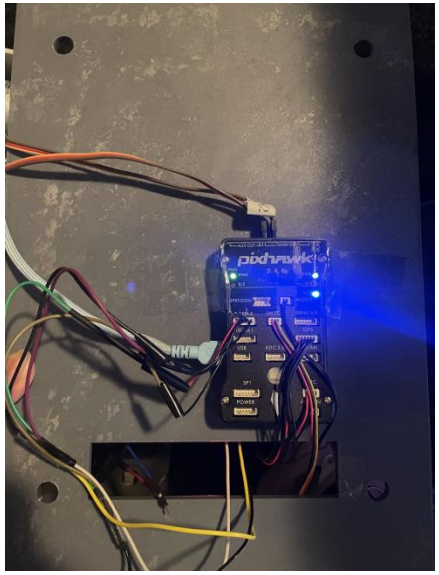
Battery Adapter



PCB Case

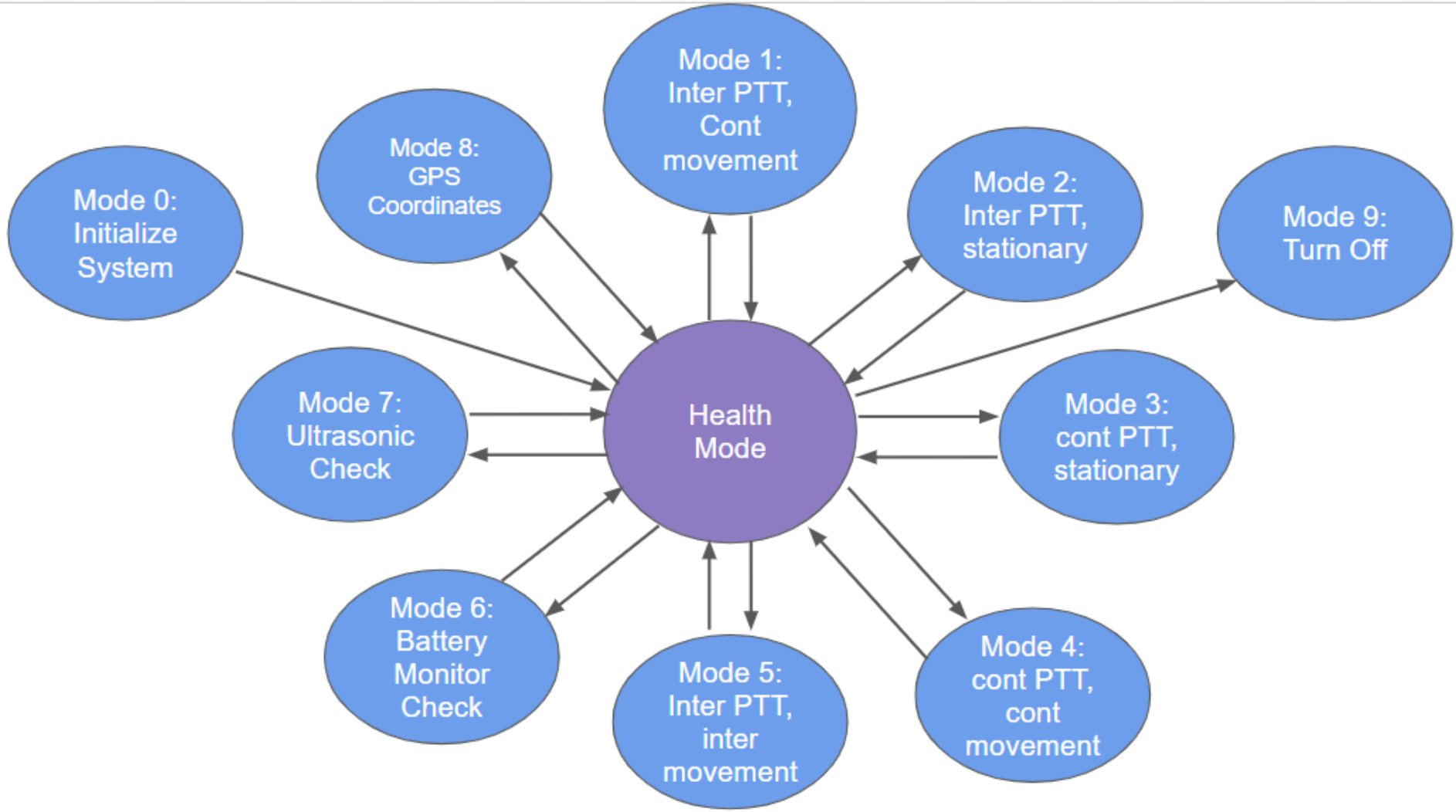


GPS mounting



Pixhawk mounting

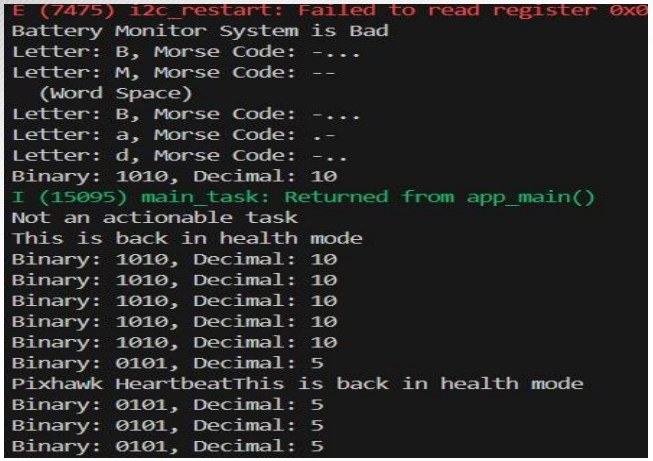
ESP Setup and Communication

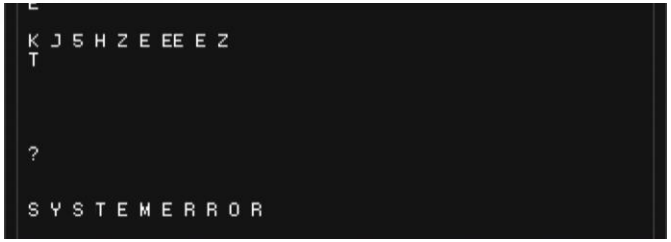


AutoPilot Results with Full System Modes

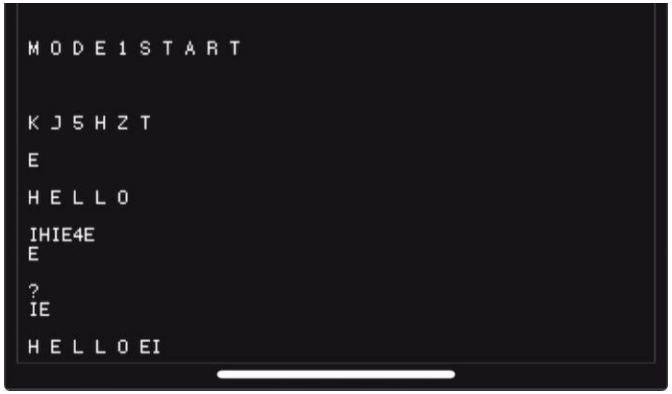
User Modes	Met	General Info
Mode 1 (Inter PTT, Cont Movement)	Yes	Radio establishes connection, PTT says "Marco" while rover completes mission
Mode 4 (Cont PTT, Cont Movement)	Yes	Radio establishes connection, while PTT is active the rover will approach designated waypoints
Mode 5 (Inter PTT, Inter Movement)	Yes	Radio establishes connection, while PTT says "Marco" the rover moves to waypoints

Integrated System Results



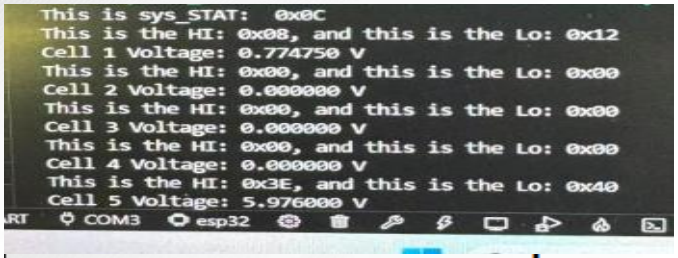


A 10 was sent for the initial system set-up. The batteries were not charged enough, so the Pixhawk would be blocked for starting its path and the radio communicated to the user that there was a 'System Error'.

