

สถาปัตยกรรมอากาศยานไร้คนขับ และหลักอากาศพลศาสตร์พื้นฐาน

UAV Architecture & Aerodynamics of Drone

19 September 2026 @ Tassana Garden



วิทยากร : คุณท๊อป | T Maker





AGENDA

UAV Architecture

- What is a UAV ?
- Type of UAV
- Quadcopter

Principles of Drone

- Drone Dynamics
- Communication System
- Flight controller
- Flight Control Loop
- PID Control

Assembly & Setup

- SimpleFly Learning Kit
- Firmware Installation
- Setup & Calibration
- Tuning
- Manual Control



What is a UAV ?

A UAV stands for Unmanned Aerial Vehicle. It's essentially an aircraft that flies **without a human pilot on board**. UAVs are controlled either remotely by a person (via radio signals, computers, or controllers) or autonomously using pre-programmed flight plans and onboard sensors.



Source: wikipedia.org/wiki/Unmanned_aerial_vehicle



Type of UAV



Fixed wing



Source: [U.S. Air Force website](#)

Single rotor



Source: [velos-rotors.com](#)

Bicopter



Source: [www.d-botix.com](#)



Type of UAV



Tricopter



Source:
[www.britannica.com/technology/
unmanned-aerial-vehicle](http://www.britannica.com/technology/unmanned-aerial-vehicle)

Quadcopter



Source: www.t-drones.com

Hexacopter



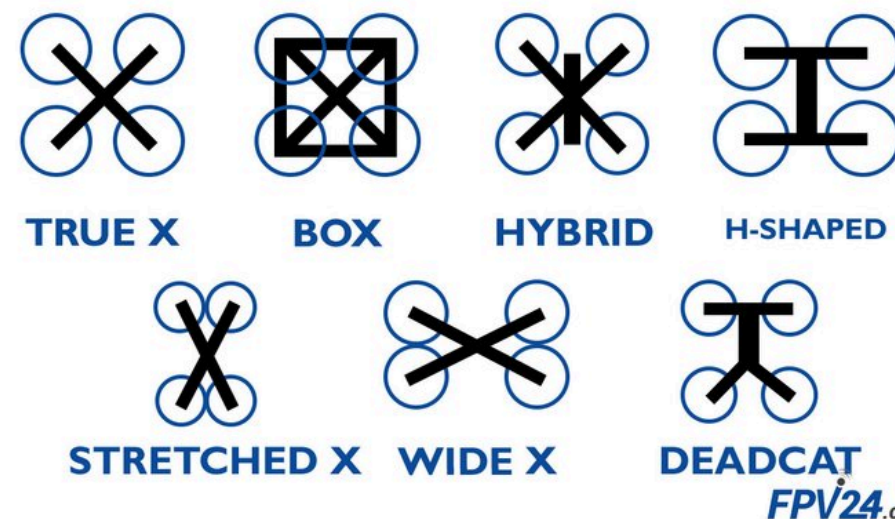
Source: www.viewprouav.com



Quadcopter

The quadcopter became the standard because it balances torque with four fixed motors alone — no complex mechanics. This makes it stable, affordable, and easy to fly, from toys to professional drones

