

# Women in Engineering Summer Engineering Academy Day

## Drone Building Project

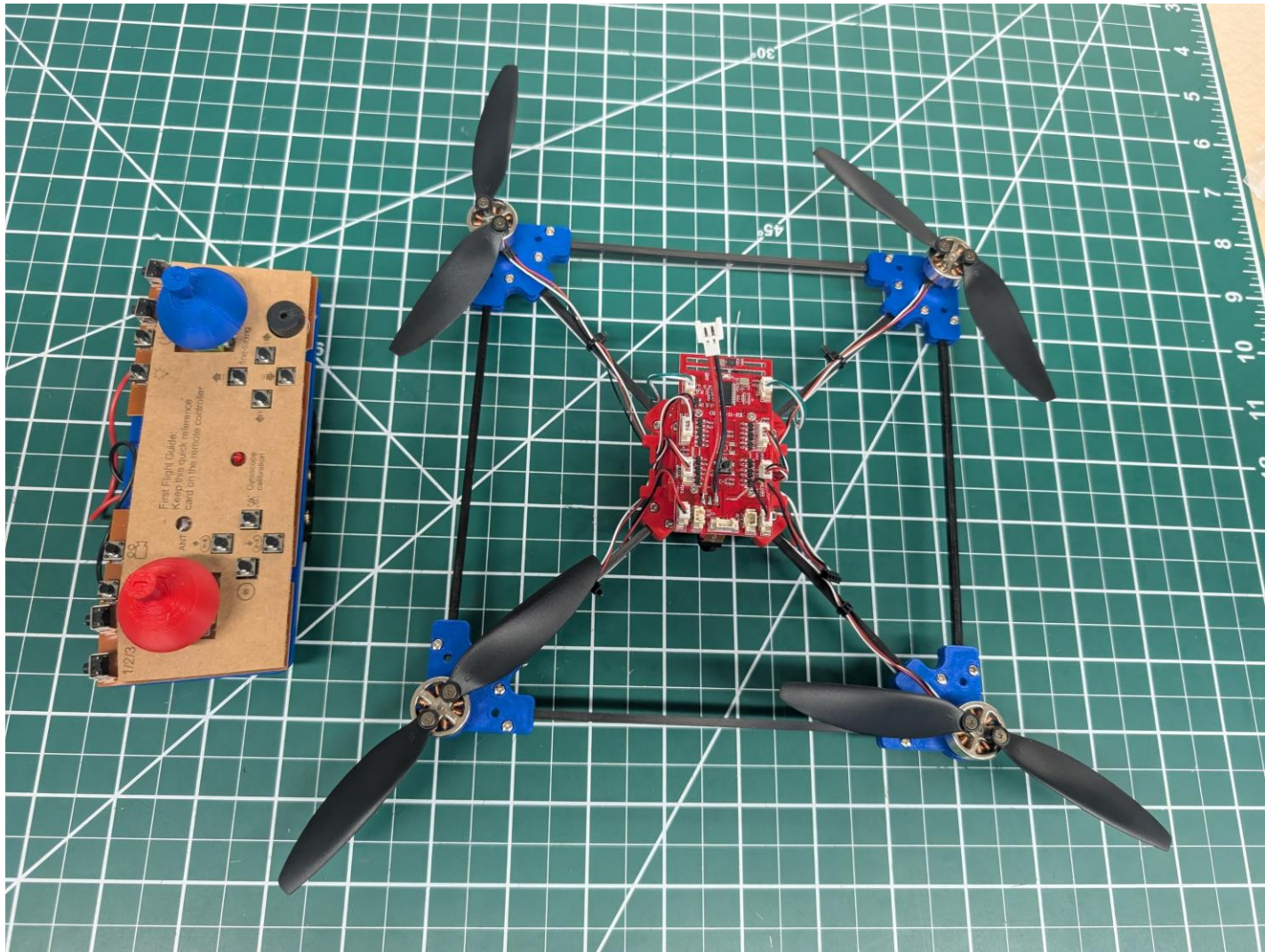
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Kamel Didan

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# We are going to build a drone



