Quadcopter Cameraman

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Project Plan

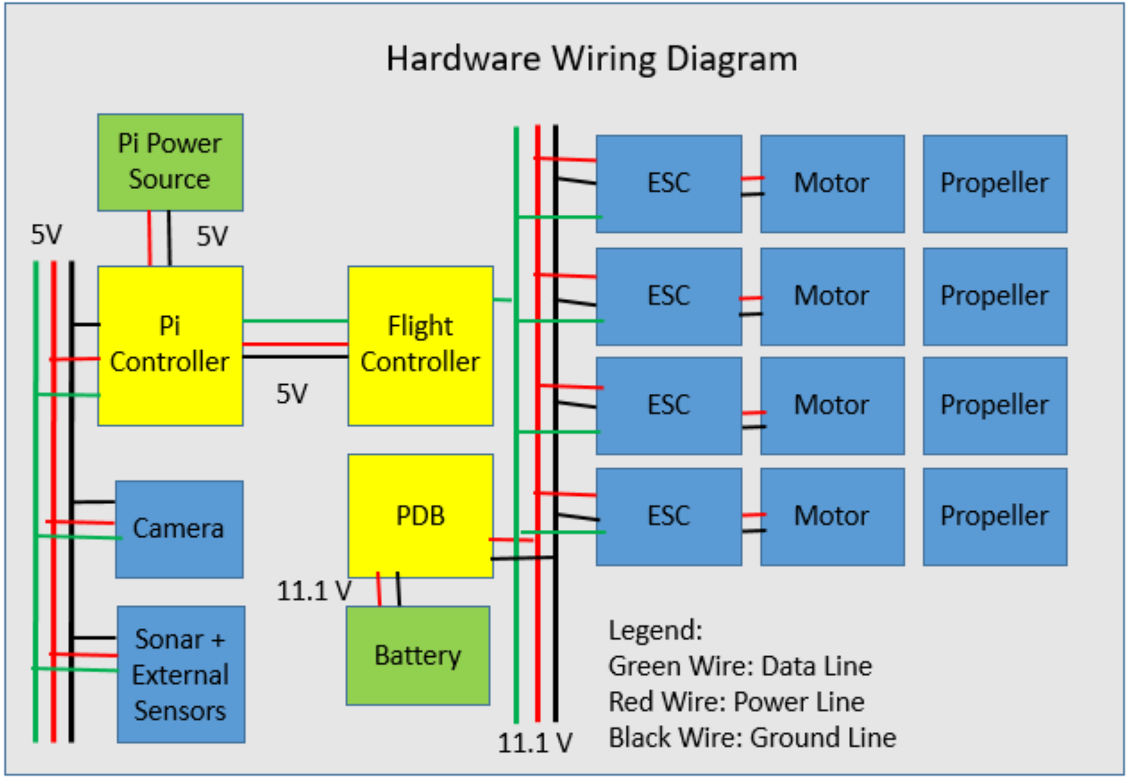
Problem Statement

- The Descarga Latin Dance Club on campus is having difficulties recording themselves and other members during performances.

