



# RF Silent Drone Navigation

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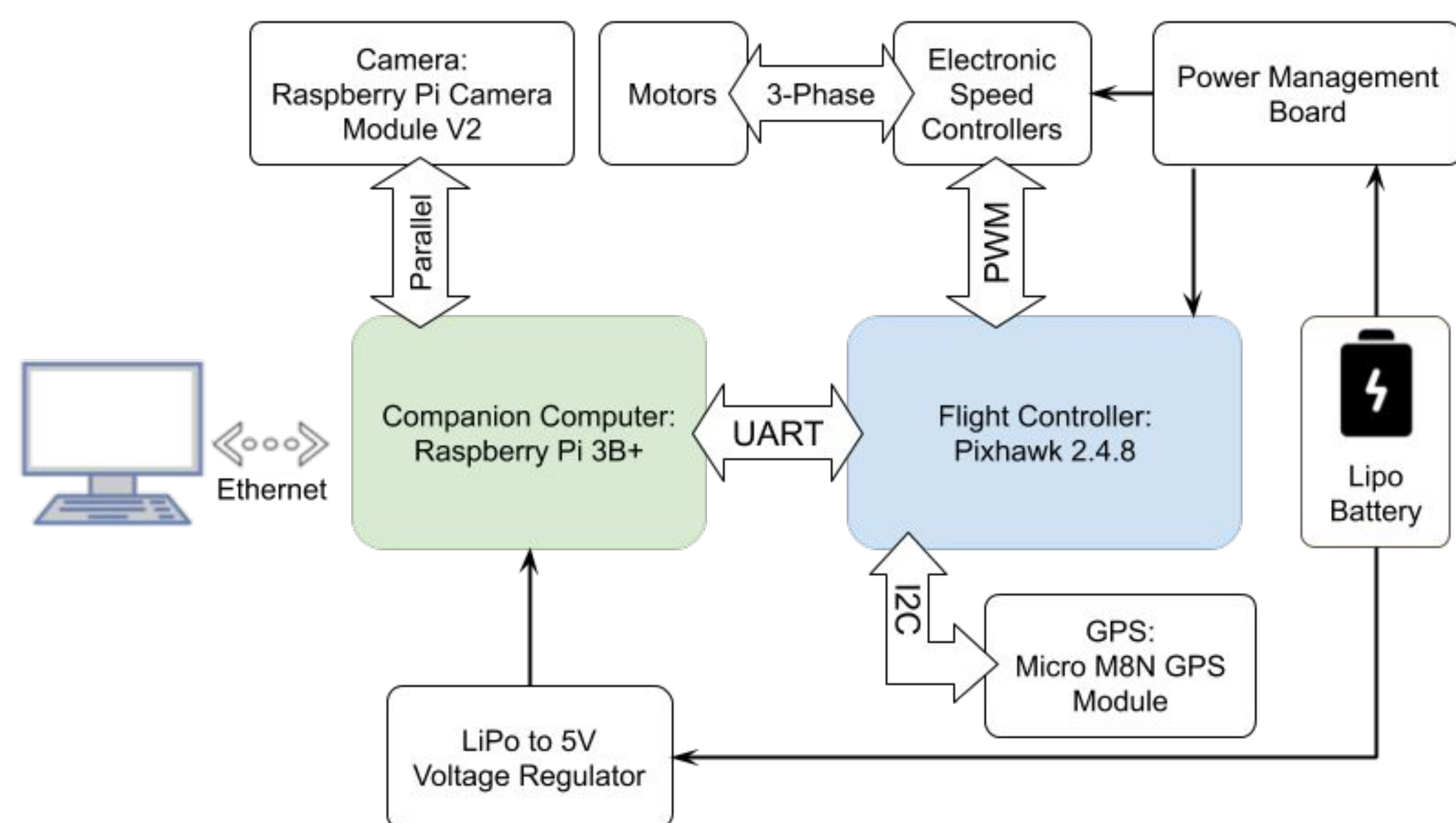
## Background

The VisHawk project seeks to advance autonomous drone technologies by developing a ship-to-ship autonomous transport solution with as little human interaction as possible. Without any ground station RF communication, our drone is capable of lifting off from a ship at sea, possibly underway, fly to an indicated target ship, and land autonomously. Ideally, this would not rely on any RF receivers of any kind, including GPS and GNSS, to limit the attack surface of the drone's autonomous systems.

