Amphibian Quadcopter

Ninfa

Team Daphne: Zhuoran Duan, Zixuan(Kevin) Fan, Likai Wei

Problem Statement

*Reptiles and **amphibians** are sometimes thought of as primitive, dull and dimwitted. In fact, of course, they can be lethally fast, spectacularly beautiful, surprisingly affectionate and very sophisticated.*

- *Sir David Frederick*

Problem Statement

Nowadays, drones can only operate in the one dimensional space of the sky. It makes a lot of places inaccessible due to the fact that most drones aren’t waterproof or not dexterous underwater. Waterproof quadcopter can be applied to geological surveys or military use.

Motivation

We want to break the boundaries of the operational space of the drone. In this sense, we can expand a vast possibilities of the applications of drones

Project Breakdown

Underwater maneuvering

Robot control

Architecture

Schedule and Milestone

Underwater maneuvering

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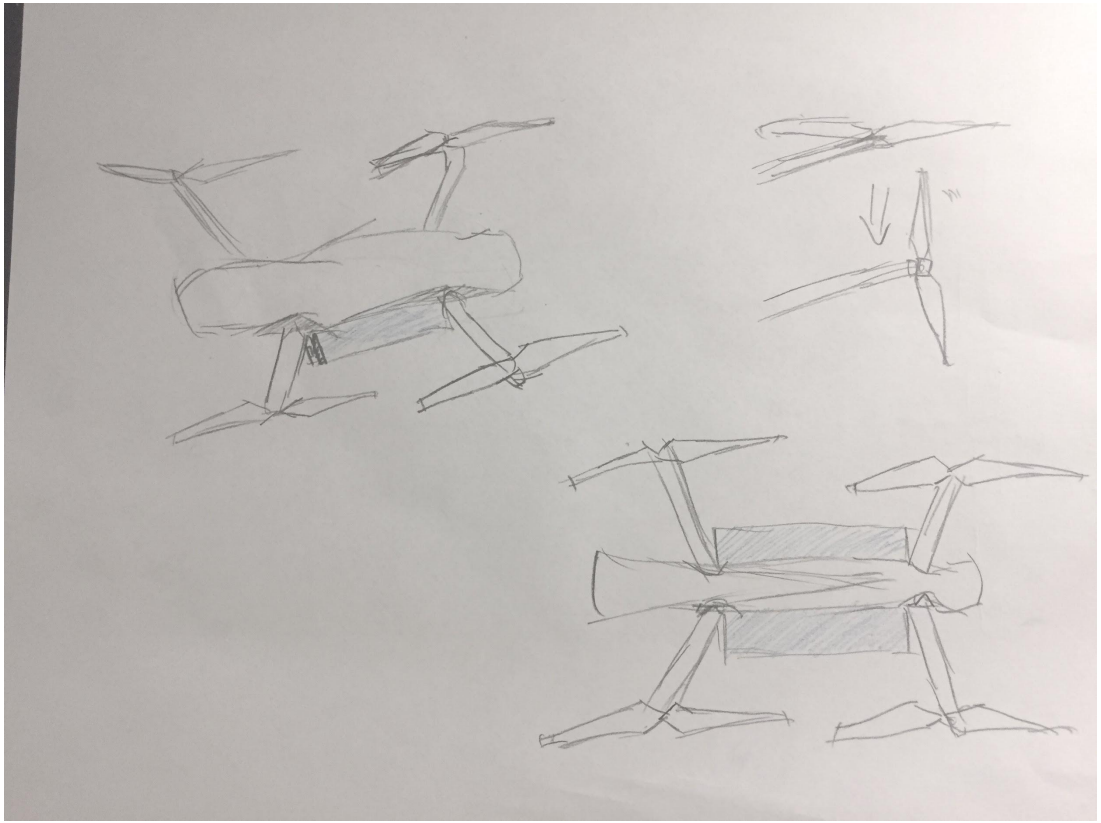
Schedule and Milestone