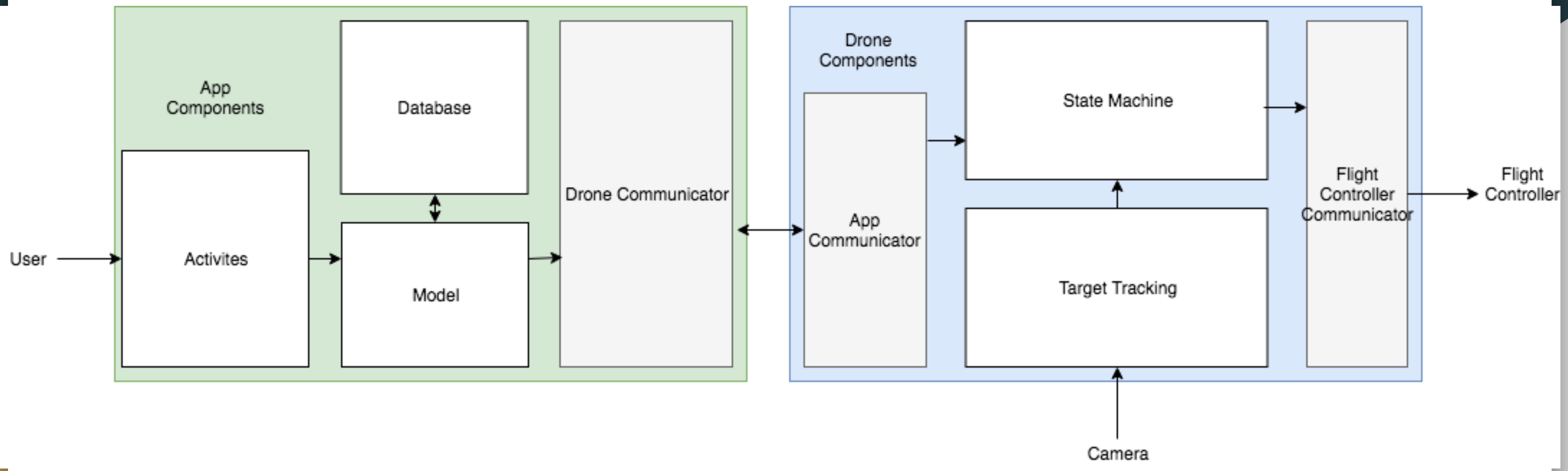
- The main issue is that a camera man can be obtrusive on a dance floor and get in the way of the dancers themselves or other dancers that may or may not be on the floor at the same time.

- To solve this issue our client has hired us to design, build, and program an **autonomous quadcopter**. This quadcopter will be able to identify the target dancers and record them at a preset distance.

Conceptual Sketch - Hardware



Conceptual Sketch - Software



Nonfunctional Requirements

- Security
  - Ensure private use of the drone
  - Not susceptible to replay attack
- Useability
  - Fit for non-tech savvy people
  - Responsiveness
- Reliability
  - Stability
  - Endurance

Functional Requirements

- Video Quality
  - 720p or better
  - 24 Frames per second or faster
- Flight Control
  - Must be autonomous
  - Must prioritize user control over autonomy
- Image Recognition and Tracking
  - Drone must follow target for full performance
  - Drone must keep target in frame for full performance

Constraints

Flight time: Must be able to fly for at least 5 continuous minutes

Budget: We are trying to keep the cost close to what team members contributed to the senior design pool

Weight: An ideal thrust to weight ratio is 2:1 at full throttle that way the drone can hover at half throttle

Constraint - Thrust to Weight Ratio

ML2212 MOTOR								
Item NO.	Volts (V)	Prop	Throttle	Amps (A)	Watts (W)	Thrust (g)	Efficiency (g/W)	Operating temperature(℃)
ML2212 920KV		APC10*4.5	65%	5.1	56.6	460	8.1	55℃
			75%	7.4	82.1	590	7.2	
			85%	10.1	112.1	730	6.5	
			100%	13.4	148.7	860	5.8	

860(g) * 4 propellers at full throttle = 3,440 (g) of thrust

Our theoretical drone weight is 1,643.217(g)

Achieves 2.09 : 1 Thrust to weight ratio

*Hovering should be achievable at ~59% throttle

Market Research

-DJI Mavic 2
$1,450

-DJI Spark
$400

Quadcopters builds are well understood and well documented

By building our drone we can customize it to address our problem

Building our own does not require us to interface with proprietary hardware or software

Our drone offers a good balance between price and functionality

HW/SW/Technology Platform(s)

- Hardware
  - Pi Model 3B
  - ZnDiy-BRY Crius All in One Flight Controller
- Software
  - Android Studio
  - ChibiOS RTOS
  - Python 3