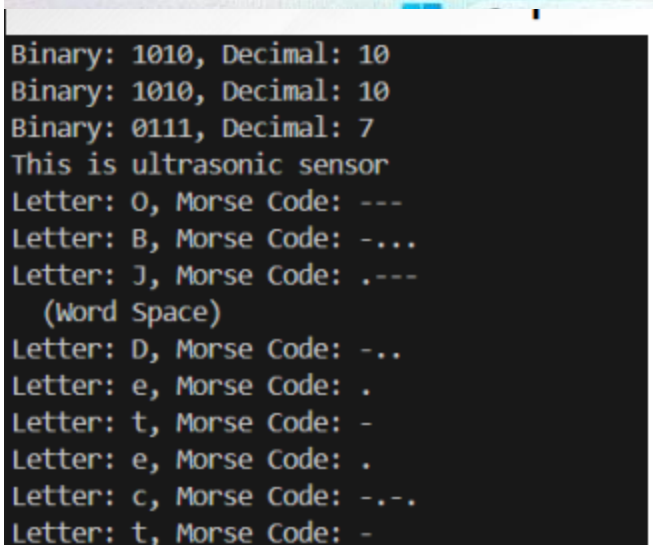


A 1 was sent by the user to the rover which was able to correctly decode the tone, sent it to the ESP, and begin the corresponding instruction. Mode 1 means intermittent PTT and continuous movement, so the rover is transmitting 'HELLO' 5 times with pauses in between while following the waypoints programmed on mission planner.

Integrated System Results Continued



For Mode 6, Battery Monitor Checking for each battery, we can accurately read the volts from each cell and sums them which is then sent to the user through morse.



Mode 7, which shows the Ultrasonic check. In this case showing that an object is detected within 1.5 meters of the ultrasonic.

Conclusions

- Moved from 2 ESPs to 1 (PixHawk sole motor control)
- AutoPilot system behaves appropriately with proper PID steering/throttle control config.
- Integration complete, but ultrasonic sensors last to implement for full autonomous navigation
- Refining the morse transmission from the rover radio so it is more user friendly