P.I.G.S.

Personal Information Gathering System

AeroVironment™

Team

Anshuman Dash - Project Lead, Computer Vision, High level logic

Tianrui Hu - Mobile Application Development

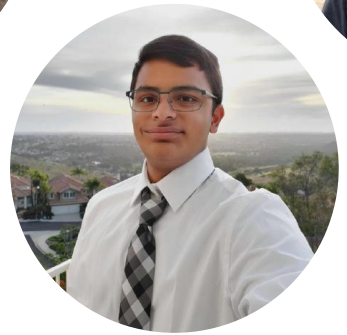
Zhiwen Wu - Raspberry Pi setup and communication, link between drone and system

Yifan Pan - Design and implementation of different drone modes

Matthew Tran - Hardware, ArduPilot configuration, RTK connection





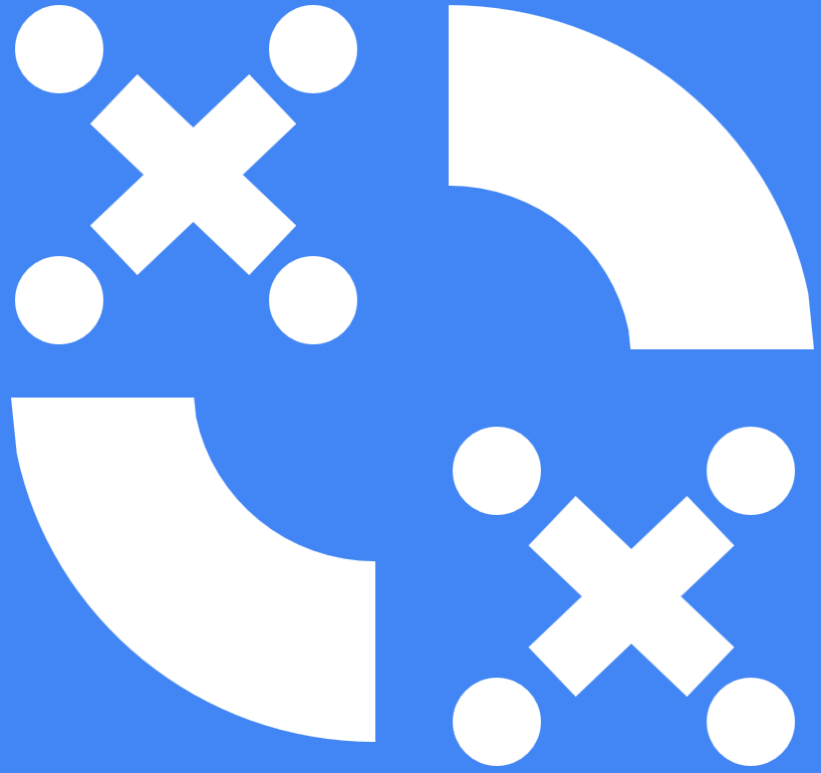


Problem Motivation

In any combat environment, information is quintessential. Traditionally, people have to risk themselves to get visuals of surrounding areas, or autonomous based solutions require a dedicated operator to man.

Our project aims to do the following:

- Collect information with an autonomous swarm of drones
- Control from a high level using a mobile phone
- Stream video from all drones to the phone
- Identify objects and mark on the phone UI



Our Solution: PIGS

Our Solution

- Network of drones coordinating with the system
- Onboard processors to handle drone interface
- Drone video streamed to system
- Mobile app to receive human-ready information
- High level functionality at a button press
- Telemetry data streamed back