Risks and Mitigation

Risk: Malfunction resulting in damage to the drone and/or injury of persons

Mitigation: Implement Safety Protocols in the control loop

Sensor Skepticism

Manual Override

Report Failures to User over App

Battery Safety: Observe safe Lithium Polymer battery practices

Resource and Costs

2 Semesters x $55/Semester x 5 Students = $550 Budget for Project

Semester 1 - $400

- Build the base drone

Semester 2 - $150

- Reserved for component upgrades and repairs

Current Cost of Drone = $393.72

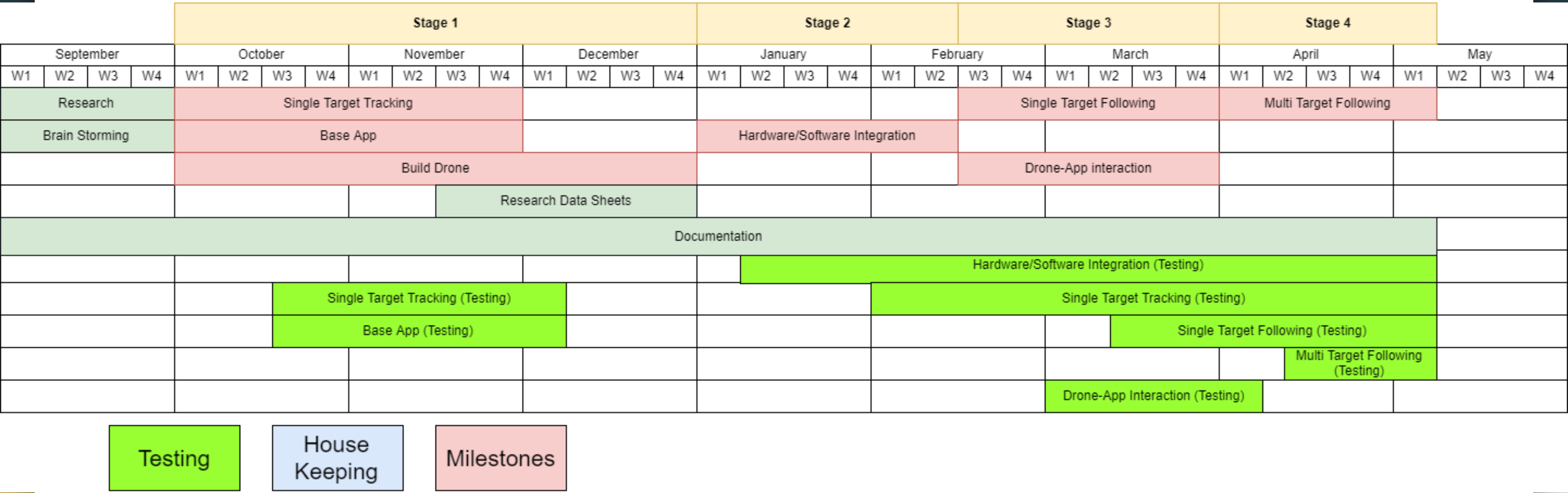
Cost Breakdown

Internal Components	Model		Price
Processor	Rspbry Pi 3 Model B		$34.99
PI power	KMASHI External Battery		$10.99
Motor System			
Battery O-2	Gens Ace		$56.05
Flight Controller	ZnDiy-BRY CRIUS All in One Pro		$53.36
Power Distribution Board	Lumenier Mini 4		$11.99
Motors	Gartt4 x 2212		$135.72
ESC	Hobbywing Skywalker		$0.00
Props	Ray Corp Gemfan		$13.99
Video System			
Frame	JRLEC		$16.90
Camera	Fosa USB Camera		$8.99
Gymbal	None		
MicroSD	Kingston 16GB		$5.75
Total Weight			
External Components			
Battery Charger	Passport P1 Mini (DYNC3015)		$44.99
Total Cost			$393.72