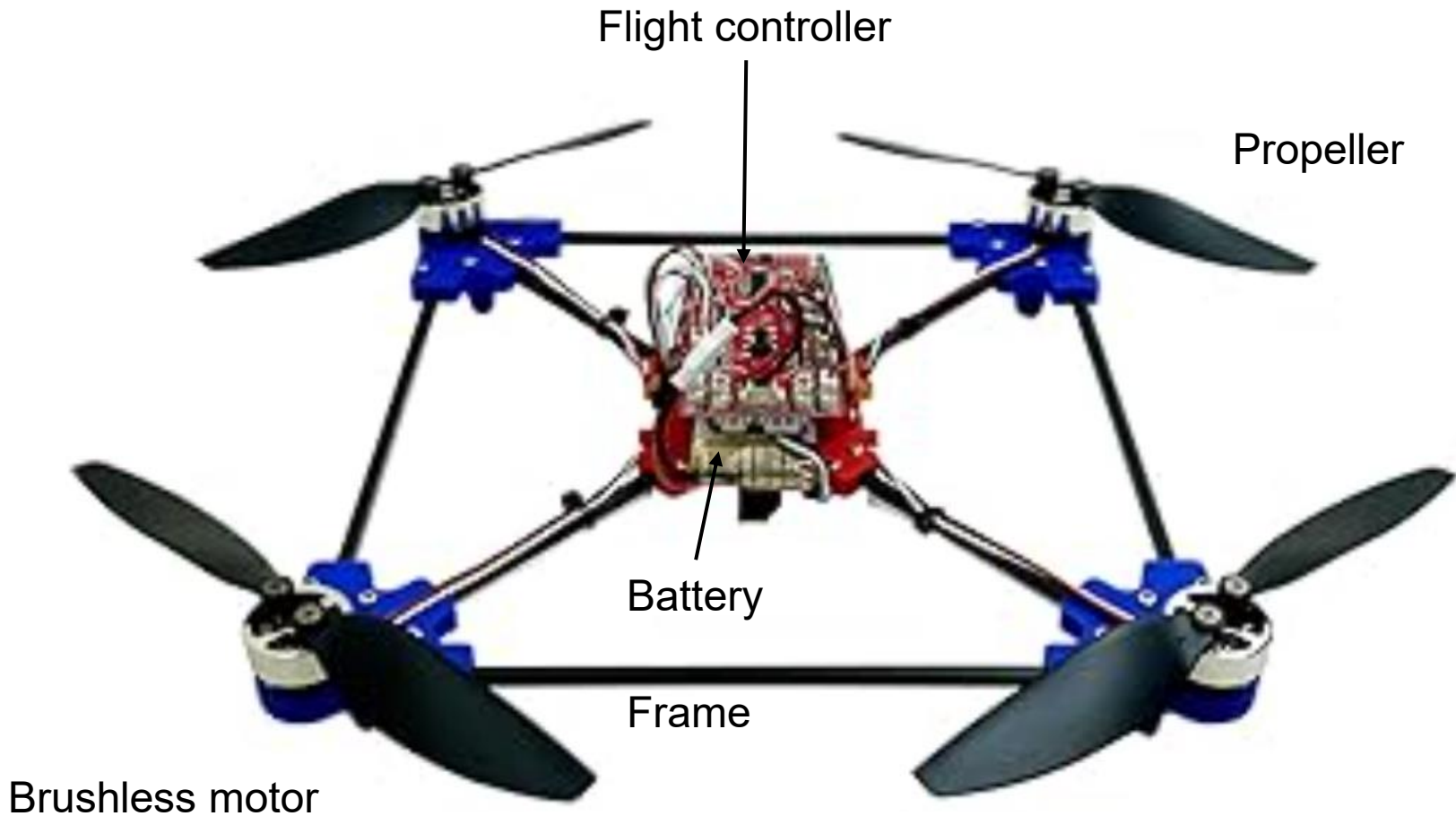
# Rules

- Small drone, no registry to FAA required
  - All drones must be registered, except those that weigh 0.55 pounds or less (less than 250 grams)
- We are not going flying a drone today
  - You need permission from the University of Arizona
- You need a pilot license
  - Similar to actual pilots of commercial planes

# Learning objectives

- We are going to learn together!
- Drone basics
- Drone parts
- Assembly process
- **Rules and security: trust but verify!**
- We teach a class BE385 – Precision observation with drones

# Drone parts



# What are Drones?

- Name derived from Honeybee “Drones”
  - Male bees with one 'mindless job' under the (supposedly) 'control' of a faraway “Queen”
- Hence Autonomous/Autopilot vehicles
- Under the control of the pilot/computer with manual intervention when needed



# Naming convention

- Unmanned Aerial Vehicles (**UAVs**)
- Unmanned Aerial Systems (**UASs**) – **FAA**
- Multirotor, Quadcopter, Quadrotor, **Drones**, etc. (Layman convention)