Underwater Problems

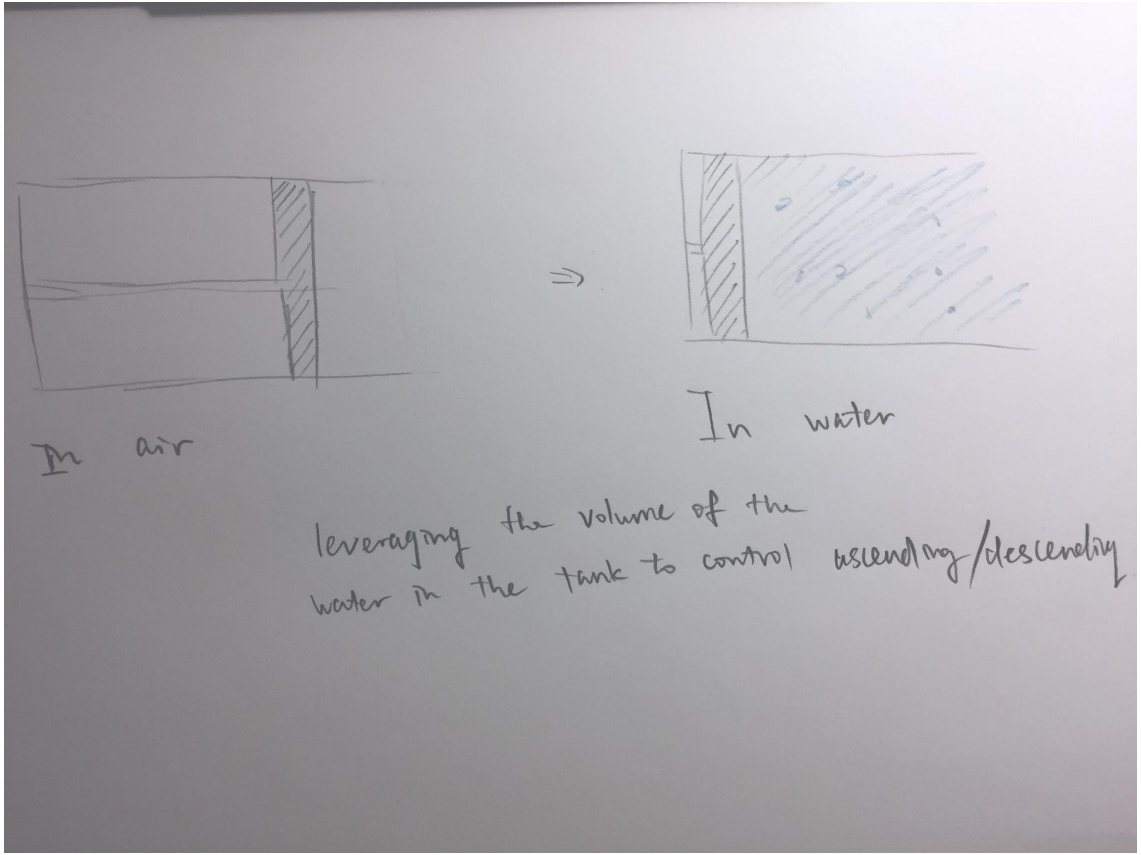
Underwater

Maneuvering

Plan A



Plan A


In air
In water
leveraging the volume of the
water in the tank to control ascending/descending