Project Milestones

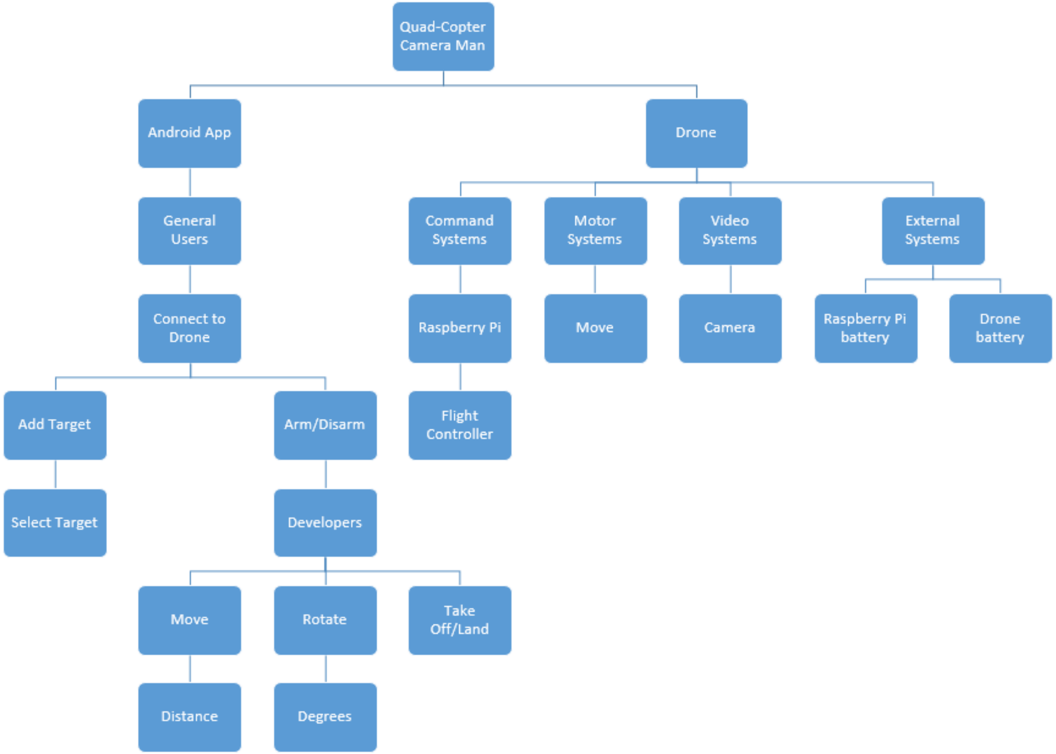
- **Stage 1**
  - **Build Drone**
  - **App**
  - **Single Target Tracking**
- **Stage 2**
  - **Software/Hardware Integration**
- **Stage 3**
  - **Remote Control Drone**
  - **Single Target Following**
- **Stage 4**
  - **Multi Target Following**

Schedule


Stage 1
Stage 2
Stage 3
Stage 4
September
October
November
December
January
February
March
April
May
W1 W2 W3 W4
Research
Single Target Tracking
Single Target Following
Multi Target Following
Brain Storming
Base App
Hardware/Software Integration
Build Drone
Drone-App interaction
Research Data Sheets
Documentation
Hardware/Software Integration (Testing)
Single Target Tracking (Testing)
Single Target Tracking (Testing)
Base App (Testing)
Single Target Following (Testing)
Multi Target Following (Testing)
Drone-App Interaction (Testing)
Testing
House Keeping
Milestones

