Drone Precision Landing with UWB Beacons

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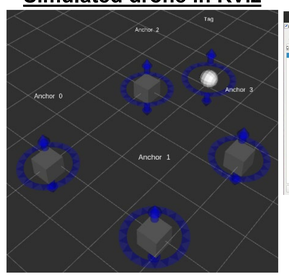
Motivation

Currently there are no commercial solutions to an automated high-precision landing drone system. We believe that our system is unique by using Ultra-Wideband (UWB) beacons that locate our drone and the target location with a high degree of accuracy. Similar systems are used for indoor positioning of objects or people, but we plan for our system to be adaptable to any location.

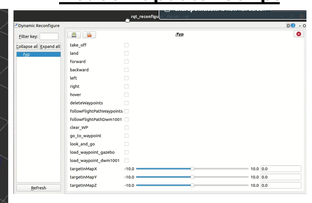
Project Definition

- Use UWB to create a Real-Time Location System (RTLS)
- Read the location of the drone to calculate flight path.
- Send updated flight path to drone's flight computer.
- Arrive at target location and land precisely onto the platform.

Simulated drone in RViz



Beacon updater script



- Components of the system:
  - F550 Hexacopter Drone
  - MDEK-1001 UWB Beacons
  - Intel Up^2 V2 computer
  - PX4 Pixhawk Flight Controller

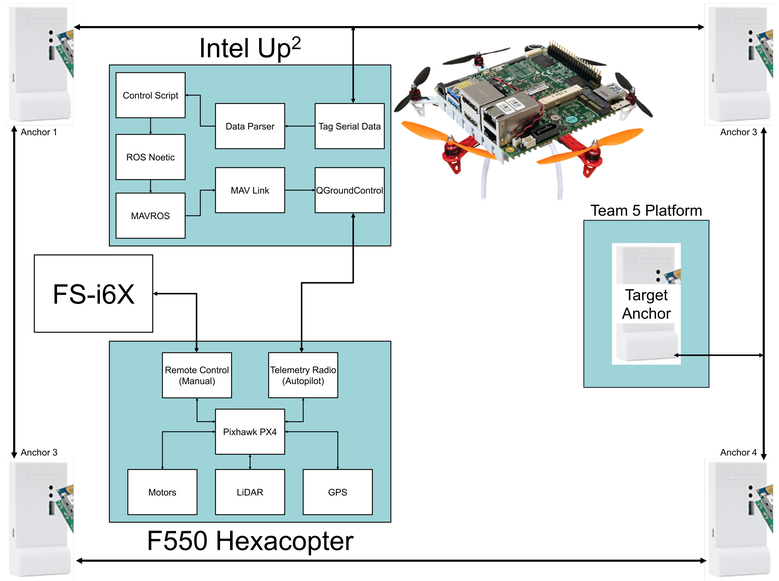
PSSC

Our project required determining Project Specific Success Criteria objectives that would improve on last year's team.

1. Design landing path using the TDoA method.
2. Test the beacons and verify their functionality.
3. Set up the Intel Board and interface it with the beacons to determine the landing path.
4. Set up MAVLINK protocol between the Intel Board and the Pixhawk.
5. Land on Team 5's platform and verify the landing algorithm functionality.

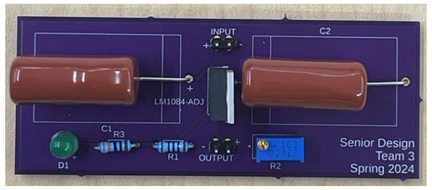
Design Description

System Diagram



The system integrates a processing computer, UWB beacons, and a hexacopter that will land on the designated target. Our design philosophy is to utilize multiple beacons as anchors to find the drone. The beacons will be setup in their own network where they can communicate with each other.

PCB



PCB designed to power the board with a drone LiPo battery. Outputs 5V 5A.