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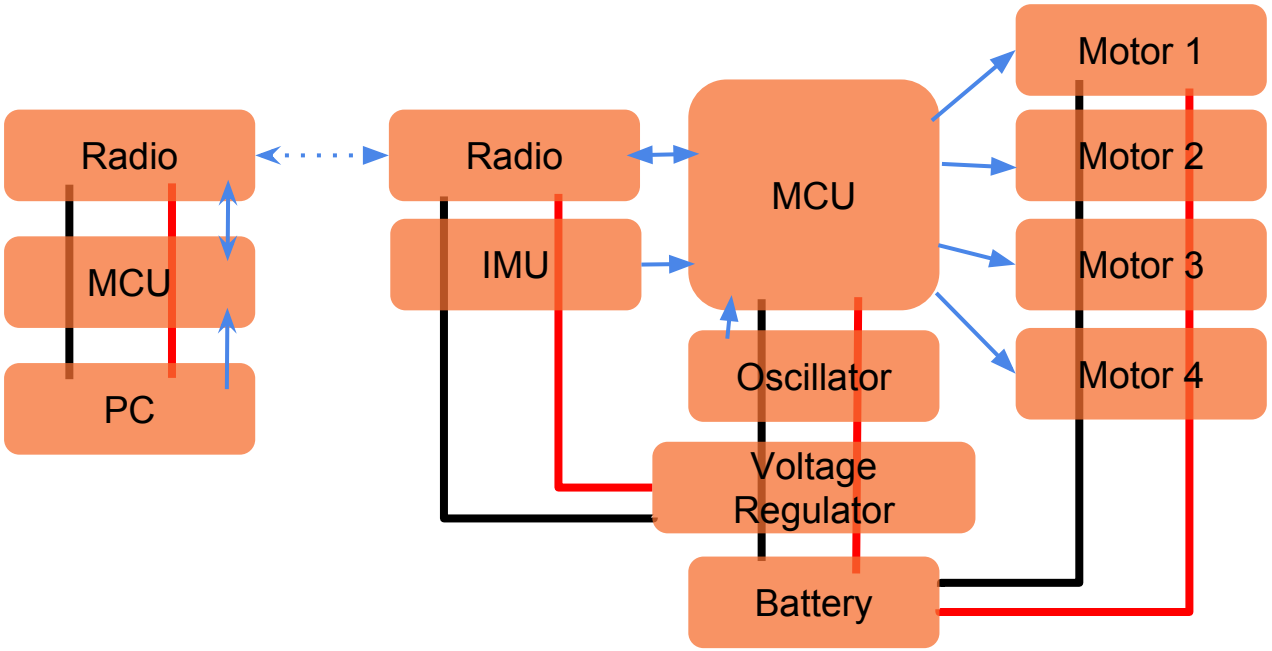
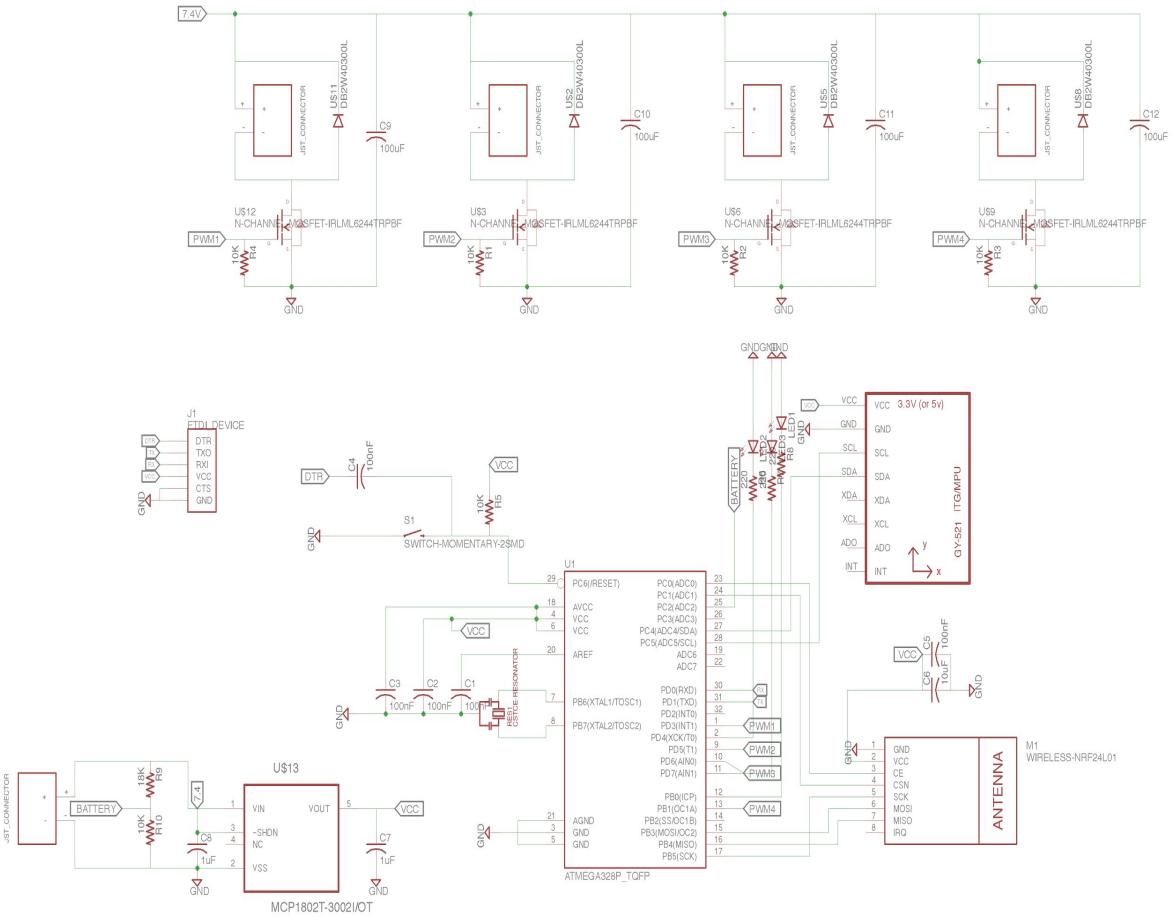
Block Diagram