## Unmanned Aerial Vehicle

First Person View

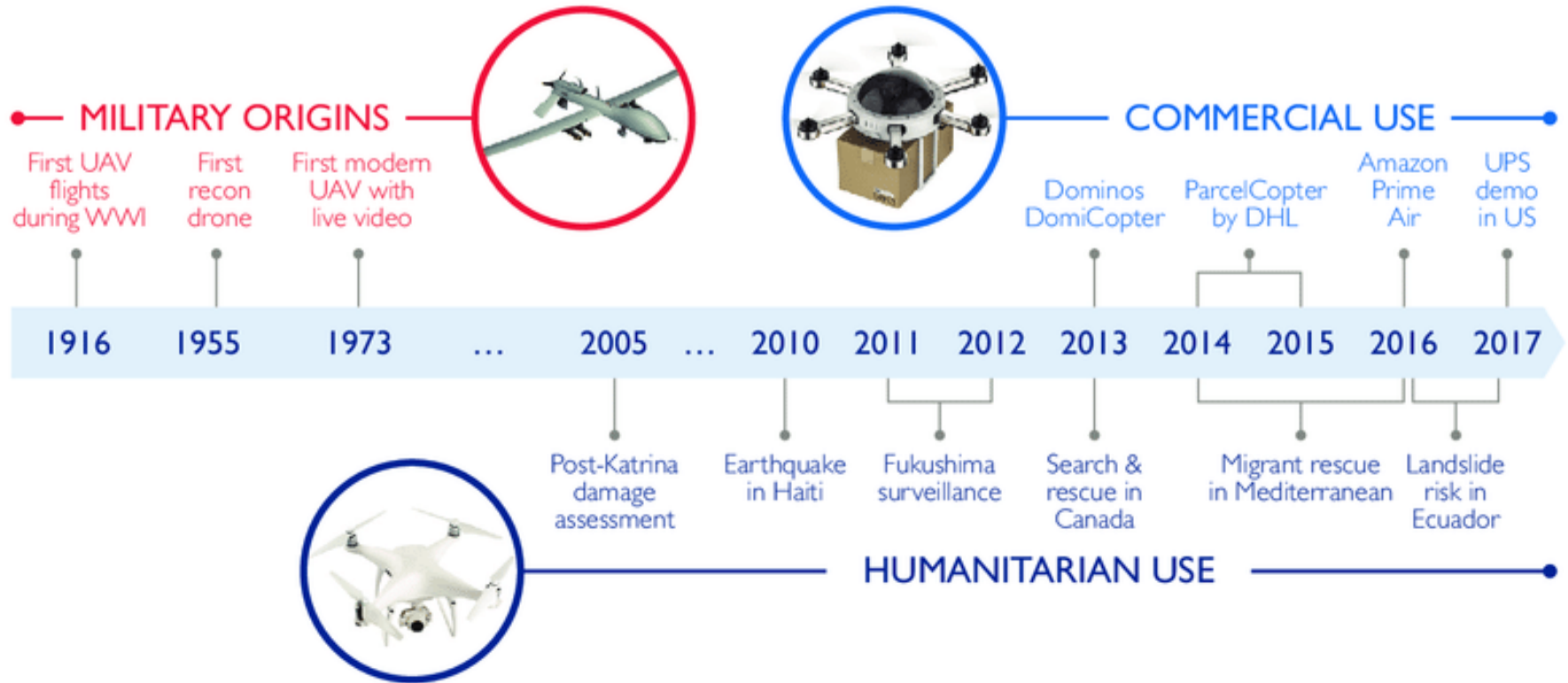
Unmanned  
Aerial System








Humming sound of  
bees, Male bee =  
Drone

Remote Pilot  
Aircraft

# Origin of drones



# Formal (academic) history

<p><b>1783</b> FRANCE</p> <p>First public demonstration of uncrewed aircraft</p> 	<p><b>1858</b> FRANCE</p> <p>First aerial photograph is taken</p> 	<p><b>1898</b> UNITED STATES</p> <p>Tesla demonstrates the first radio controlled craft</p> 
<p><b>1849</b> AUSTRIA</p> <p>Invention of the Balloon Bomb</p> 	<p><b>1896</b> SWEDEN</p> <p>First camera on an uncrewed aircraft</p> 	<p><b>1915</b> UNITED KINGDOM</p> <p>First aerial reconnaissance photos taken</p> 
<p><b>1941</b> UNITED STATES</p> <p>First radio-controlled target plane, 'The Radioplane'</p> 	<p><b>1936</b> UNITED STATES</p> <p>U.S. Drone Program begins</p> 	<p><b>1917</b> UNITED STATES</p> <p>First UAV Torpedo, 'The Bug' is invented</p> 
<p><b>1943</b> UNITED STATES</p> <p>First First-Person View semi-uncrewed aircraft</p> 	<p><b>1937</b> UNITED STATES</p> <p>First radio-controlled UAV torpedo is unveiled</p> 	<p><b>1935</b> UNITED KINGDOM</p> <p>First low-cost radio-controlled target aircraft</p> 

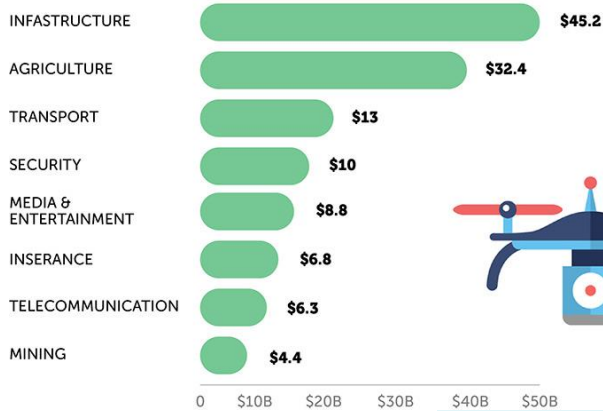
<p><b>1973</b> ISRAEL</p> <p>First UAV designed for surveillance and scouting</p> 	<p><b>1985</b> UNITED STATES</p> <p>U.S. significantly scales up drone production</p> 	<p><b>1991</b> THE GULF WAR</p> <p>First conflict utilizing UAVs at all times</p> 
<p><b>1982</b> ISRAEL</p> <p>First Battlefield uncrewed aircraft</p> 	<p><b>1986</b> ISRAEL/UNITED STATES</p> <p>The US and Israel join forces to develop 'The Pioneer'</p> 	<p><b>1996</b> UNITED STATES</p> <p>The 'Predator' drone is developed</p> 
<p><b>2014</b> WORLDWIDE</p> <p>Rapid growth in the UAV industry begins</p> 	<p><b>2013</b> CHINA</p> <p>Camera equipped UAVs enter the consumer market</p> 	<p><b>2006</b> UNITED STATES</p> <p>UAVs are first permitted in U.S. civilian airspace</p> 
<p><b>2019</b> WORLDWIDE</p> <p>First episode of the Consortiq Podcast 'Unmanned Uncovered'</p> 	<p><b>2013</b> WORLDWIDE</p> <p>Major companies investigate drone delivery</p> 	<p><b>2010</b> FRANCE</p> <p>First smartphone-controlled quadcopter</p> 

# Usage by Sector

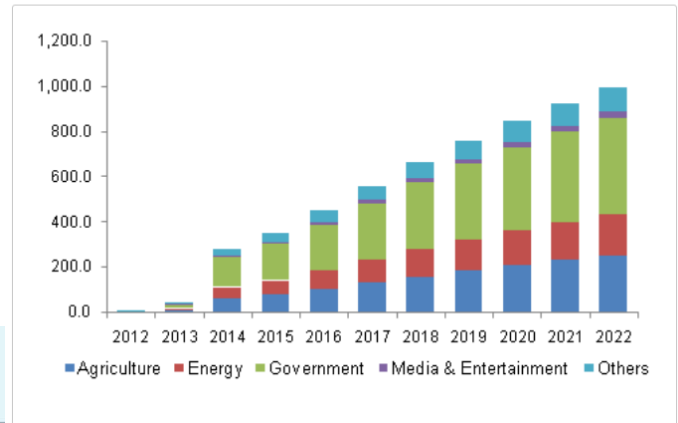
## PREDICTED VALUE OF DRONES BY INDUSTRY

Referenced from businessinsider.com in "Commercial Unmanned Aerial Vehicle (UAV) Market Analysis - Industry trends, companies and what you should know" (Joshi, August 8, 2017)

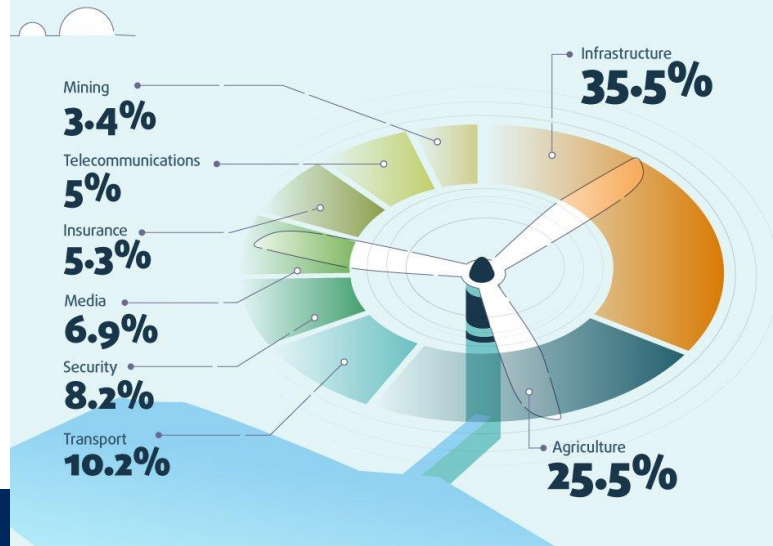
Value of business services and labor in billions



U.S. commercial UAV market size, by application, 2012-2022 (USD Million)