Intel Up^2 V2

- ROS Noetic: Automated control software.
- MAVROS: Translation layer between ROS and MAV Link.
- MAV Link: Transmission protocol between drone and flight computer software.
- QGroundControl: Flight control software that programs PX4 and sends flight commands.

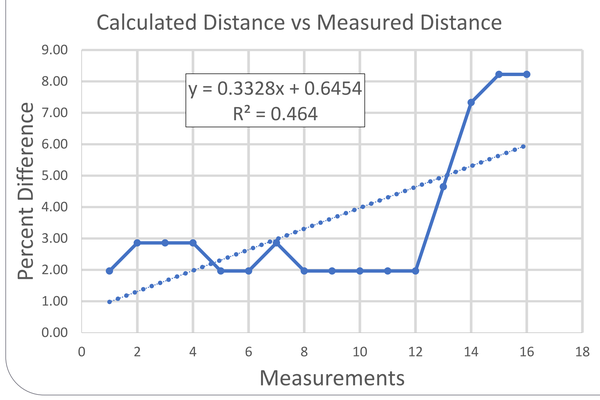
F550 Drone

- PX4: Flight computer that interfaces with all sensors and receives commands.
- Telemetry Radio: Interface between drone and computer.
- LiDAR: Ranges altitude for landing portion.
- GPS: Needed for pre-flight checklist.
- Motors: Used for flight.

Design Validation

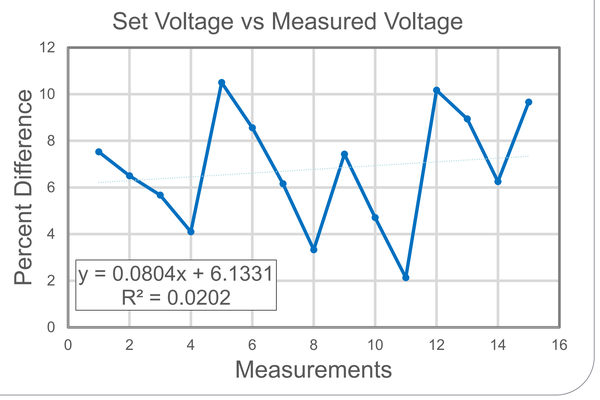
MDEK1001 Validation Data

We tested the predicted location of a tag versus the real physical location and calculated the difference between them.



Voltage Regulator Validation Data

This test had a requirement of outputting 5V to power our board. To test we put components in a breadboard and took voltage measurements.



Final Product

- Successful build of the drone.
- Intel board has all required software.
- Able to interface with the beacon network.
- Tested PCB output for powering board.
- Flashed firmware onto beacons and drone.

Future Work

- Implement ROS script to automate flight and tag location updates.
- Test and refine high-precision landing with test platform.
- Test landing with bigger and smaller platforms.
- Reconfigure beacon locations and check automated script.
- Test flight with computer flying on the drone.