EAGLE

Schematics

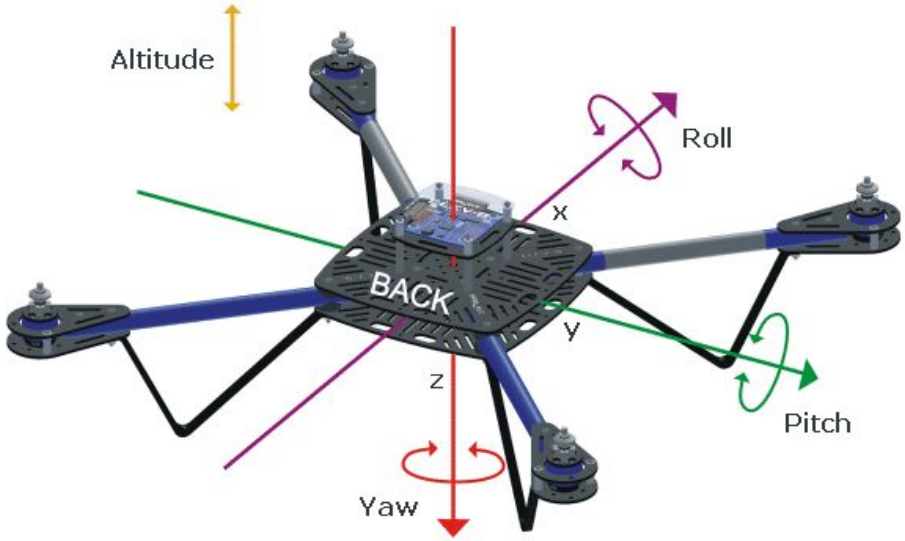


Board Components

- **Oscillator**: CSTCE8M00G55-R0
  - 8MHz Ceramic Resonator
- **Voltage Regulator**: MIC5219-3.3YM5-TR
  - Input up to 12V
  - Output 3.3V
- **MOSFET**: IRLML6244TRPBF
  - Vds(Max) = 20V
  - Low Rds(on) and low thermal resistance
- **WiFi Module**: nRF24L01
  - Single chip 2.4GHz transceiver
- **IMU:** MPU6050
  - Accelerometer & Gyroscope
  - Can calculate Roll, Pitch and Yaw using DMP