System Design

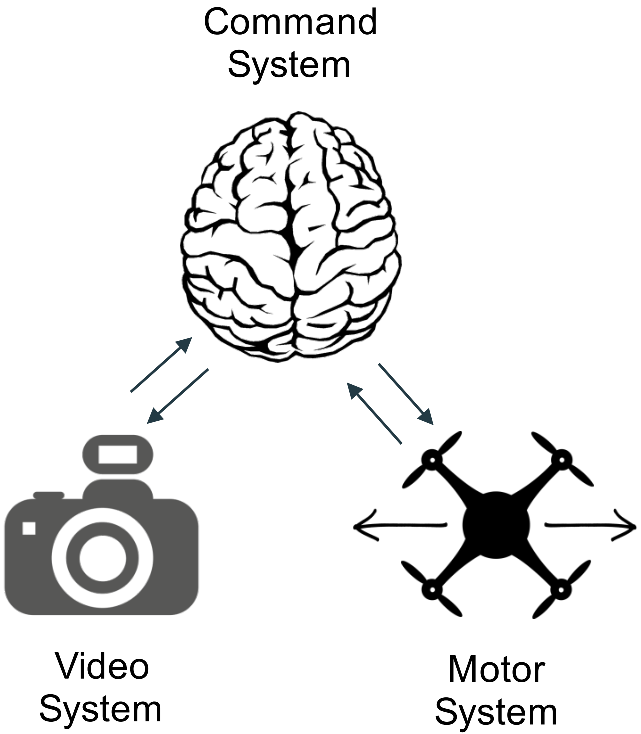
Functional Decomposition



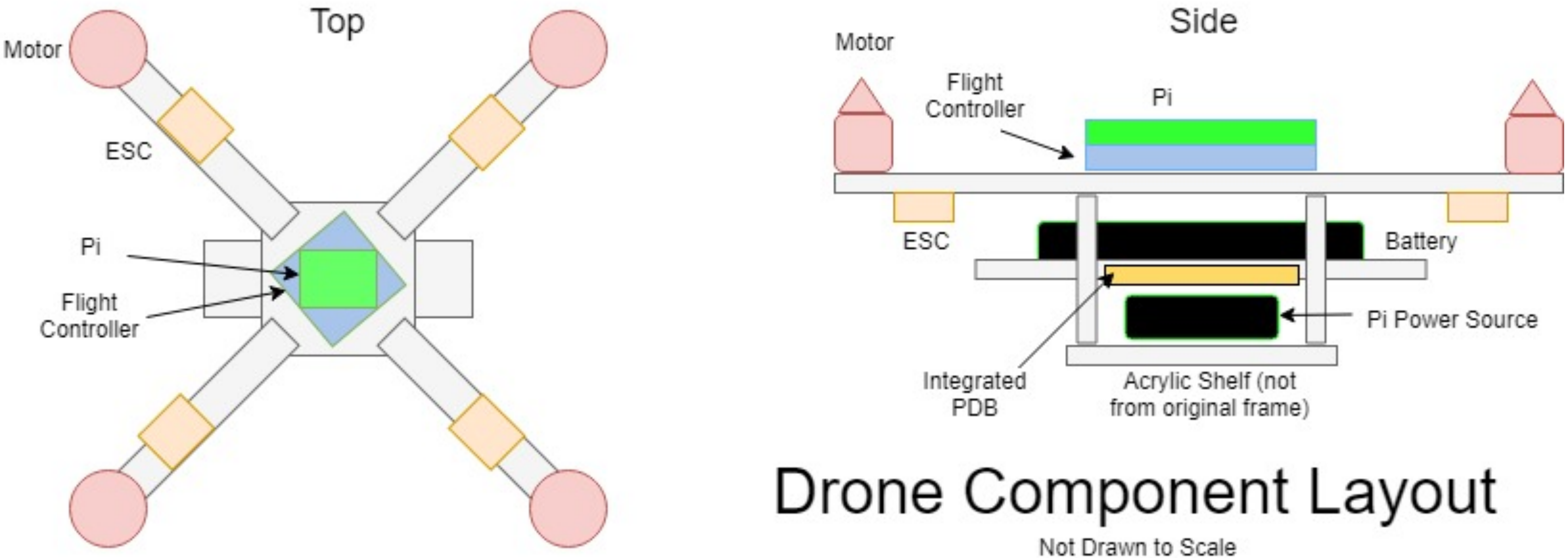
Detailed Design - Hardware

4 Modules:

- Command Systems
    - How to Move
- Motor Systems
    - Makes Drone Move
- Video System
    - Records Video
- External Systems
    - Any Hardware not Mounted on the Drone