Functionality

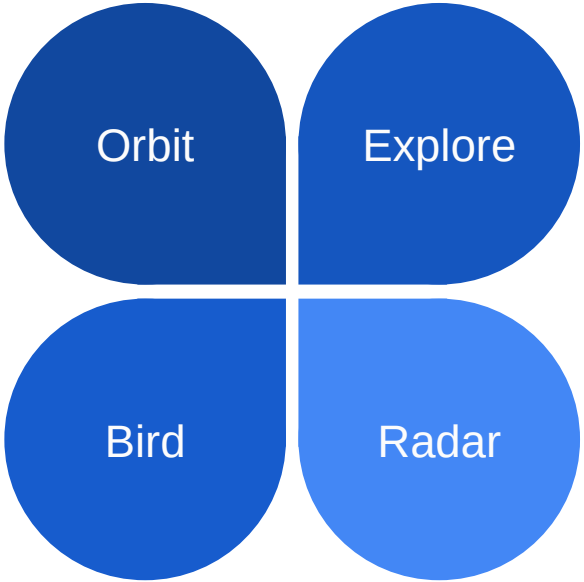
Four Modes

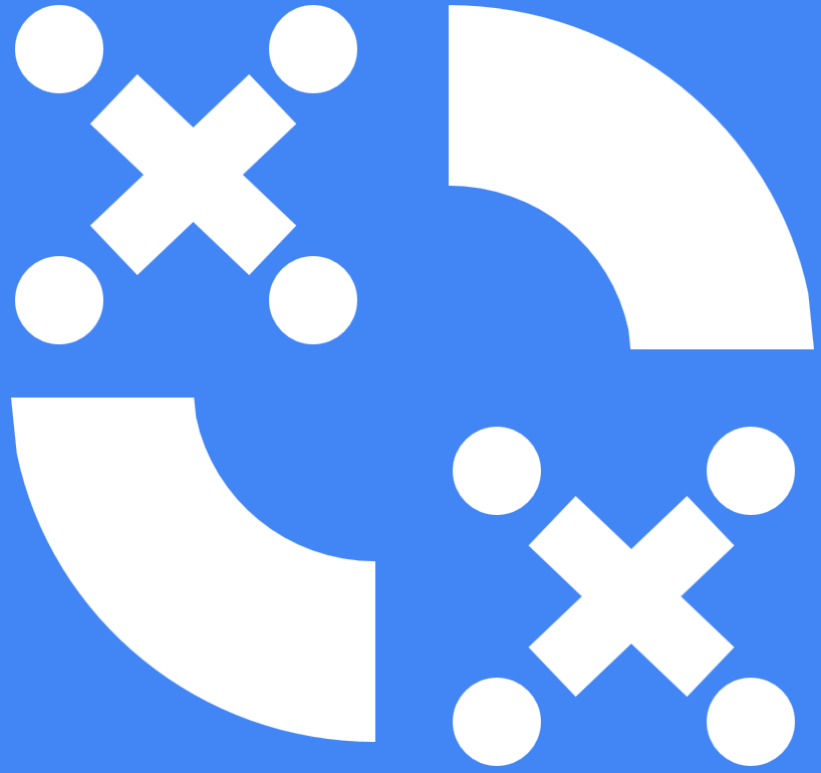
a) **ORBIT MODE** The drones will follow and circle around the user while streaming video to the accompanying app

a) **EXPLORE MODE** One drone will be dispatched into a direction to survey and gather information and relay the streamed information to the user.

a) **BIRD MODE** One drone will be dispatched to go to a high vantage point (birds-eye) above the user, then rotate around to get a 360° view of the surrounding area.

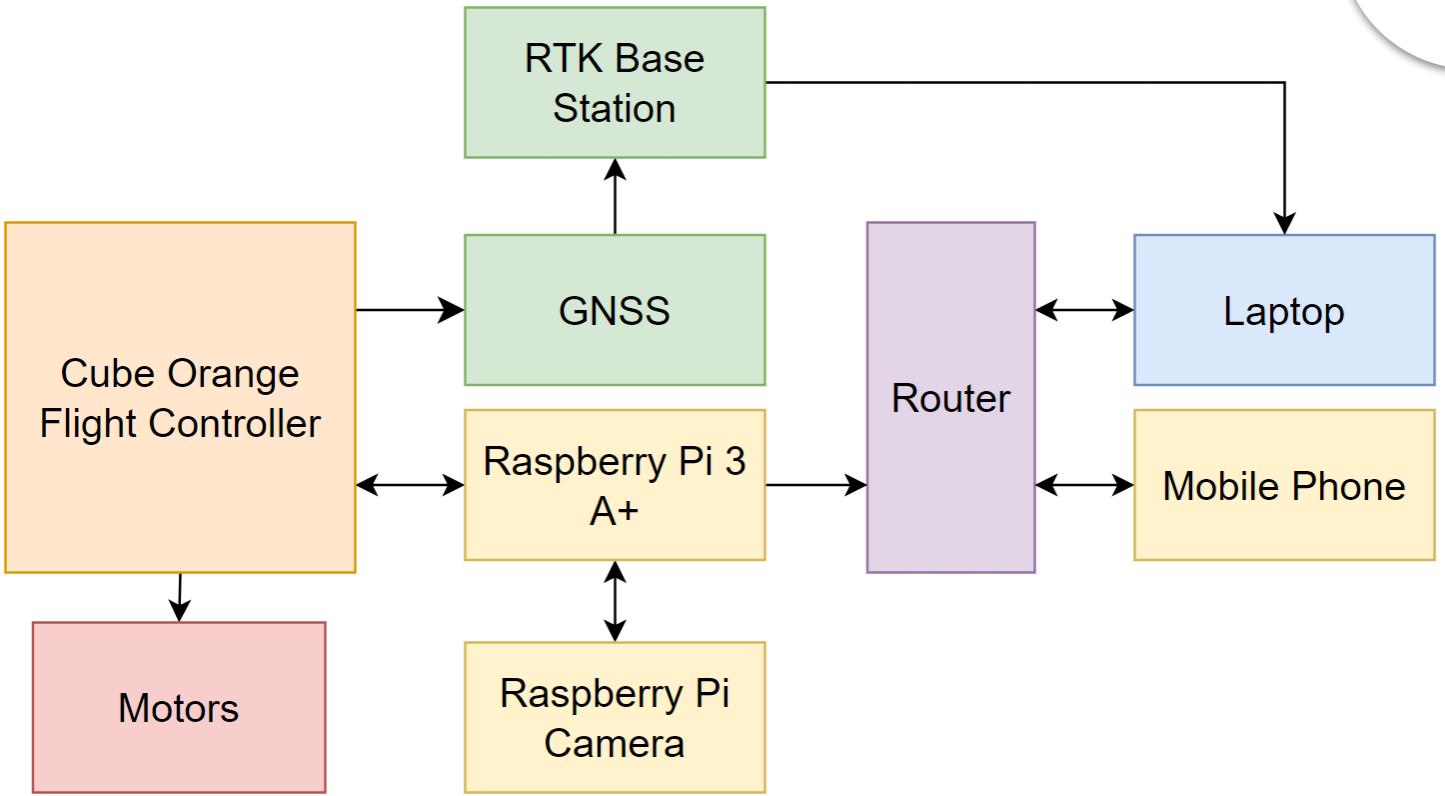
a) **RADAR MODE** The drones will go to vantage points around the user, sweep the camera yaw, and utilize computer vision to detect people, and report it on the app with bounding boxes.