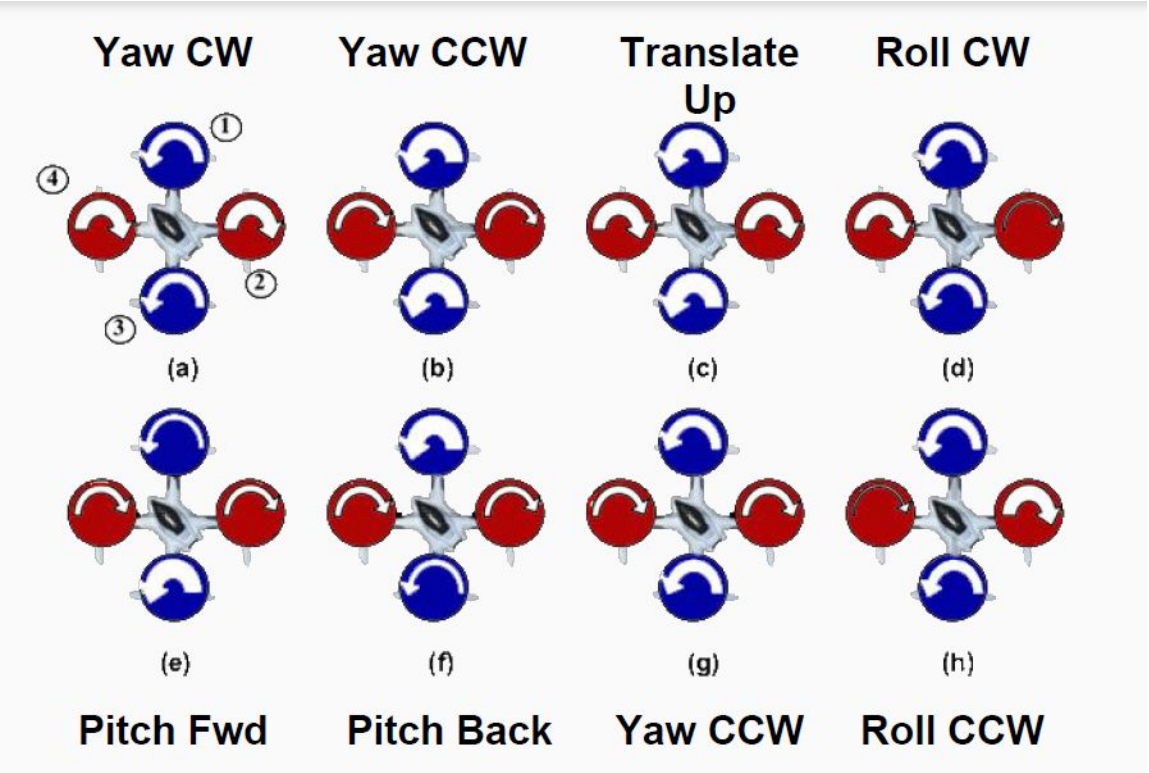
Control of the Quadcopter

Yaw, Pitch and Roll



Control of the Quadcopter

Yaw, Pitch and Roll



Control of the Quadcopter

Feedback Control Diagram

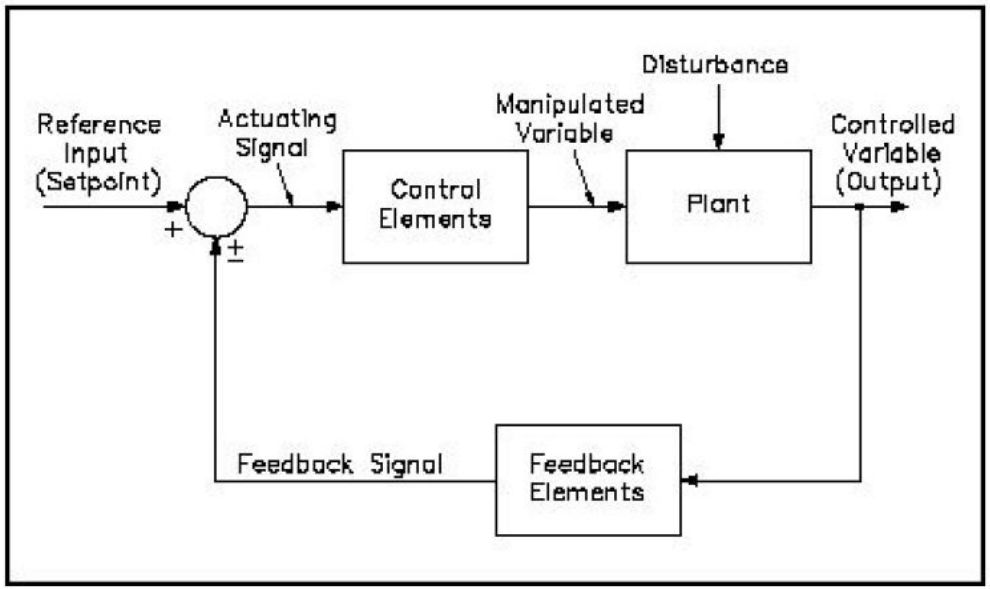
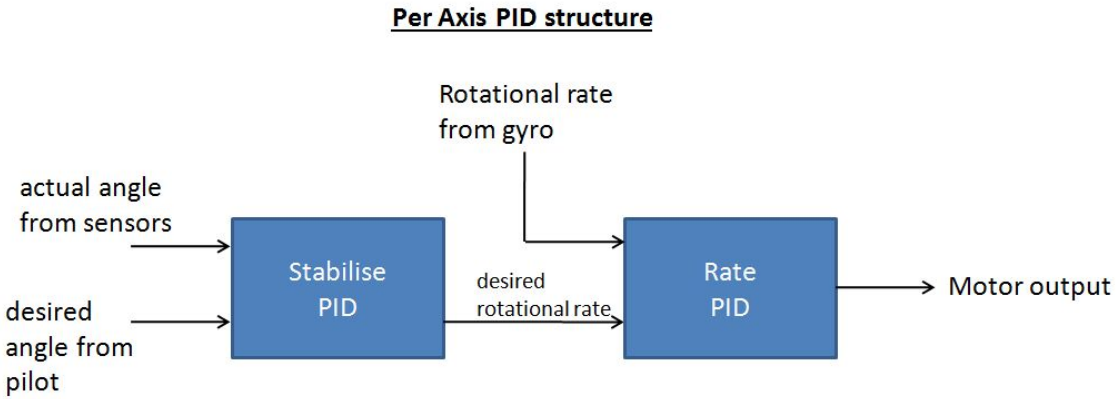