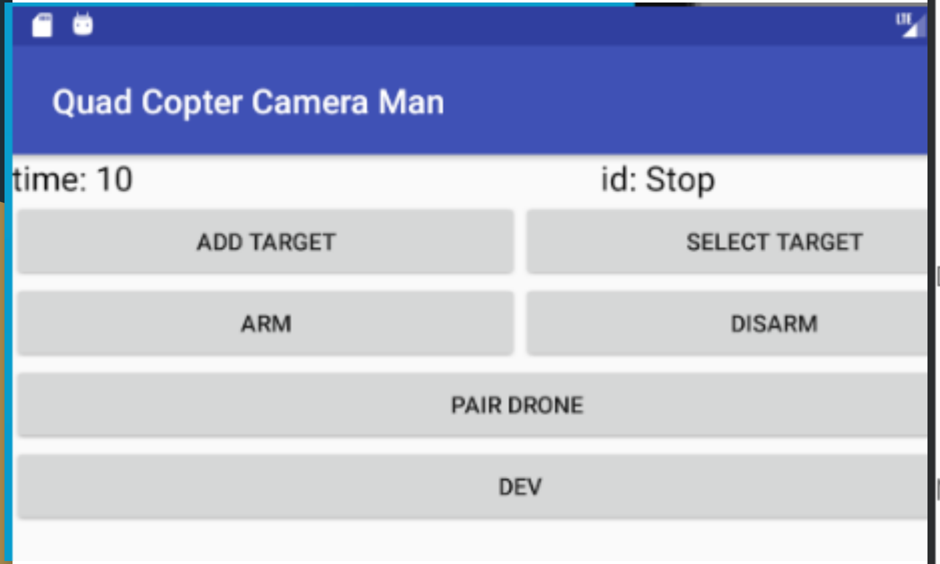
Detailed Design - Hardware

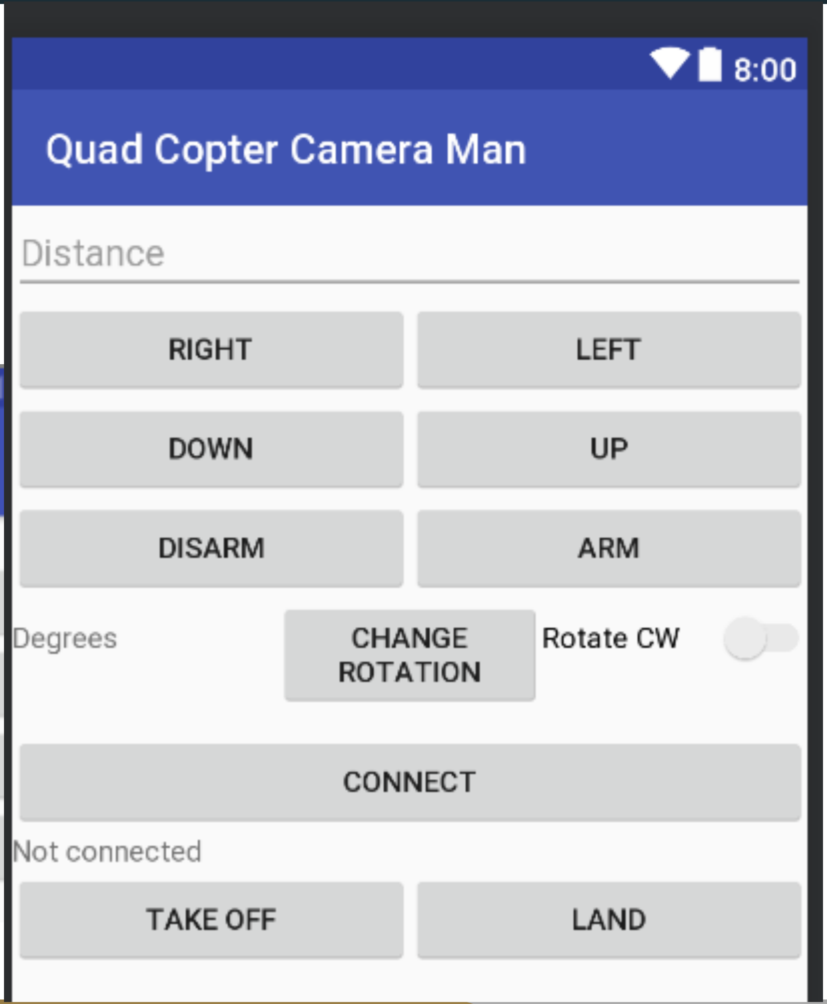


Drone Component Layout

Not Drawn to Scale

Detailed Design - UI



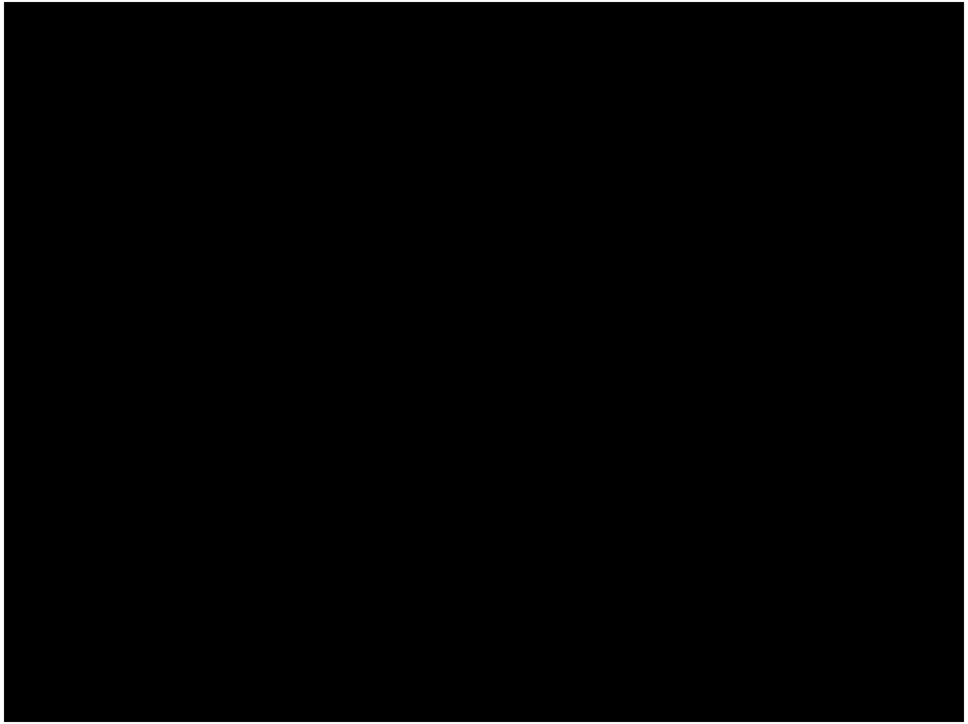


Test Plan

- Individual hardware component tests
  - Command Systems
  - Motor Systems
  - Video Systems
  - External Systems
- Individual Software component tests