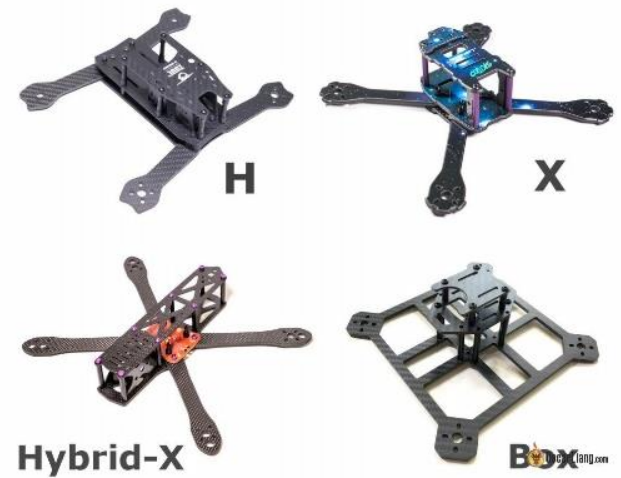
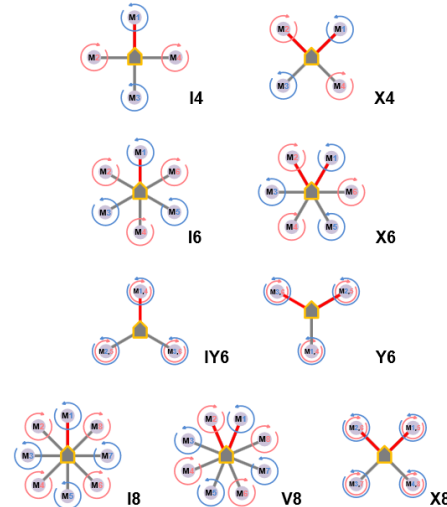
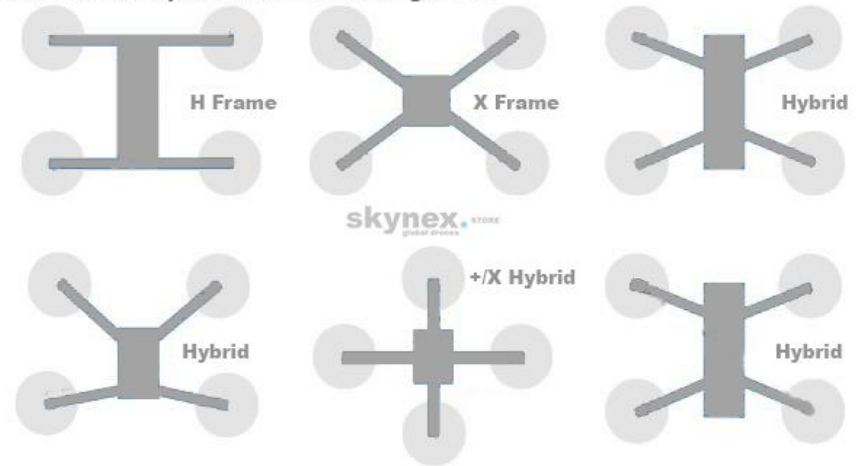
## DRONE USAGE BY INDUSTRY SECTOR



# 3 basic frame shapes

- PLUS (+)
- X
  - Stretched X and True X
- H Frame
  - Aerodynamic considerations
  - Payload
  - Size
  - Taste

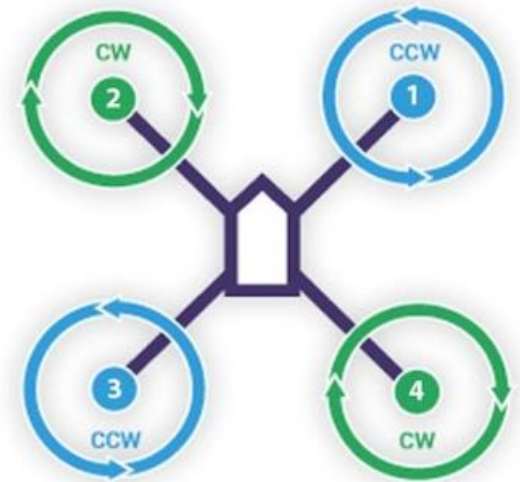
Common Quadcopter Drone Frame Configuration



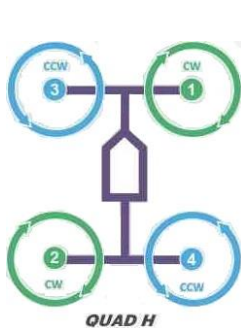
# Motor order

- Convention used to help setup the drone and couple it with the Flight Controller (FC)
- Different FCs require different order/sequence (always check FC specs)