Figure 8 Feedback Control System Block Diagram

Control of the Quadcopter

PID Controller



- Error is the difference between the desired value and actual value
  - Angular Velocity in Rate PID
  - Angle in Stabilise PID
- Use the PID output to control the motors
- A separate set of PID Coefficients for each axis

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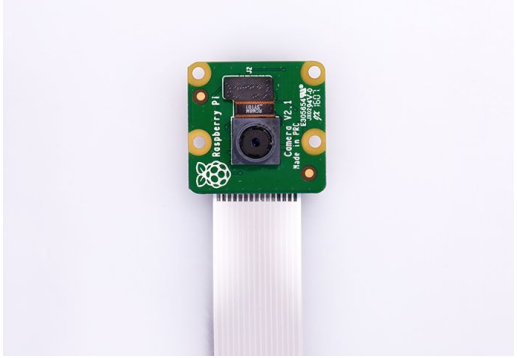
Electronics Enclosures

- All electronics(Motor Control Circuit & Raspberry Pi) goes inside the waterproof project box
- Drill holes for motor cables and use liquid rubber for waterproofing
- Dimension: 158 x 90 x 60mm

Raspberry Pi & Camera



- We use Raspberry Pi(a small Linux Machine) Camera Module for Video Streaming from quadcopter
- 5 megapixel sony sensor for HD video and still pictures
- Interfacing camera: VLC software on Linux can be used for streaming feature through WiFi
- Liquid Rubber for camera case waterproofing

Actuators

- Use four 2212 KV960 waterproof motors as actuators for quadcopter
- For 11.1V input voltage and 2A current can provide 250G Thrust
- Weight: 65g

Quadcopter Frame

- FY450 Quadcopter Frame compatible for standard 2212 Motors
- Motors and waterproof box will be screwed on frame
- Weight: 262g

Battery

- Tenergy 11.1V 2200mAh 25C LIPO Battery
- Lipo battery: lighter than other types of battery for same battery life
- 2200mAh is enough for testing and also save budget

Bill of Materials(BOM)