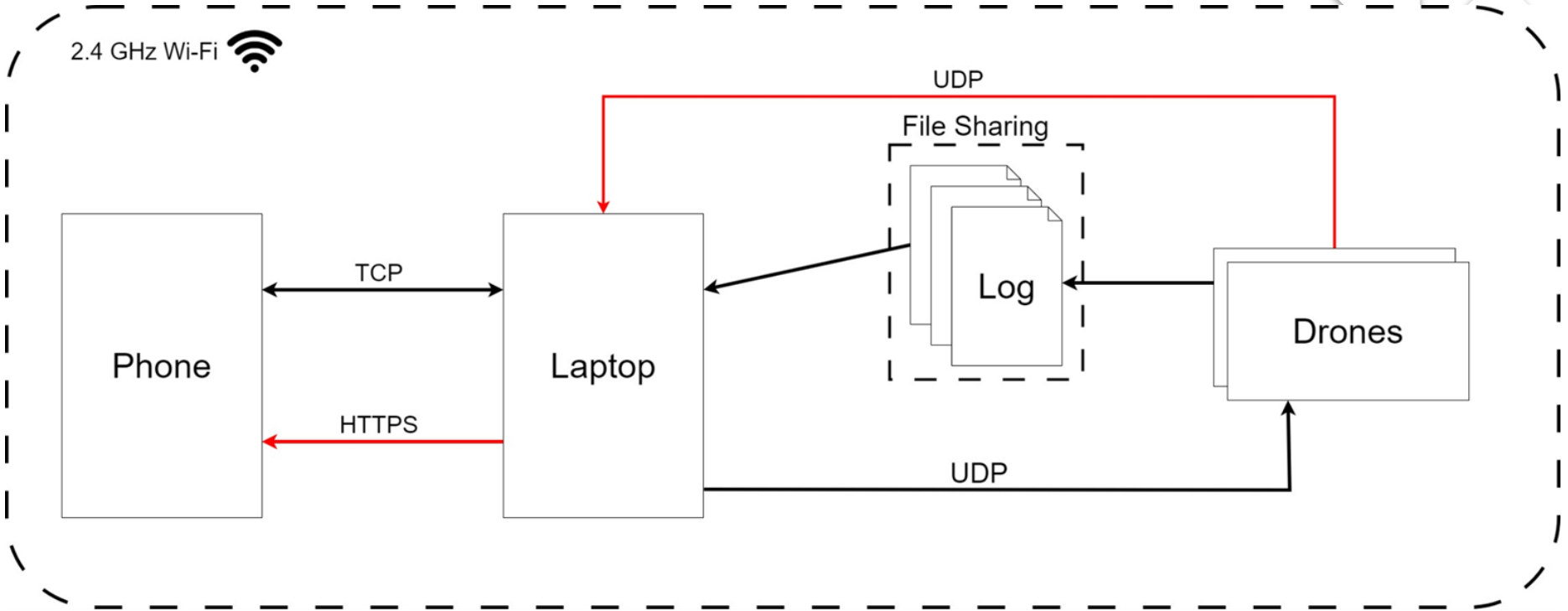


Design

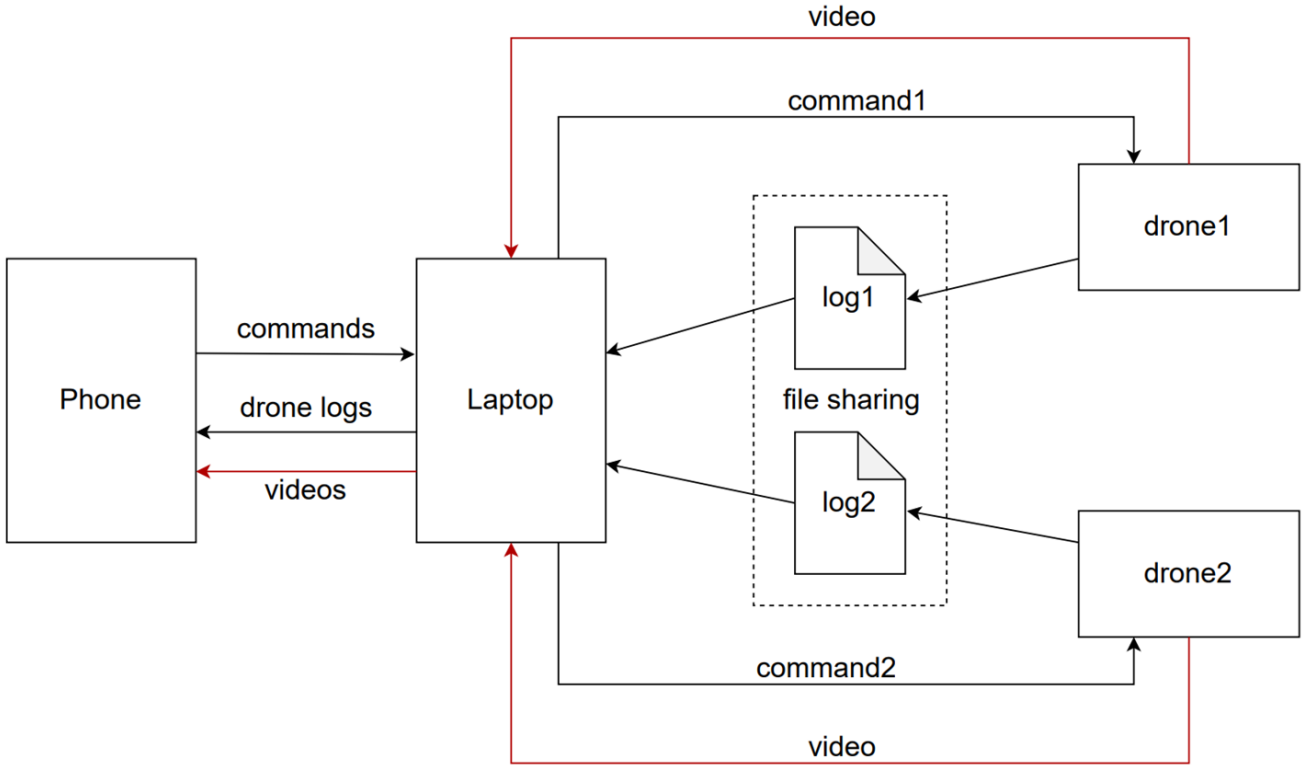
Block Diagram



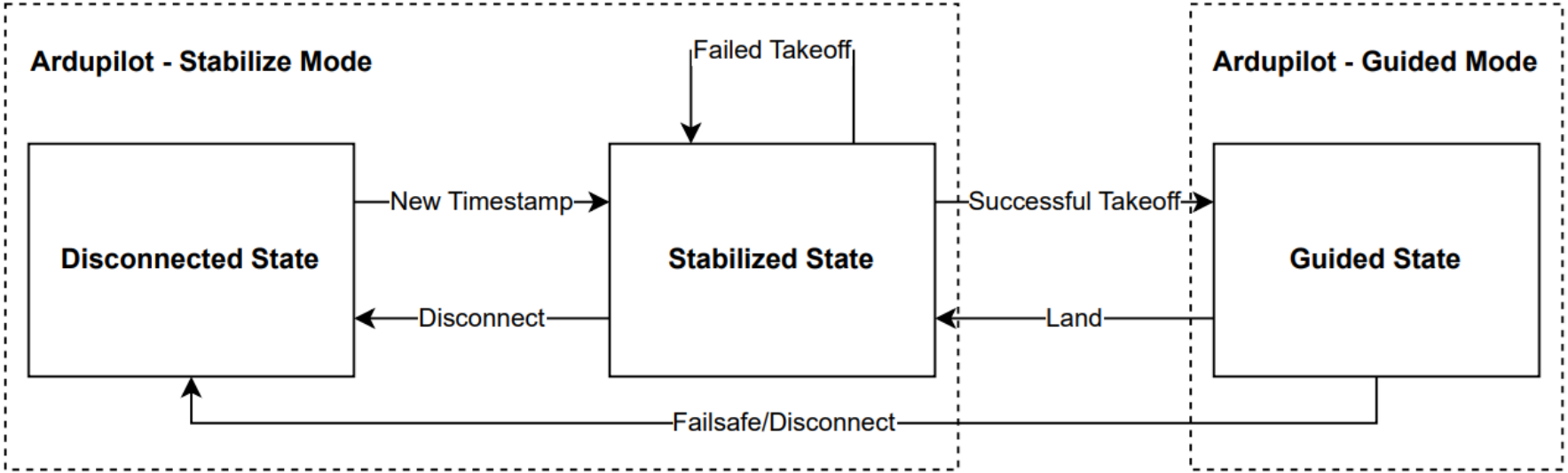
Network Design

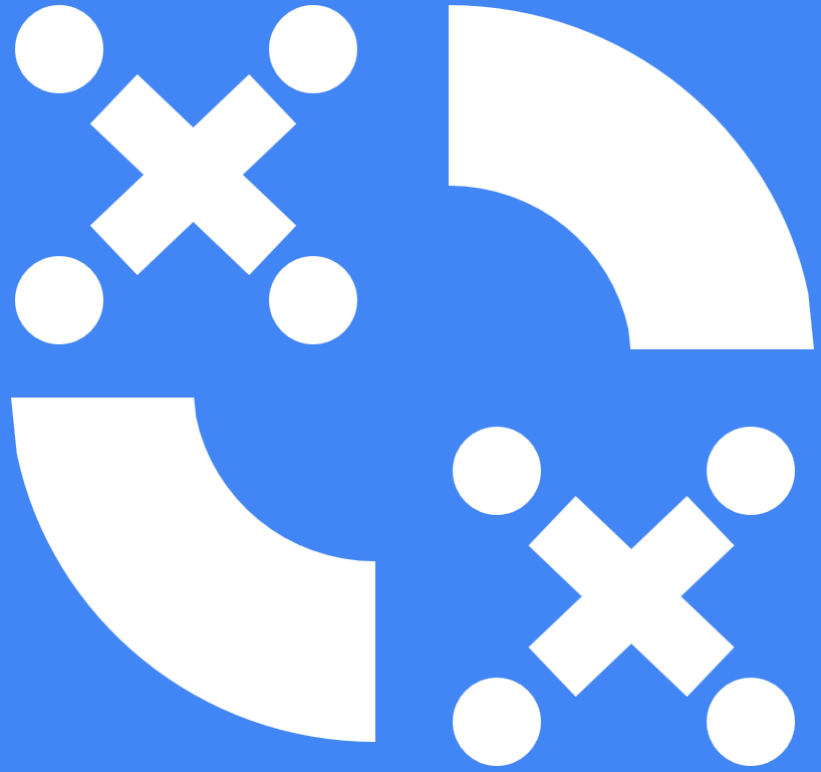