References

QR code links to the GitHub repo we created for this project. Contains documentation we wrote and a list of references.
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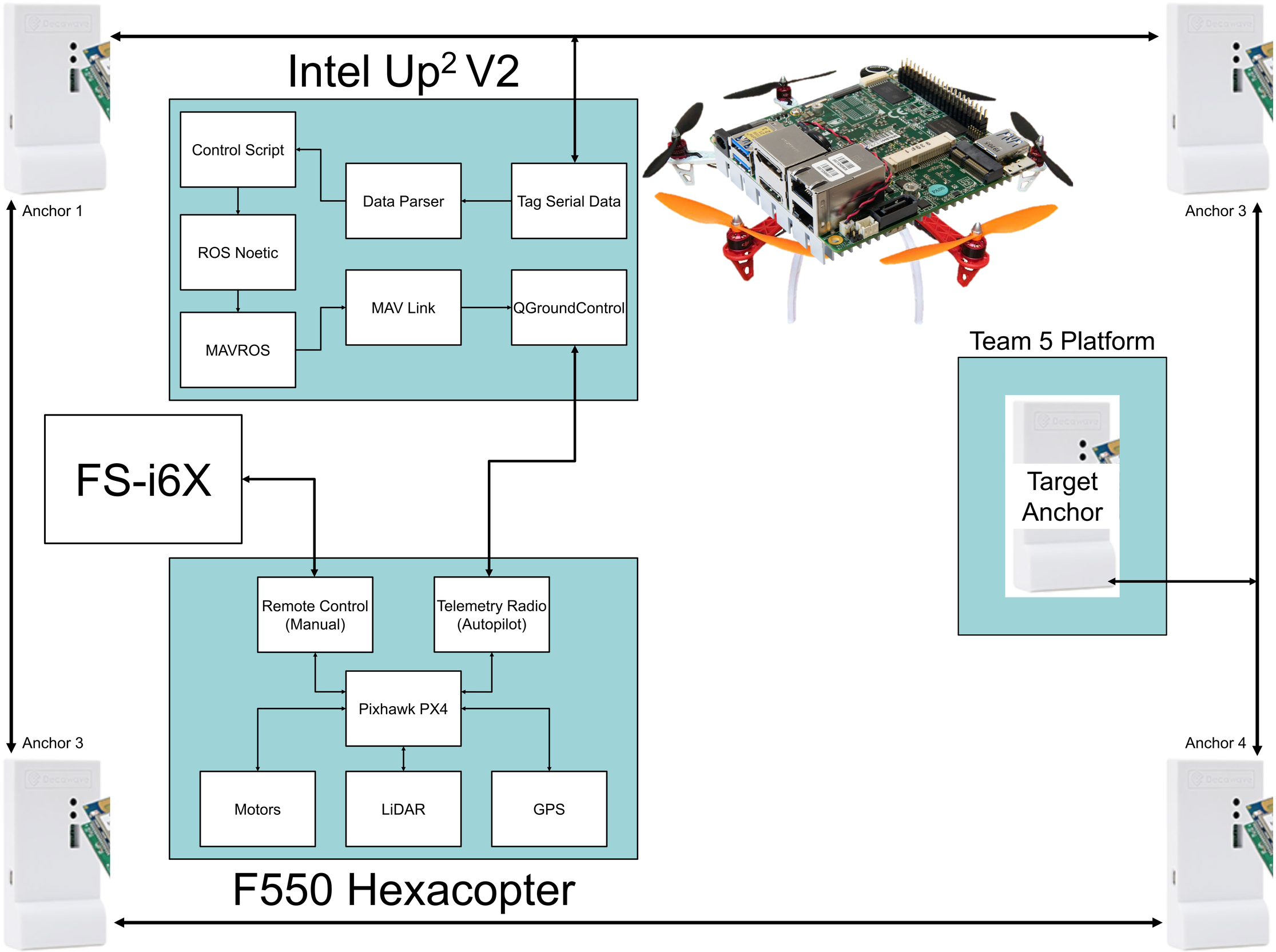
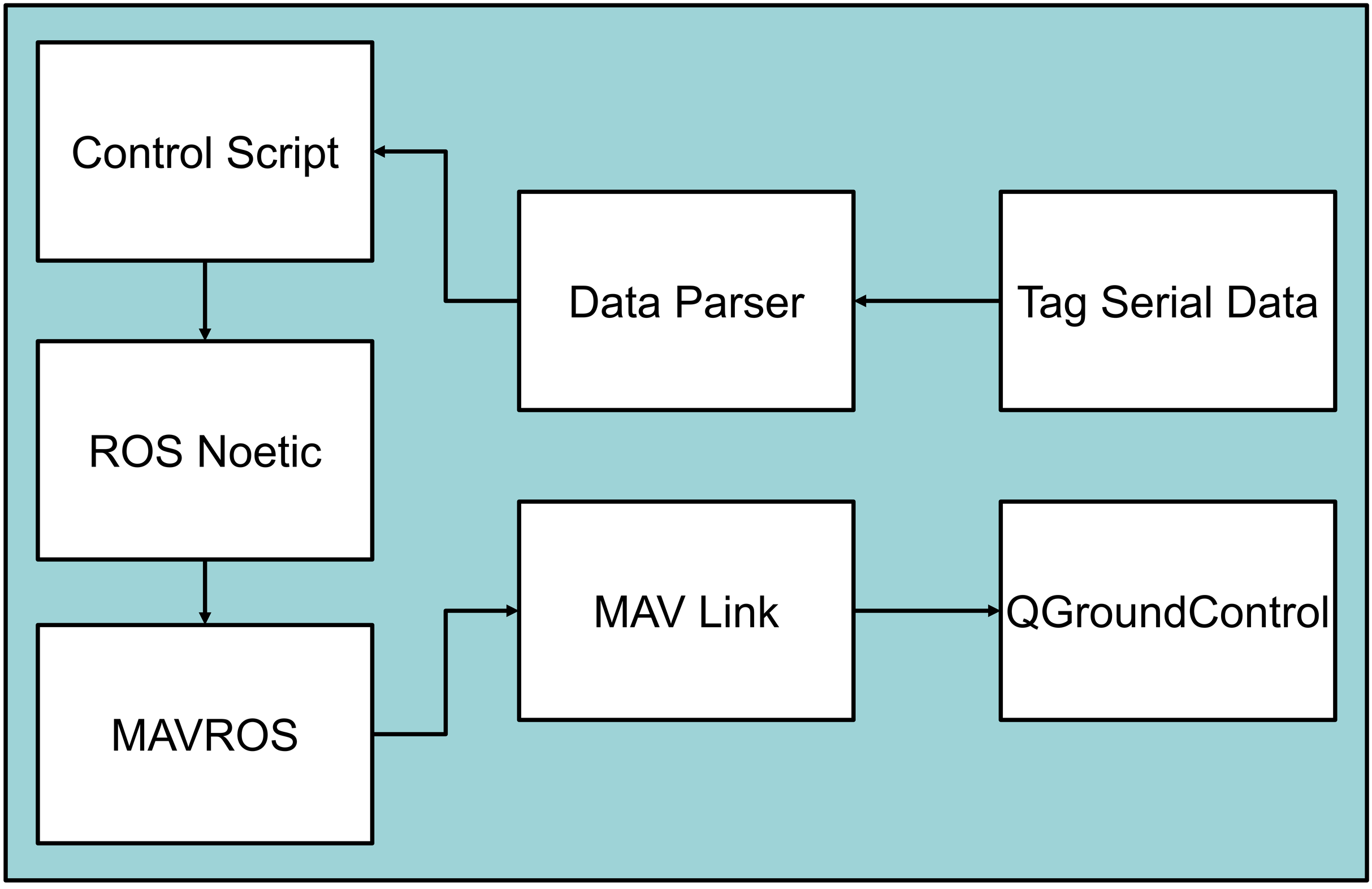
Acknowledgement