	Manufacturer Part No.	Datasheet Link	Vendor	Description	Vendor Part No.	Qty.	Unit Price	Total Price	Vendor Link	Primary Use	No
Raspberry Pi	Raspberry Pi Model B	http://docs-e	N/A	Raspberry Pi	N/A	1	$19.99	$19.99	https://www.spar	Camera Interfacing	Preown
N/A	N/A	N/A	Ebay	Electronic Project Box	N/A	1	$3.85	$3.85	http://www.ebay.(	Waterproof Casing	
Raspberry Pi	Raspberry Pi Camera Module		Ebay	Raspberry Pi Camera	N/A	1	$9.99	$9.99	http://www.ebay.(	Video Streaming	
JFRC	U2212	N/A	Taobao	Motor	N/A	4	$13.28	$53.12	https://world.taob	Actuators	
Feiyue	FY450 TL2749-05	N/A	Taobao	Quadcoptor Frame	N/A	1	$9.71	$9.71	https://world.taob	Support Motors	
APC	APC 1147	N/A	eBay	Quadcoptor Blade	N/A	2	$4.49	$8.98	http://www.ebay.(	For Motor	
Tenergy	Tenergy 11.1V 2200mAh 25C LIPO	N/A	All-Battery.com	Battery	N/A	1	$19.99	$19.99	http://www.all-bat	Power Supply	
Microchip Technol	MIC5219-3.3YM5-TR	http://ww1.m	Digi-Key	Voltage Regulator	576-1281-1-ND	1	$0.92	$0.92	http://www.digike	Voltage Regulation	
Infineon Technolo	IRLML6244TRPBF	http://www.ir	Digi-Key	N-Channel MOSFET	IRLML6244TRPBFCT-ND	5	$0.36	$1.80	http://www.digike	Motor Control	
Murata Electronics	CSTCE8M00G55-R0	http://www.m	Digi-Key	Ceramic Resonator	490-1195-1-ND	1	$0.46	$0.46	http://www.digike	MCU Timing Contro	
Microchip Technol	ATMEGA328P-AUR	http://www.a	Digi-Key	Microcontroller	ATMEGA328P-AURCT-ND	1	$3.81	$3.81	http://www.digike	Microcontroller	
Parasonic Electro	DB2W40300L	http://www.s	Digi-Key	Diode	DB2W40300LCT-ND	4	$0.55	$2.20	http://www.digike	Motor Control	
Bourns Inc	CR0603-FX-1002GLF	http://www.b	Digi-Key	Resistor 10kΩ	CR0603-FX-1002GLFCT-ND	6	$0.10	$0.60	http://www.digike	Motor Control	
Bourns Inc	CR0603-JW-221GLF	http://www.b	Digi-Key	Resistor 220Ω	CR0603-JW-221GLFCT-ND	3	$0.10	$0.30	http://www.digike	LED Circuit	
Bourns Inc	CR0603-JW-183ELF	http://www.b	Digi-Key	Resistor 18kΩ	CR0603-JW-183ELFCT-ND	1	$0.10	$0.10	http://www.digike	Voltage Divider	
Yageo	CC0603ZRY5V9BB104	http://www.y	Digi-Key	Capacitor 100nF	311-1343-1-ND	5	$0.10	$0.50	http://www.digike	Decoupling Capacit	
Yageo	CC0603KRX7R7BB105	http://www.y	Digi-Key	Capacitor 1uF	311-1446-1-ND	2	$0.10	$0.20	http://www.digike	For Voltage Regulat	
Yageo	CC0603MRX5R5BB106	http://www.y	Digi-Key	Capacitor 10uF	311-1448-1-ND	1	$0.21	$0.21	http://www.digike	For Antenna	
KEMET	C1210C107M9PACTU	http://www.k	Digi-Key	Capacitor 100uF	399-4697-1-ND	4	$1.06	$4.24	http://www.digike	Smooth out motor transient	
RAFI USA	1.14001.5030000	http://media.	Digi-Key	Switch	1715-1032-1-ND	1	$2.34	$2.34	http://www.digike	Reset Button	
Invensense	MPU-6050	https://store.	Invensense Onlir	Gyroscope	MPU-6050	1	$5.45	$5.45	https://store.inve	Measure acceleration, angul	
Nordic Semicondu	nRF24L01	https://www.s	GearBest	Radio Module	nRF24L01	2	$0.93	$1.86	http://www.gearb	Wireless Communication	
								$150.62			

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Project Management

Task	Owner	Status	Notes
Camera Streaming Configuration	*Likai*		
Chassis Building	*Kevin* *Likai* *Jerry*		
Circuit Soldering	*Likai*		
Coding and Adjustment	Kevin *Jerry*		
Waterproof Coating	Kevin		
Underwater Testing	*Kevin* *Likai* *Jerry*		
Air-to-water Landing Test	*Kevin* *Likai* *Jerry*		

Timeline & Milestones

Time	Status	Metrics
Week 1-4		Quadcopter fully functional in air
Week 4-7		Waterproof implementation & Underwater Control finished
Week 7-10		Testing

Potential Challenges

- No previous experiences with Machining and knowledge about UCLA Machine resources
- Figure out right PID parameters for controlling quadcopter
- Weight tradeoff
- Transitions:
  - Air to water
  - Water to air
- How to achieve motion underwater
- Testing
  - How to test robot underwater
  - What if electronics damaged by water leakage

One more thing...

Concern: 2.4GHz Microwave tended to be absorbed really well by water

- Solution 1:
  - Stay with wireless and test out the functional depth of quadcopter underwater
- Solution 2:
  - Use waterproof wire for Raspberry Pi and Motor Control
- Solution 3:
  - Only goes into shallow water for stable connection
- Solution 4:
  - Install antenna stick out of water surface for signal transmission

Expected Results

Design and implement a quadcopter that is able to move smoothly both in air and underwater. It can also provide stable camera stream, allowing pilot to wirelessly control quadcopter.

Questions