  - Pi Software Systems
  - Android App Systems
- Combined/Full run tests

Prototype Implementations

- Simulation
  - Bare bones animation
  - Controlled test



Conclusion

Project Status

Current project status with respect to milestones

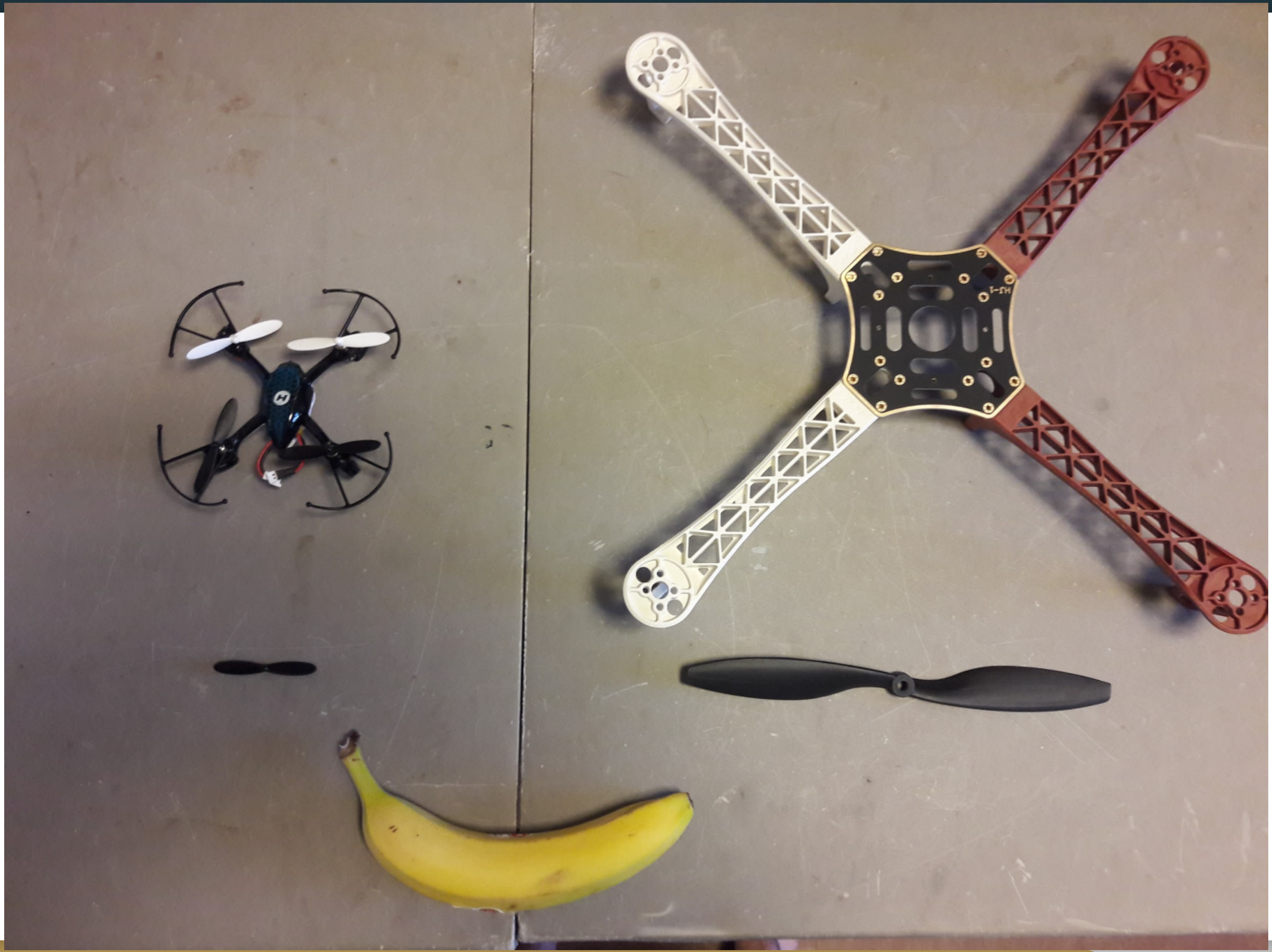
- Drone Built
- Base App
- Drone Remote Control
- Single Target Tracking
- Single Target Following
- Multi Target Following