Communication Flow



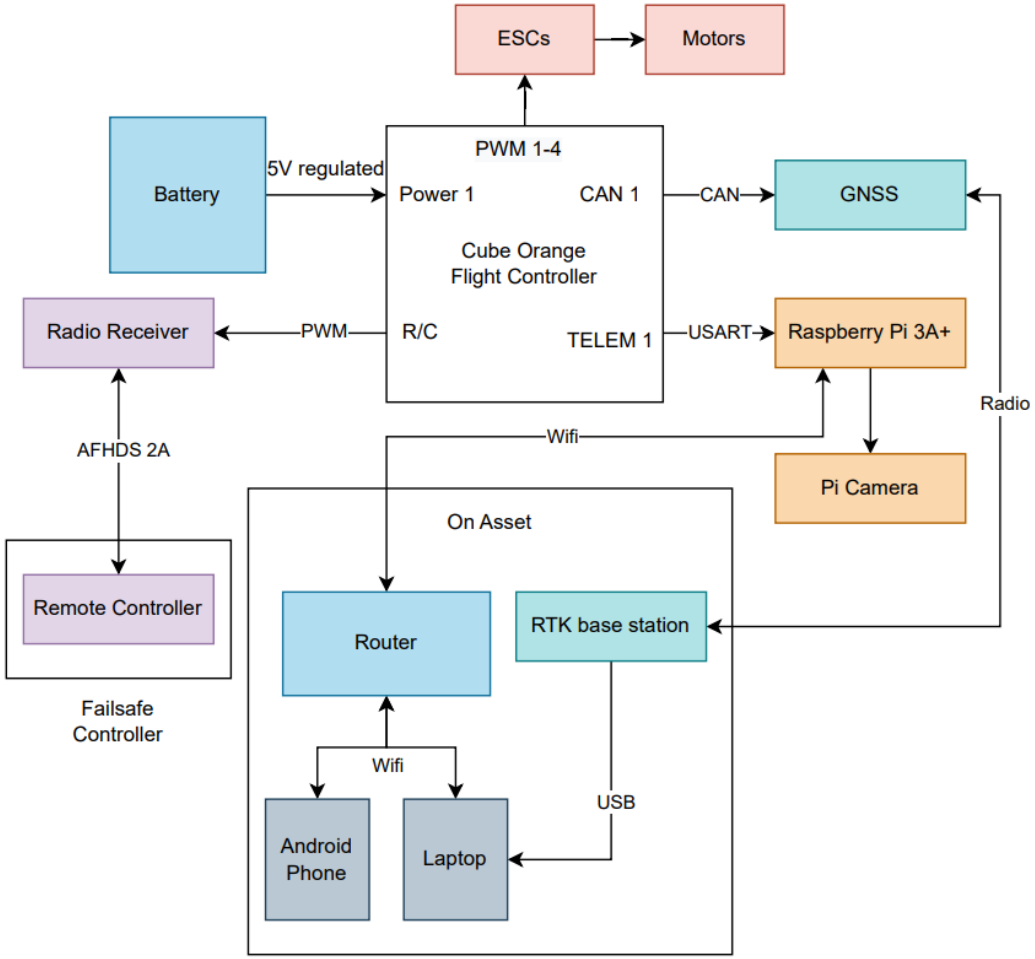
Drone Control





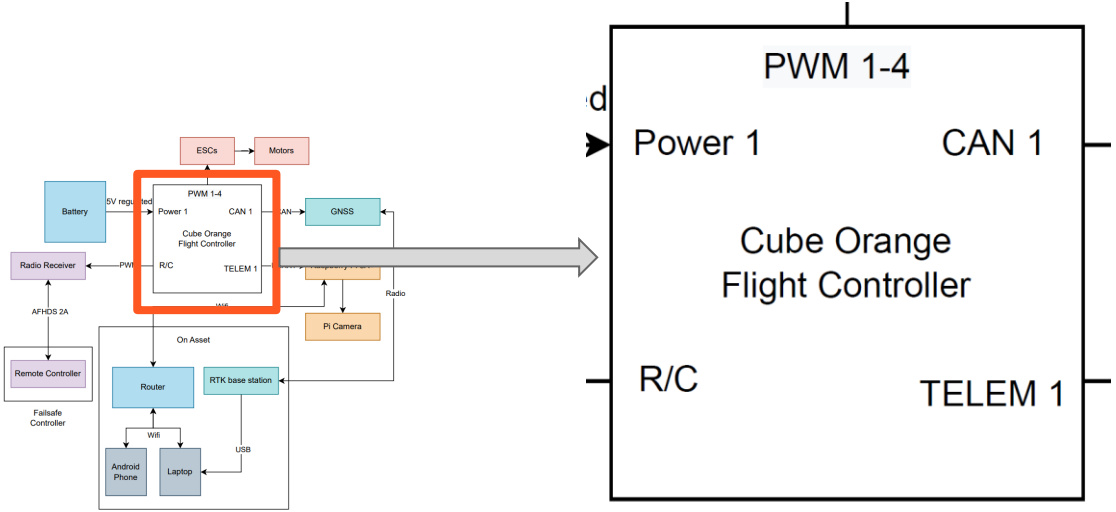
Hardware

Block Diagram