We would like to show our gratitude to the Department's Director of Technical Ops, Andrew Davis; Prof. Matthew Bell; Prof. Kiersten Kerby-Patel; Prof. Michael Rahaim; Prof. Tomas Materdey; and fellow classmates.


Intel Up² V2
Control Script
Data Parser
Tag Serial Data
ROS Noetic
MAV Link
QGroundControl
MAVROS
FS-i6X
Remote Control (Manual)
Telemetry Radio (Autopilot)
Pixhawk PX4
Motors
LiDAR
GPS
F550 Hexacopter
Team 5 Platform
Target Anchor
Anchor 1
Anchor 3
Anchor 3
Anchor 4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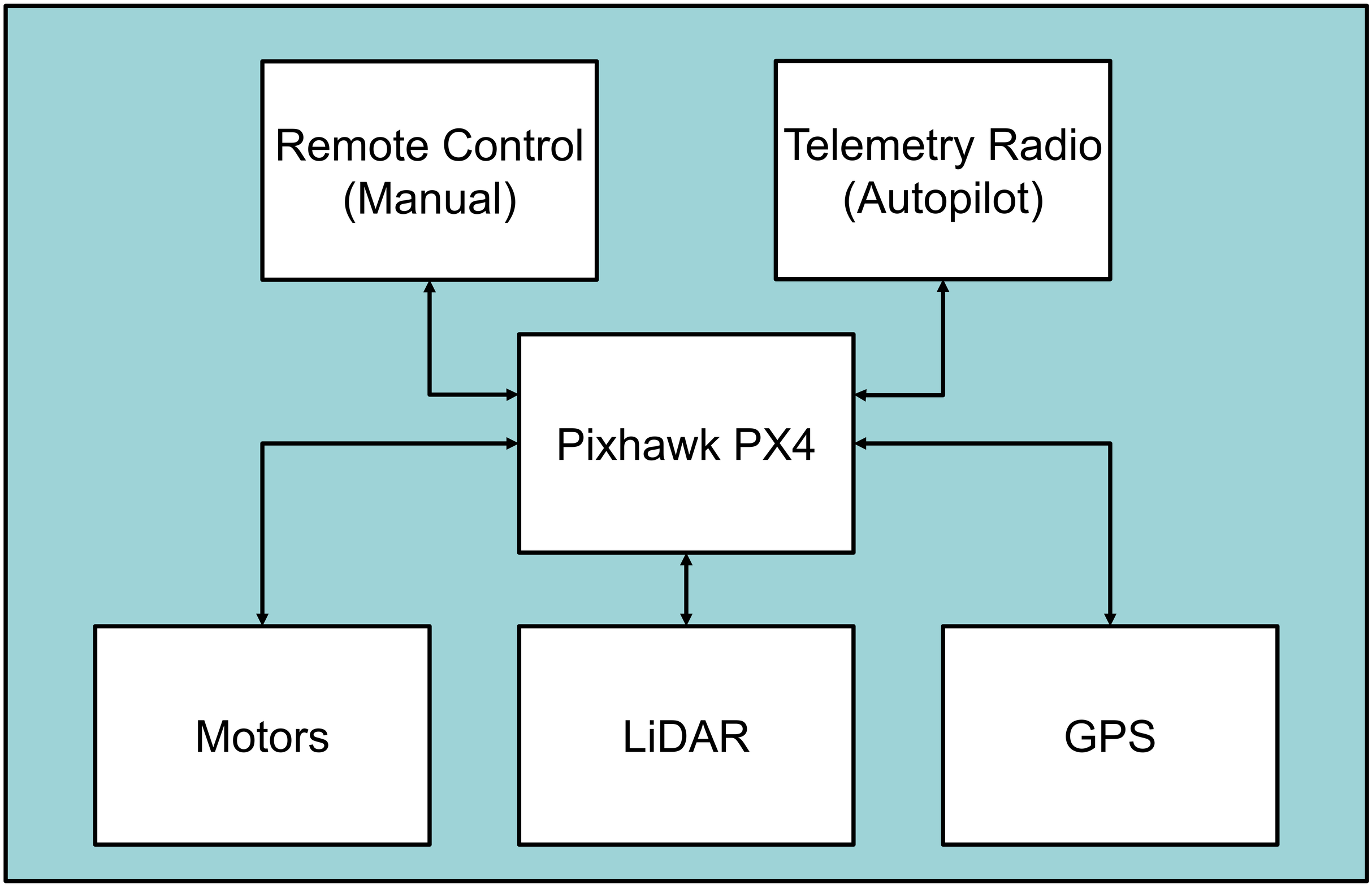
Remote Control
(Manual)
Telemetry Radio
(Autopilot)
Pixhawk PX4
Motors
LiDAR
GPS