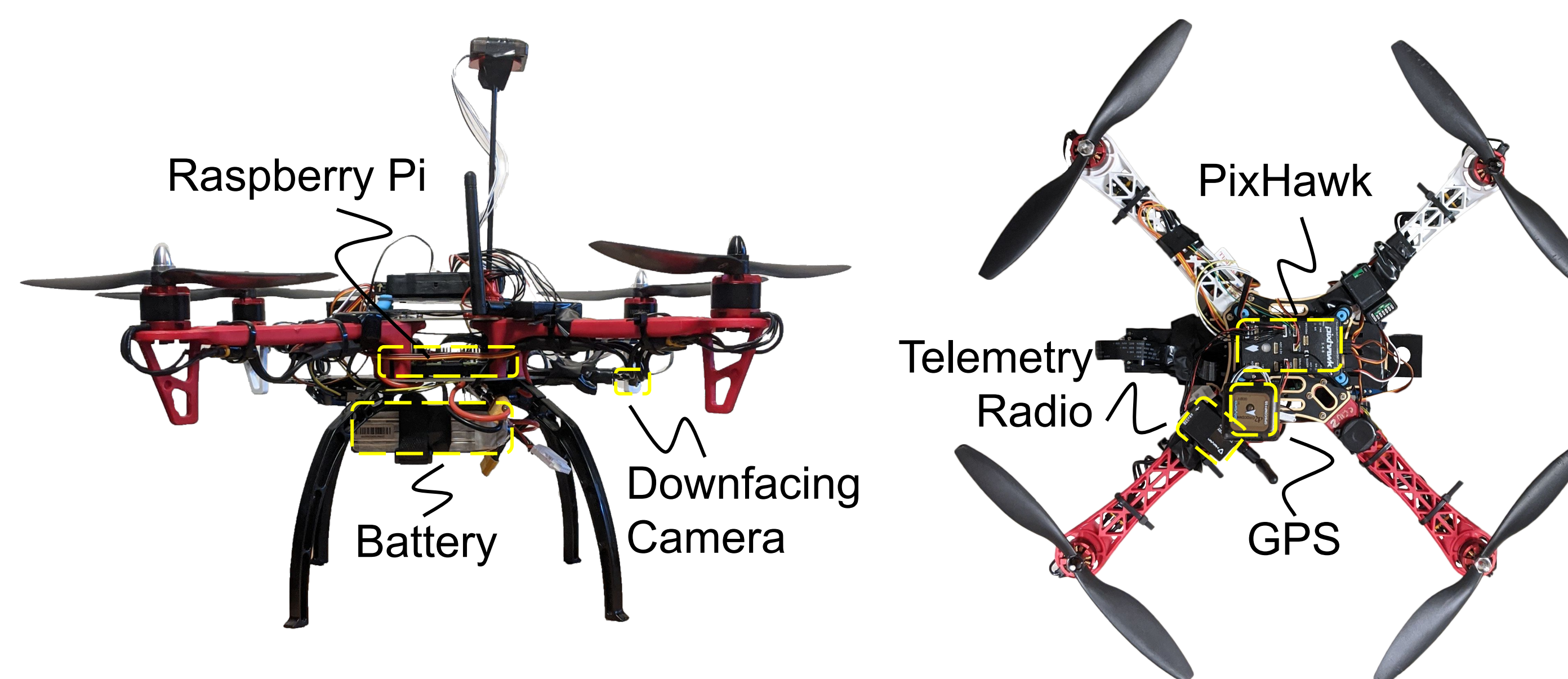
## Overview

This project uses a flight control unit (FCU) that interfaces with a companion computer using the open-source UAV communication protocol MAVLink. The FCU ensures drone stability in flight, while the companion computer performs Computer Vision (CV) tasks to identify the target vessel and provide the FCU a coordinate frame with a safe landing trajectory. After initial mission programming on the launch vessel and deployment of an AprilTag visual fiducial marker on the remote vessel, all mission operations take place autonomously.