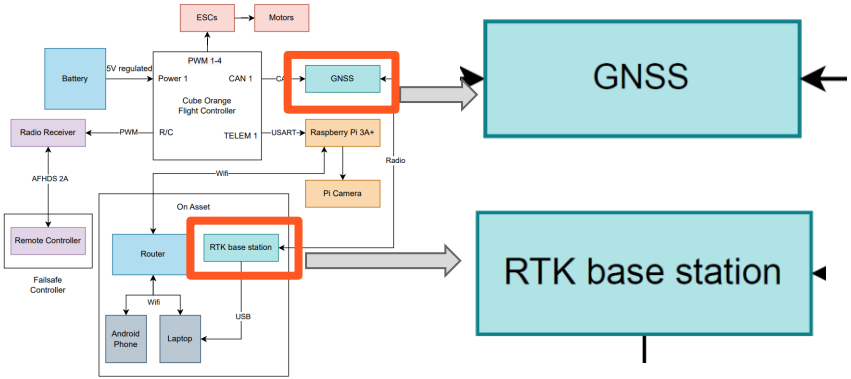
Cube Orange

- Triple Redundant IMUs (Vibration Isolated and Temperature Controlled)
- Two Barometers
- One Magnetometer
- 32-bit ARM Core with Flight Processor Unit



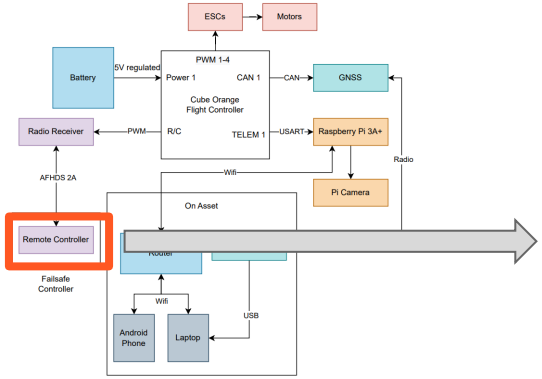
HERE3 GNSS + Here+ RTK Base

- U-blox High Precision GNSS Module
- GNSS: 2.5 meter accuracy
- RTK: 0.025 meter accuracy
- IMU and Processor