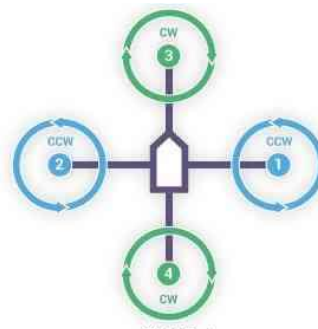
MOTOR DIRECTION  
QUAD X



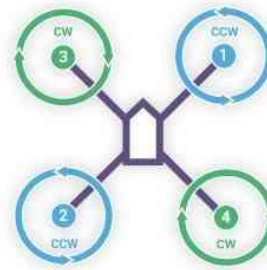
DJI PHANTOM EXAMPLE



QUAD H

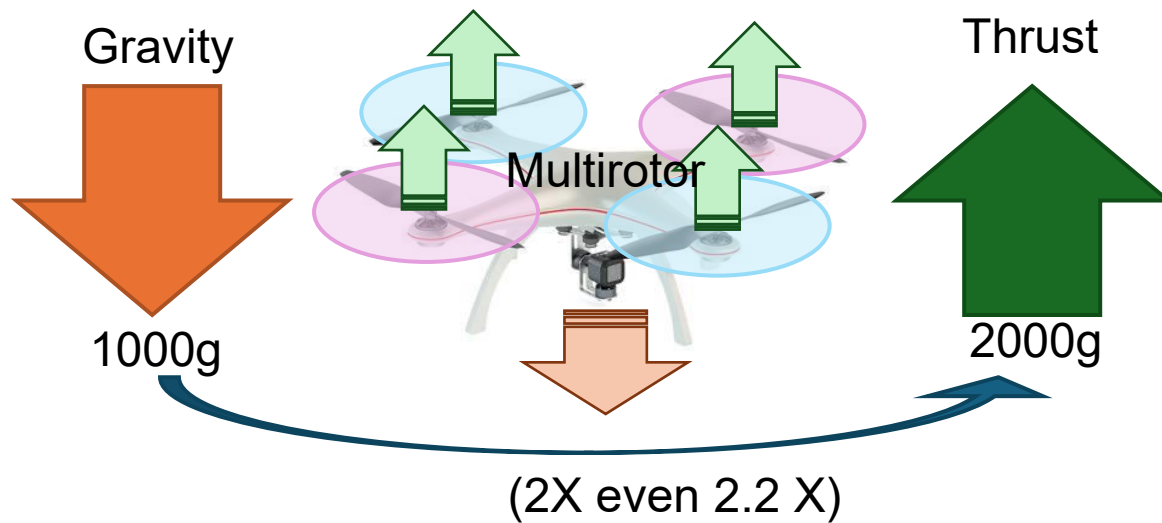


QUAD +



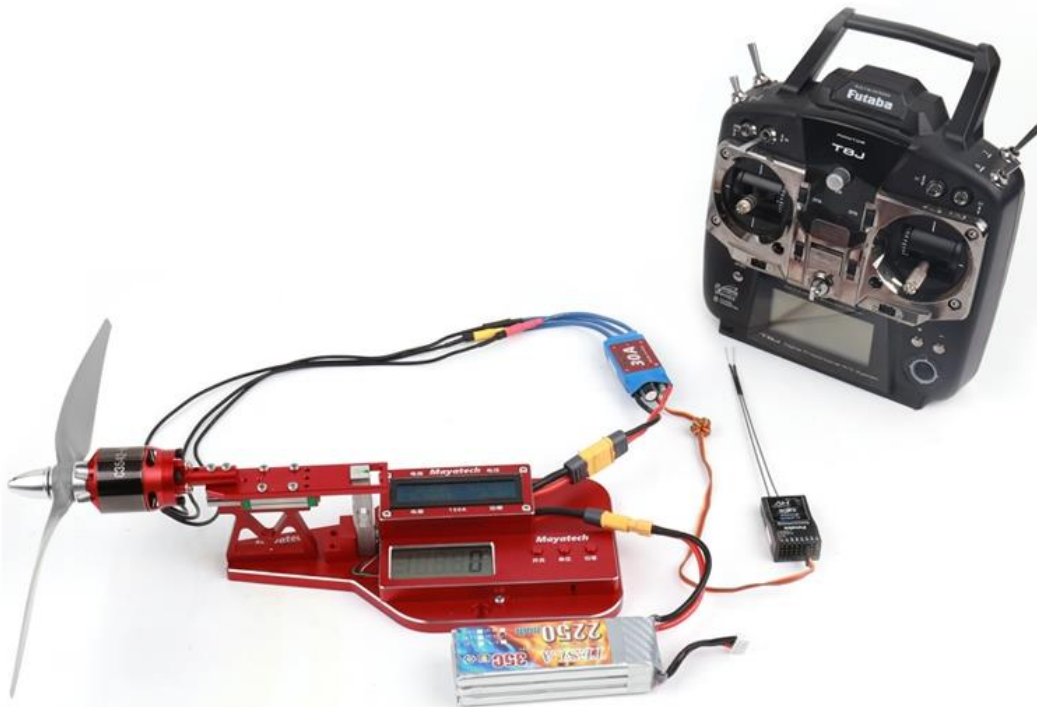
QUAD X

# Flying principle



# Thrust measurement

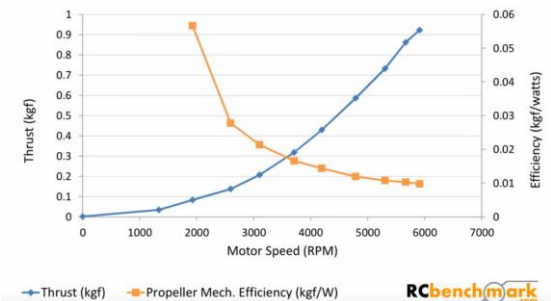
## Motor + Propeller + Battery



Engine Power and Torque Curves

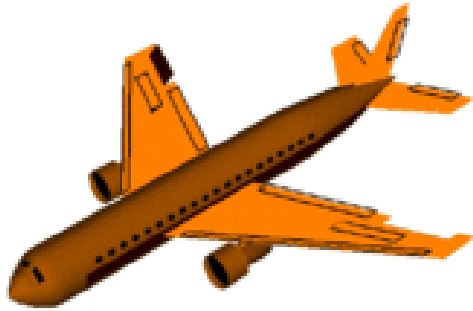


Propeller Thrust and Efficiency as a Function of Speed

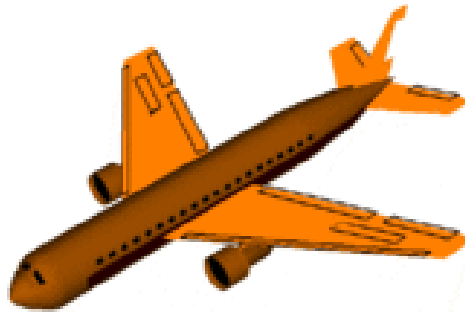
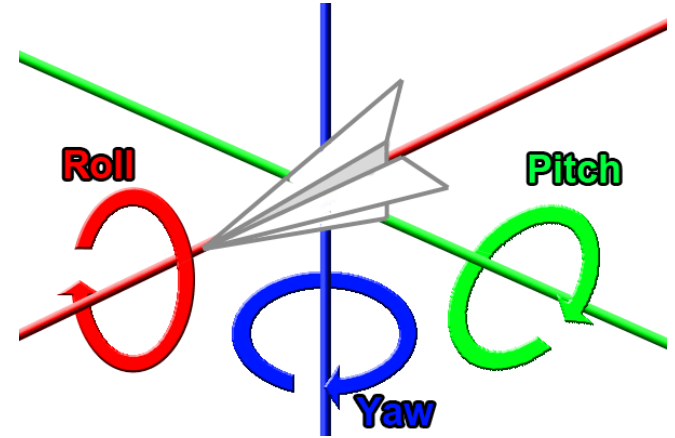


— Thrust (kgf) — Propeller Mech. Efficiency (kgf/watts)