## System Block Diagram



## Final Design



Three-layer design

- Top: GPS, Flight Controller, Telemetry radio
- Middle: Companion Computer, Camera
- Bottom: 4s Lipo Battery

## Hardware



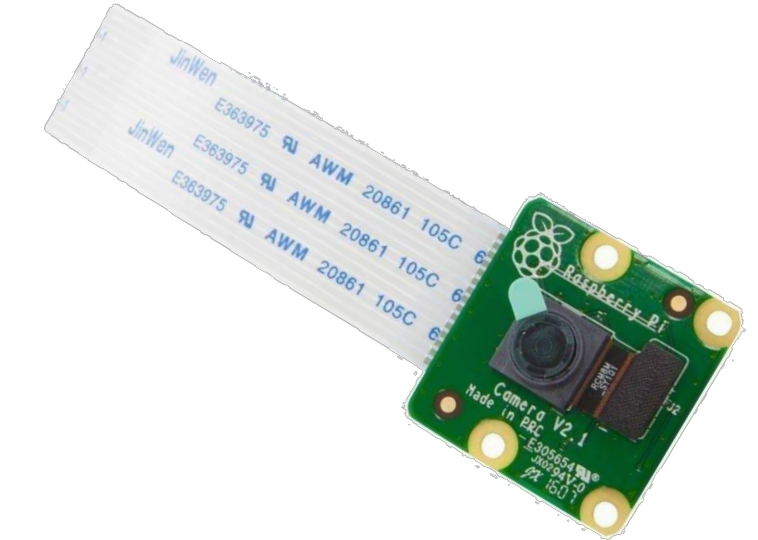
### Raspberry Pi 3B+

- Companion computer
- Performs CV tasks to identify the target and provide the autopilot a coordinate frame



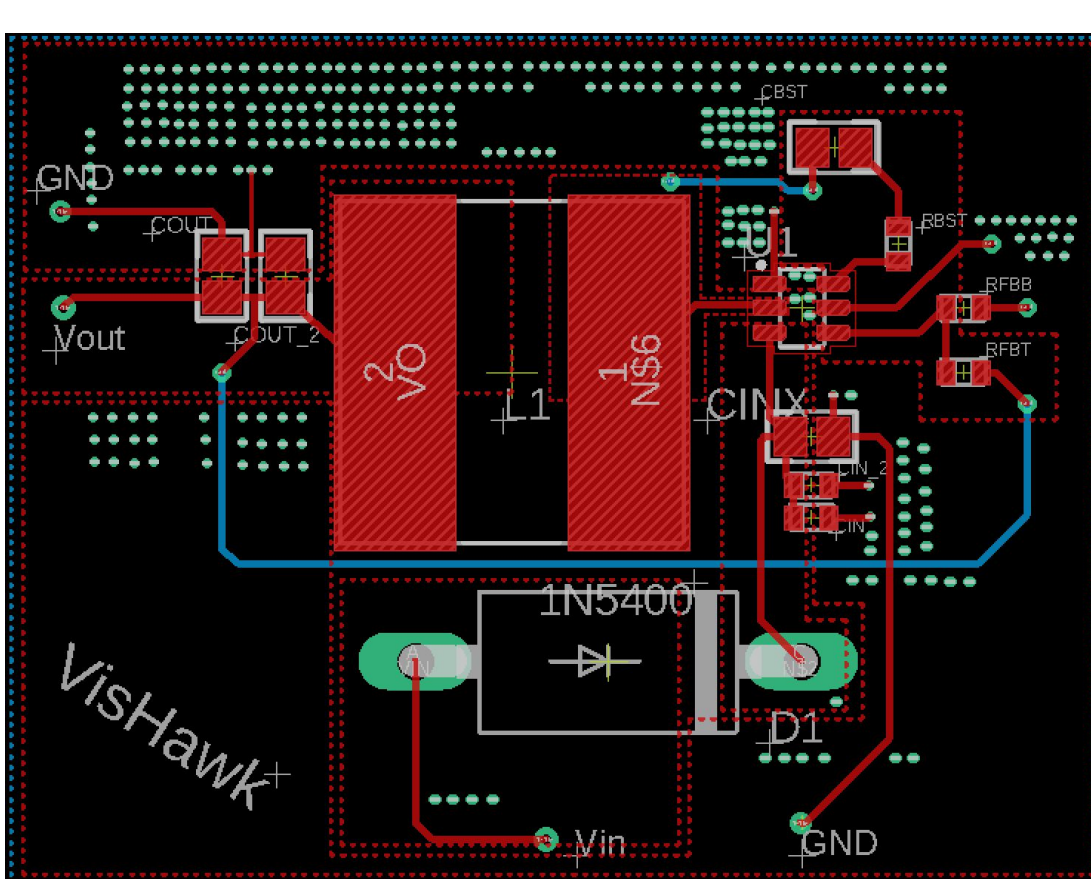
### PixHawk v2.4.8

- Flight controller
- Uses ArduPilot firmware
- Ensures drone stability in flight