FrSky Taranis X9D Plus

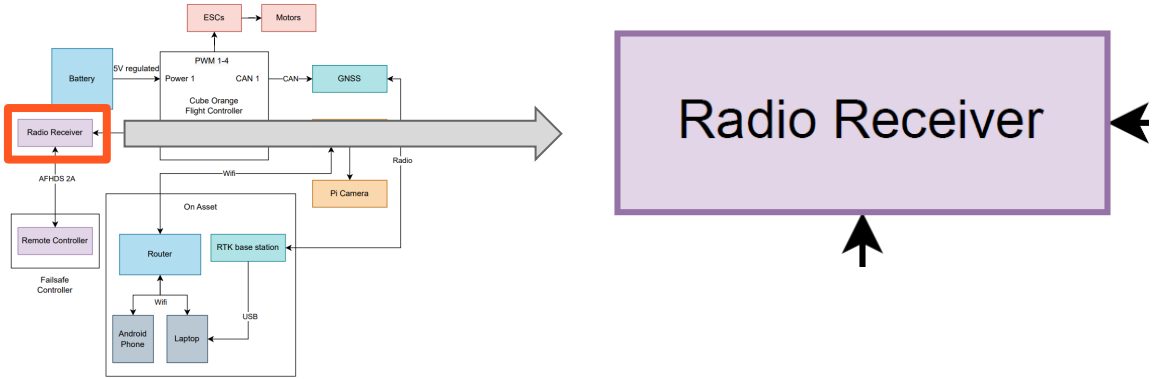
- OpenTX operating system
- Channel configuration to allow usage of multiple drones (up to 16)
- Vibration alerts for failsafes



Remote Controller

FrSky Taranis X8R

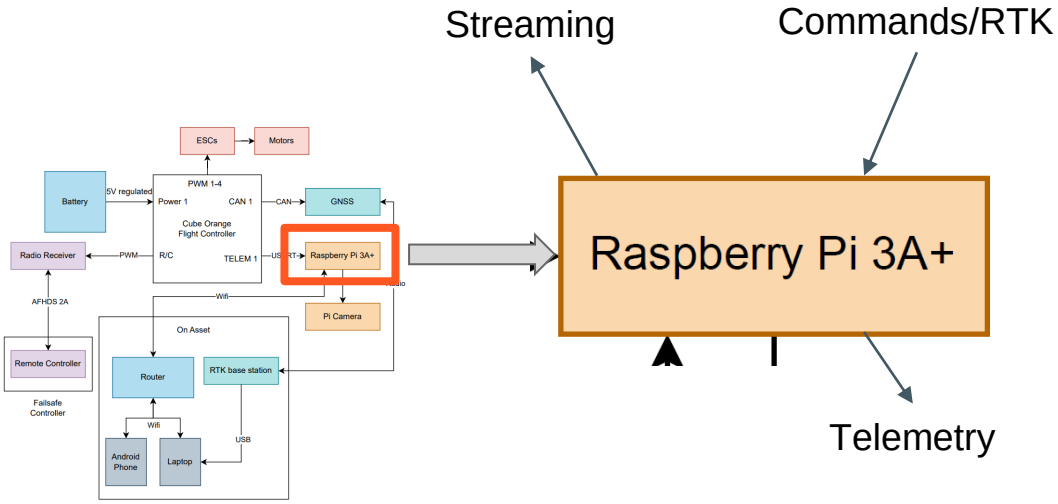
- Compatible with X9D Plus Transmitter
- Operating range of 1.5 km
- Supports usage of up to 16 different channels



Radio Receiver

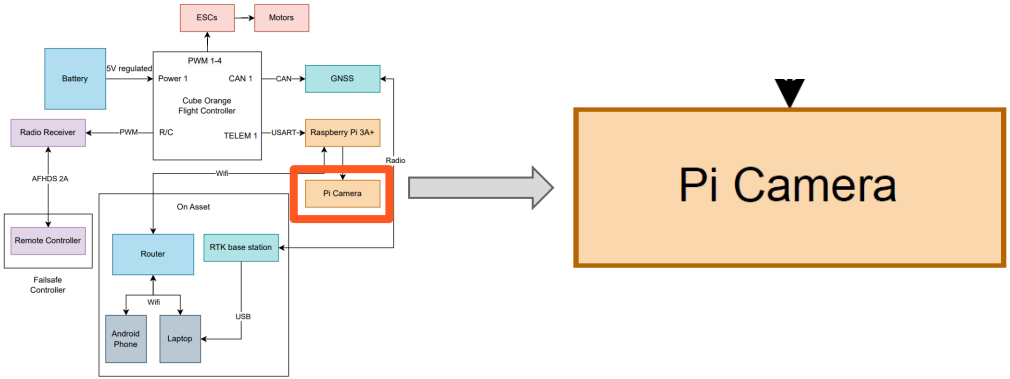
Raspberry Pi 3 A+

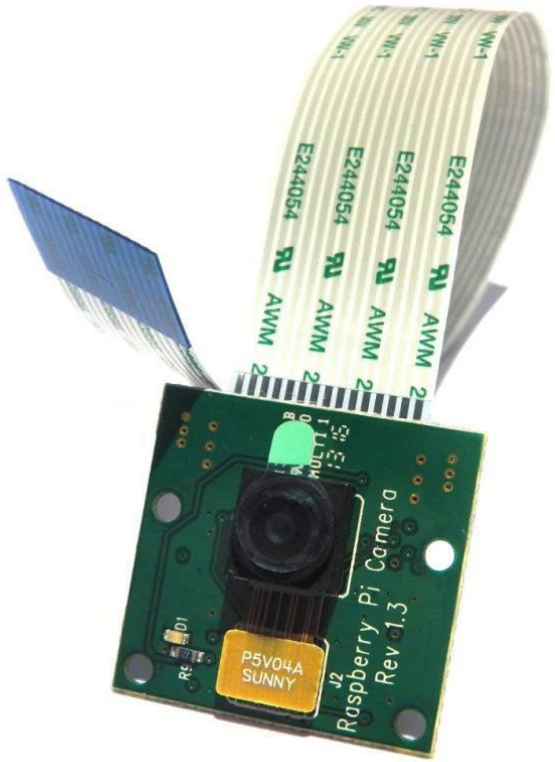
- 1.4 GHz 64-bit quad-core CPU
- 802.11 b/g/n/ac wireless LAN
- CSI camera connector