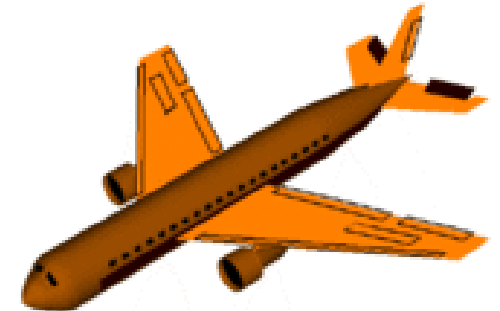
# Orientation



ROLL

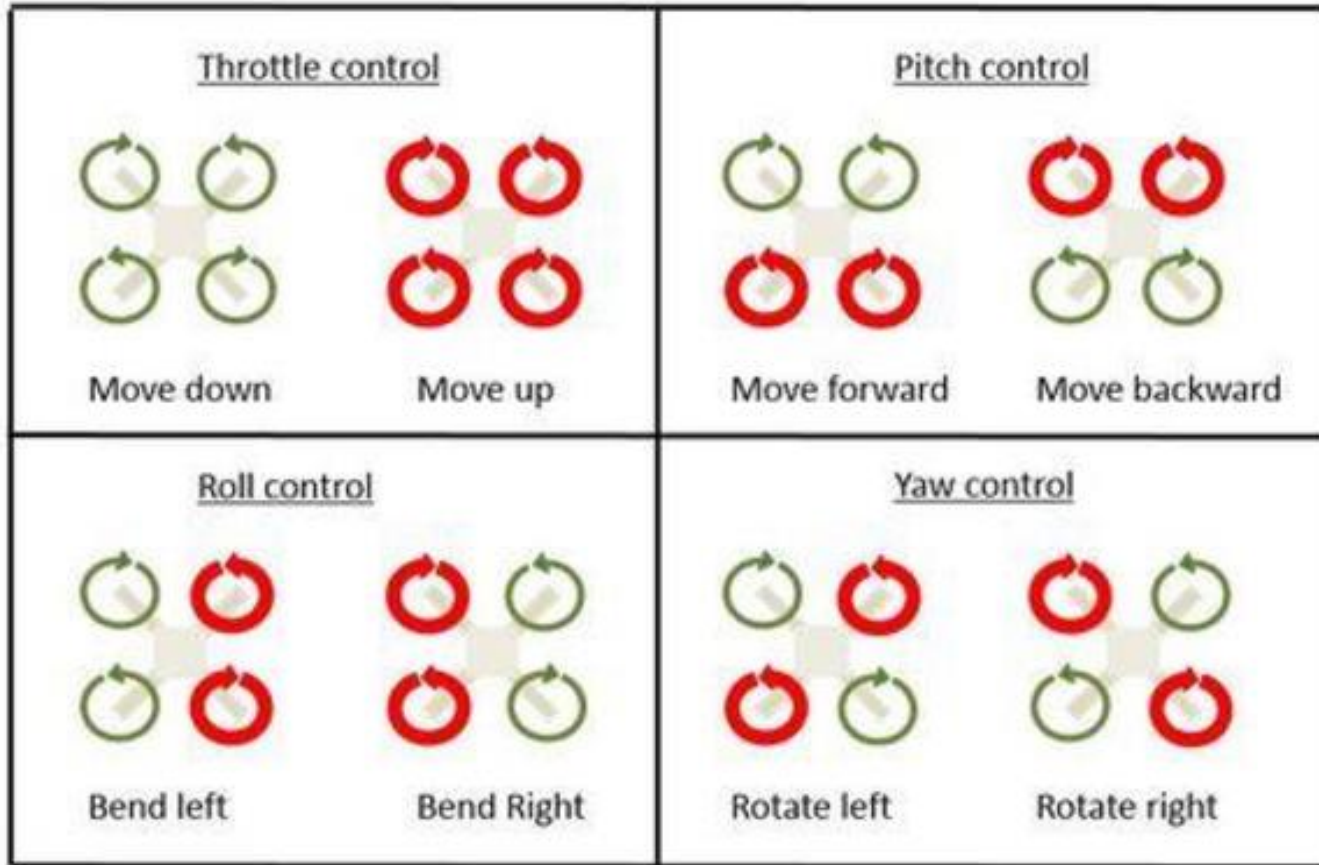




YAW



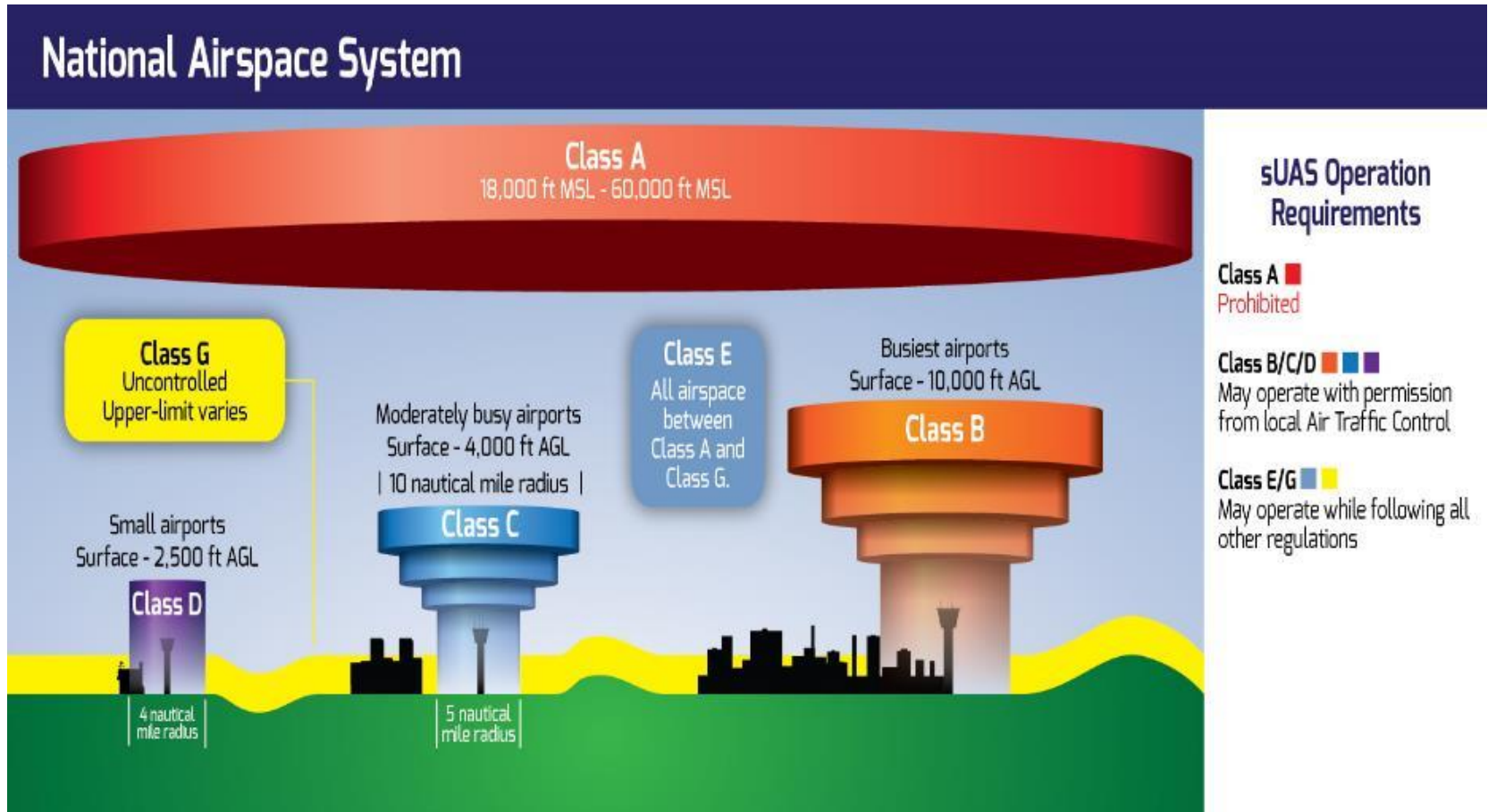
PITCH

# Quadcopter Flight Patterns



 Normal Speed  
 High Speed

# Flight restrictions



# Drone kit

WiFi video  
transmission



Frame