What’s Next?

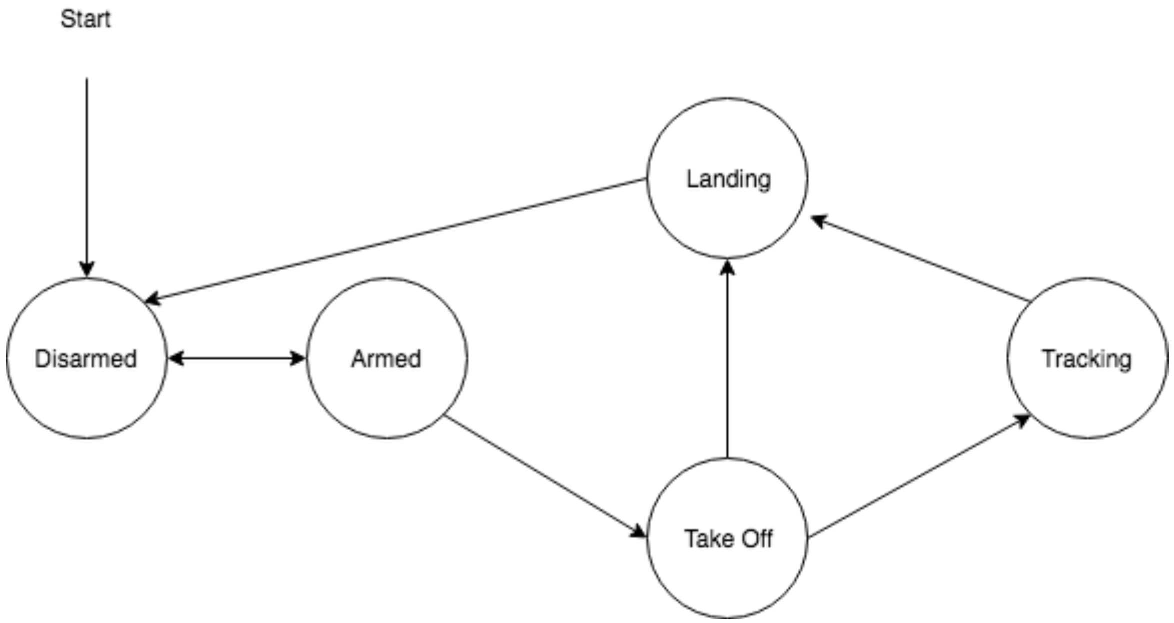
- Establish communication between App and Drone
- Integrate Pi with Flight Controller
- Assemble Flight Controller into Hardware
- Fly drone
- Test drone

Contributions

- Luke
  - Android App
  - Drone Communications
  - Facial Encoding
- Nate
  - Trigonometry Libraries
  - Image Utility Libraries
  - Tracking Algorithm
- Alex
  - ChibiOS RTOS
  - Physical Drone R&D
  - Physical Domain Elicitation
- Isaach
  - Android App
  - Drone Communications
- Aamid
  - Hardware Design
  - Physical Drone R&D



State Machine Diagram



Questions?