Raspberry Pi Camera V2

- 8 Megapixel Camera
- Horizontal FOV: 53.5 degrees
- Vertical FOV: 41.41 degrees
- Up to 1080p30 Video





Other Drone Parts

ReadyToSky S500

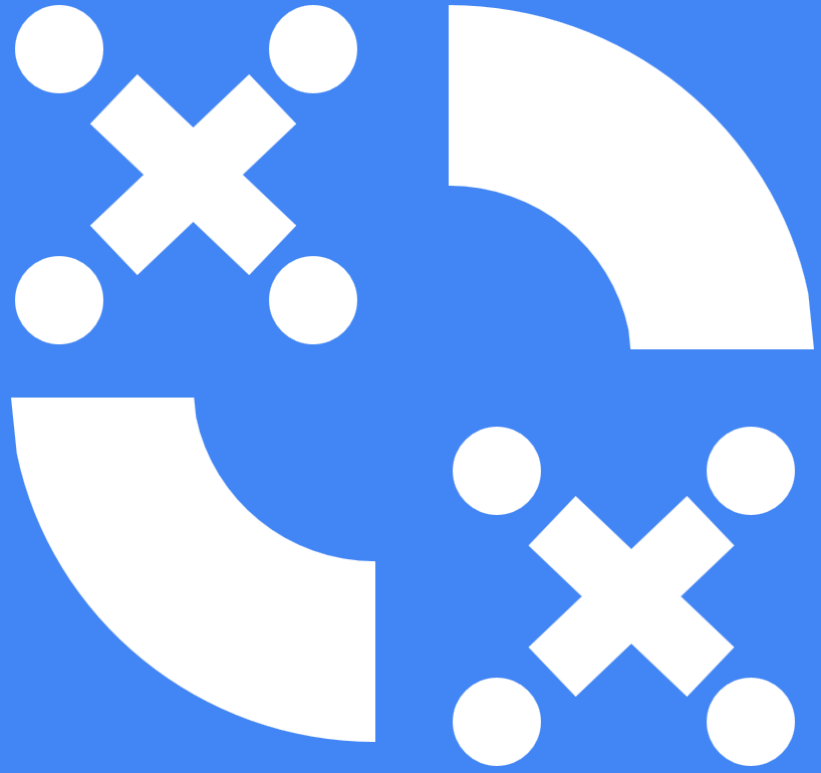
ReadyToSky 40A ESC

D3530 1100KV Brushless Outrunner Motor

Master Airscrew Multi-Rotor Propellers

Socokin 4S LiPo Battery 6500 mAh

Technical Decisions



GPS vs RTK

	GPS	RTK
Refresh Rate	1Hz (can be pushed to 4-5Hz)	Above 20Hz
Accuracy	4.9m in open sky	2cm

https://www.gps.gov/systems/gps/performance/accuracy/

Network Design

Drone-to-Laptop Video & Command	UDP protocol	UDP protocol is convenient for low-energy raspberry pi.
Laptop-to-Phone Video	HTTPS protocol	HTTPS-based video service can easily support multiple streaming simultaneously.
Phone-Laptop Command & Log	TCP protocol	TCP protocol can provide stable connection between device.
Laptop-Drone Log	File Sharing	Shared files as command to simplify the communication, can reduce the number of threads we need.

Command Format

Command from Drone to Phone

Command from Phone to Drone

Mobile App Design Choices

Map

Camera

Location

Drone Camera Switch

Commands

- Large map for drone tracking
- 360p Drone video streaming
- Seven Drone Commands

Deliverables

Orbit

- Both drones controlled from mobile app
- Stream video to phone
- Configurable height and radius
- Revolve around mobile phone GPS

Explore

- Dispatches the closest drone to a target location from mobile app, the other keeps orbiting
- Sweeps area to record 360 footage
- Once commanded to release, routes to orbit position without collision

Birds-Eye

- Dispatches one drone to fly above user to high vantage point, the other keeps orbiting
- Sweeps yaw over 360°
- Streams footage back to mobile phone
- Once released, returns to orbit position

Radar

- Drone streams back 360° footage
- Mobile phone runs computer vision model to identify objects in frame
- GUI displays bounding boxes with confidence intervals

Special Thanks

Professor Yoga - Overall mentorship and individualized help

Phil Tokumaru - Expertise in field along with practical advice

Tiziano Fiorenzani - Specialized help with autonomous drones

Alex Lai - Help with ordering parts

Jimmy Kraemer - Overall support

Question & Answer