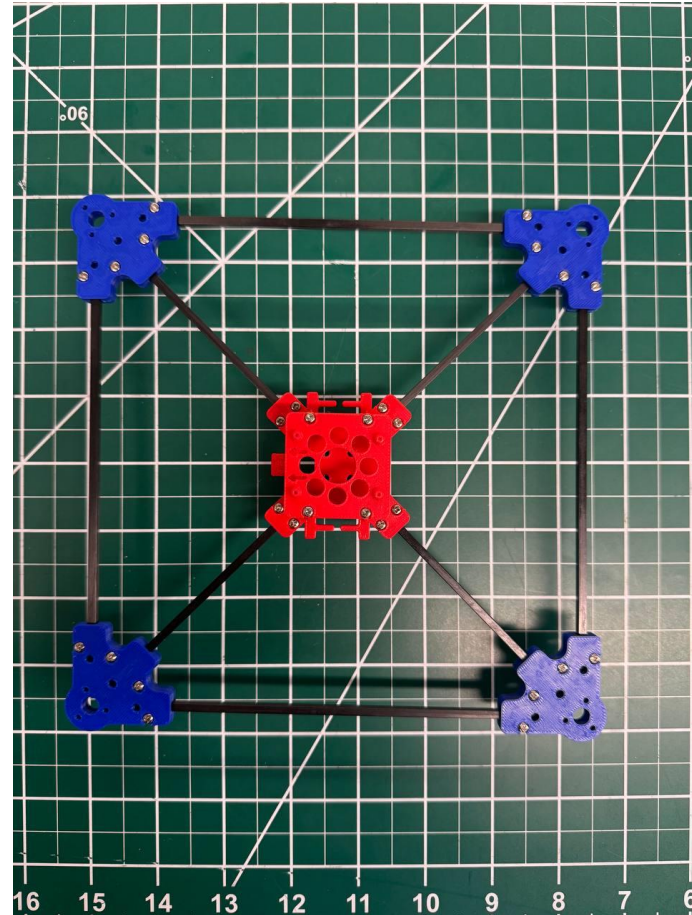
Brushless  
Motors

Flight  
controller

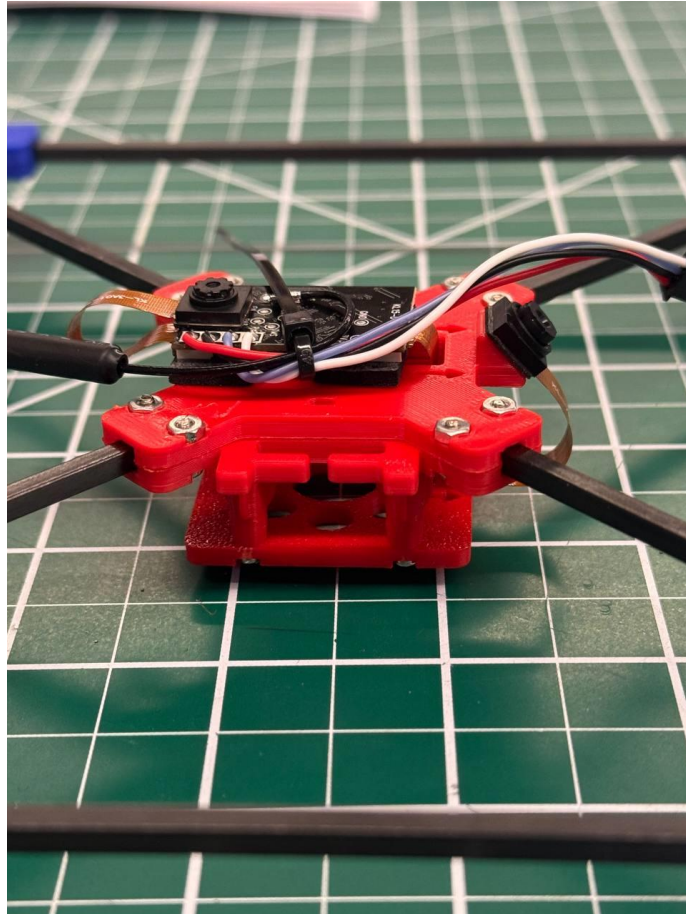
Battery

Propellers

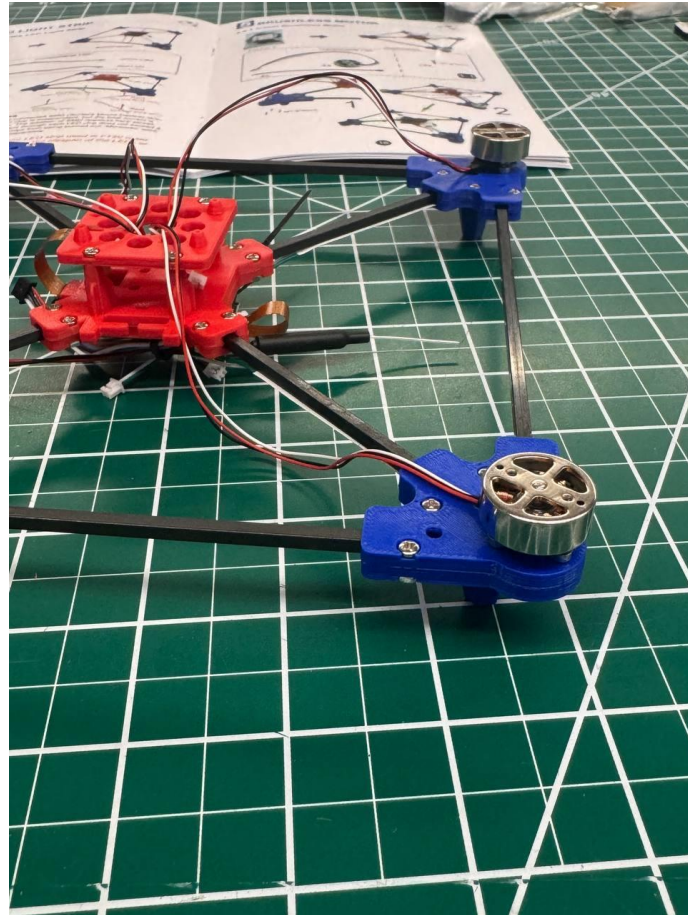
# Frame



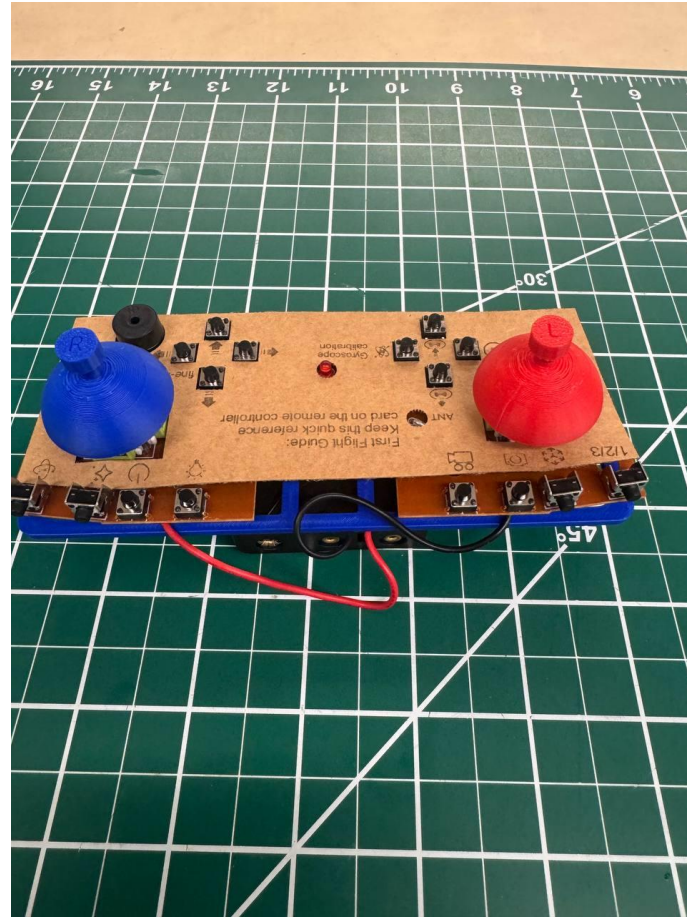
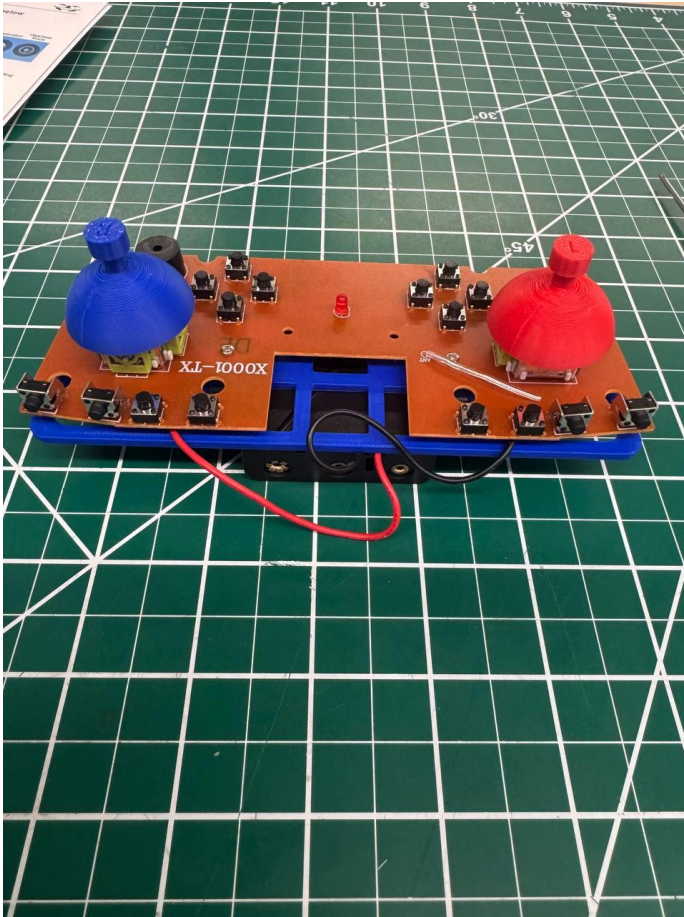
# Cameras



# Motors



# Build the radio controller



# Security

- If successful we will test inside the cages
- Wear goggles or face shields
- Please be careful of things that can be in the way of propellers, like **long hair, scarfs, necklaces**, etc.
- We will test the drone inside the cage
- Call us when you are ready

Now is your turn to  
try!