### Raspberry Pi Camera Module v2

- 8 megapixel camera capable of taking photographs of 3280 x 2464 pixels
- Used to detect AprilTags

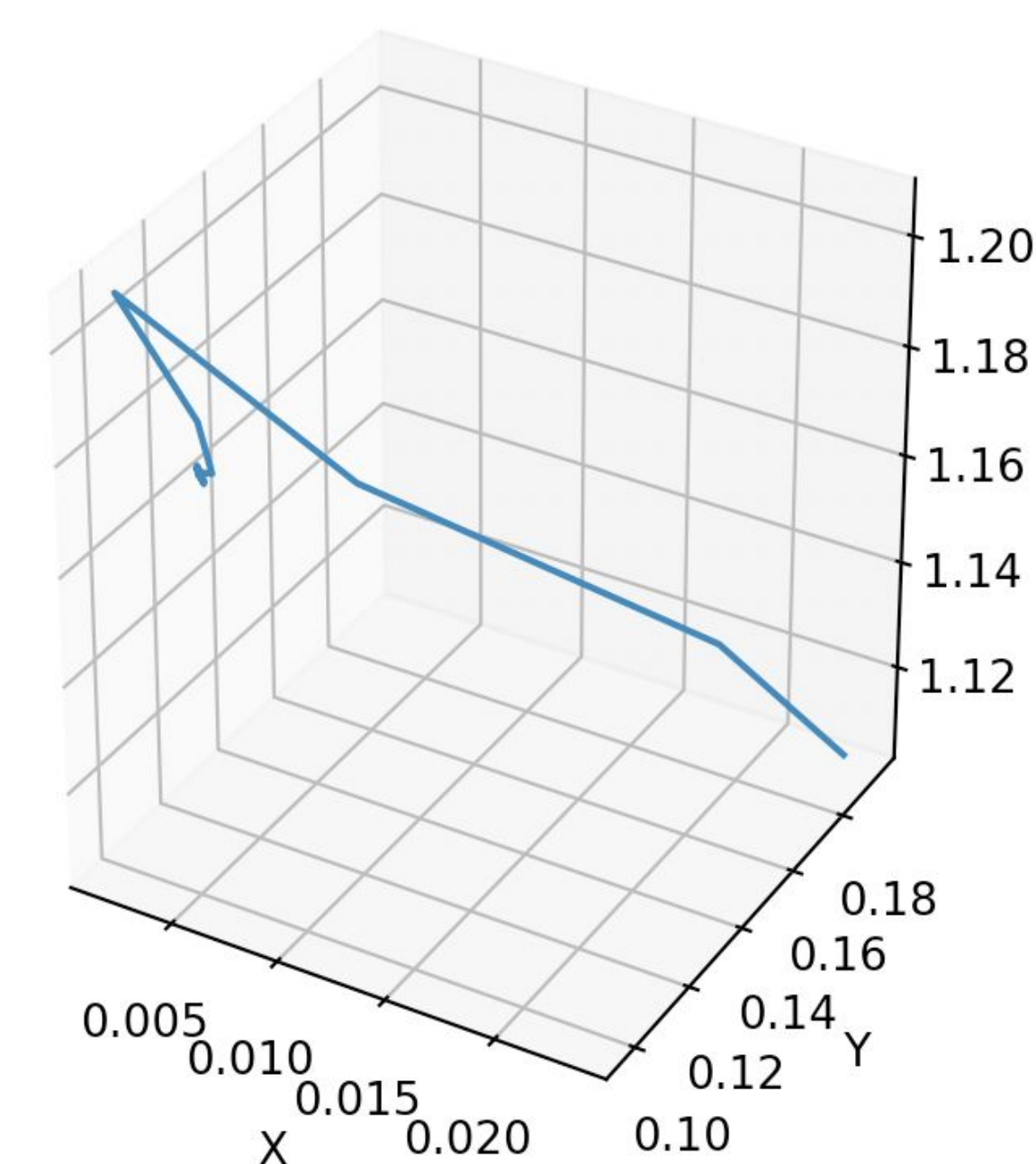


### Custom Power PCB

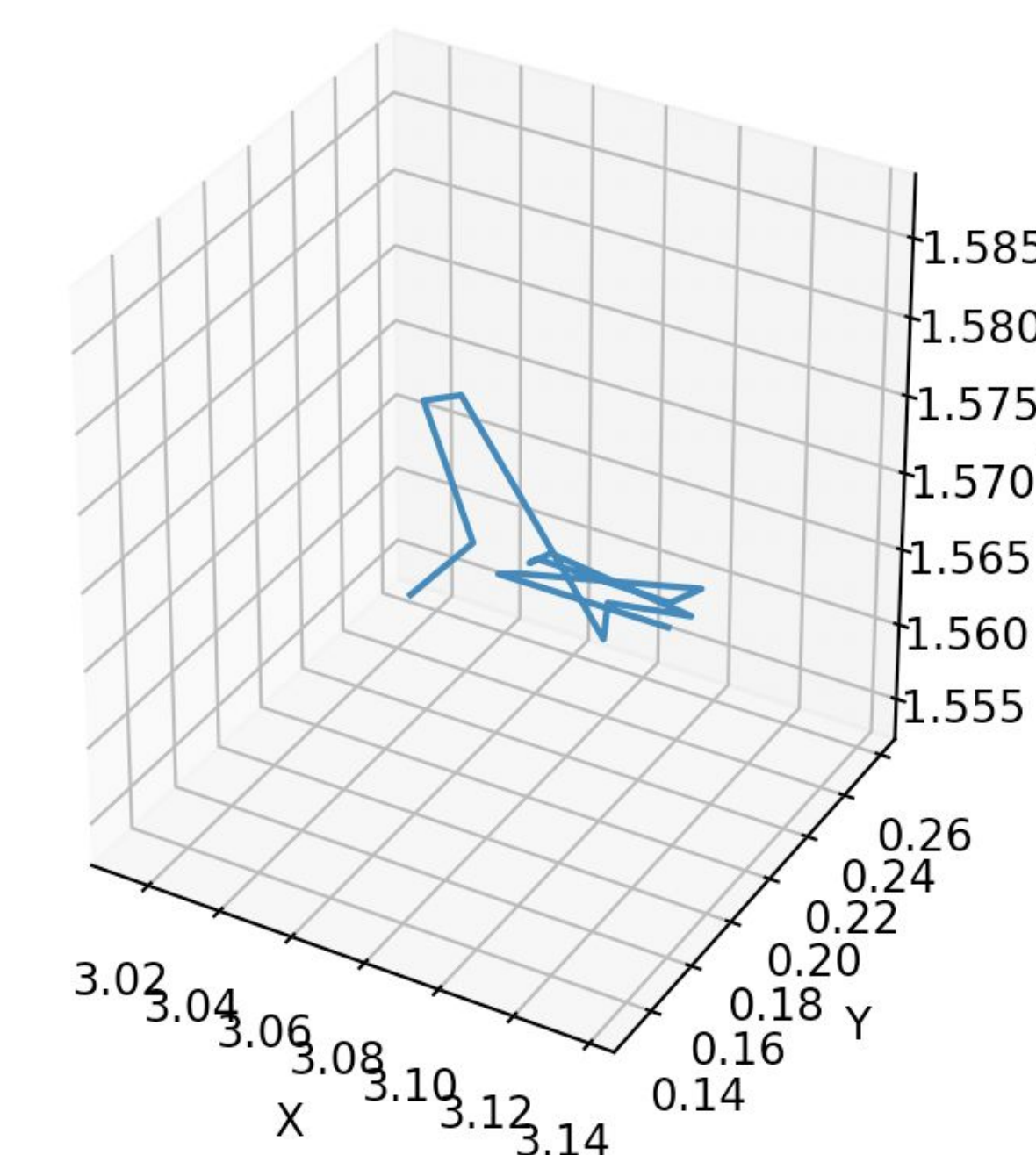
- Function as a voltage regulator to convert the input voltage from 14-22V to 5V output voltage

## Vision Data Extraction

### Position



### Rotation



- Used the streaming data from the drone and plotted the recent 25 live data points onto a Matplotlib 3D plot.
- Data points sent to drone show the relative position and orientation of the drone to the AprilTag.

## Precision Landing

- An AprilTag fiducial marker is fixed to the landing surface.
- Start the drone and trigger the mission mode manually.
- The drone will start automatically to search the tag in the designated area.
- Once it detects the tag, it will land on the tag.



### Key Metrics:

- AprilTag size: 17cm x 17cm
- Maximum search altitude: 7.2m
- Camera frame rate: 10Hz
- Optimum wind speed: <15mph

## Acknowledgements:

Special thanks to Alan Jaeger from Navsea, and to Yogananda Isukapalli, Aditya Wadaskar, and Kyle Douglas from the UCSB capstone program.



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