COMMON FPV FRAME SHAPES

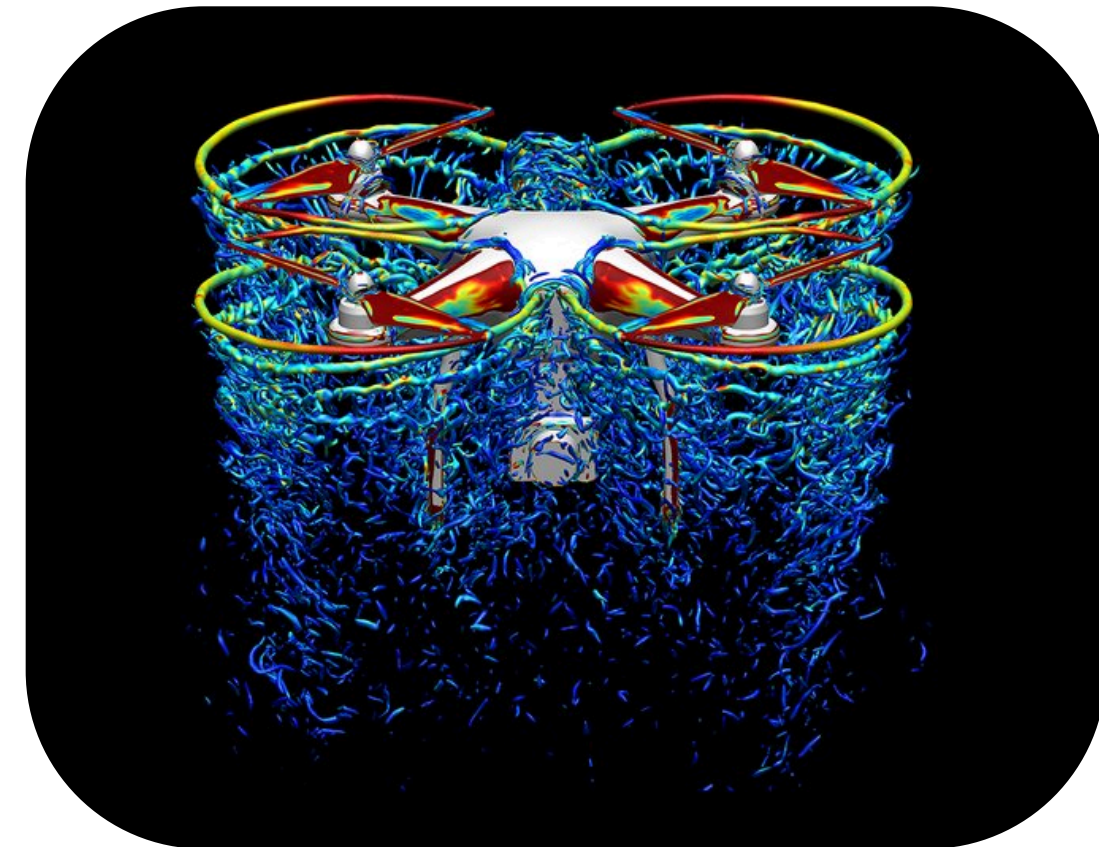


Source: www.fpv24.com



Drone Dynamics

- How Drones Generate Lift
- Forces and Torques
- Frames of Reference
- Degrees of Freedom (DOF)



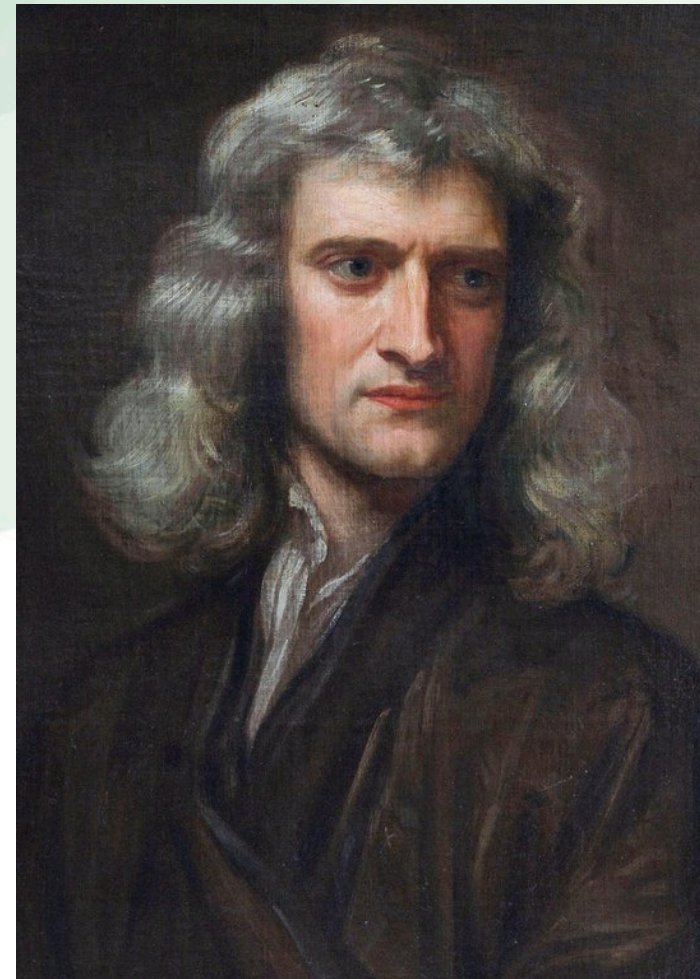
Source: www.nas.nasa.gov/SC17/demos/demo5.html



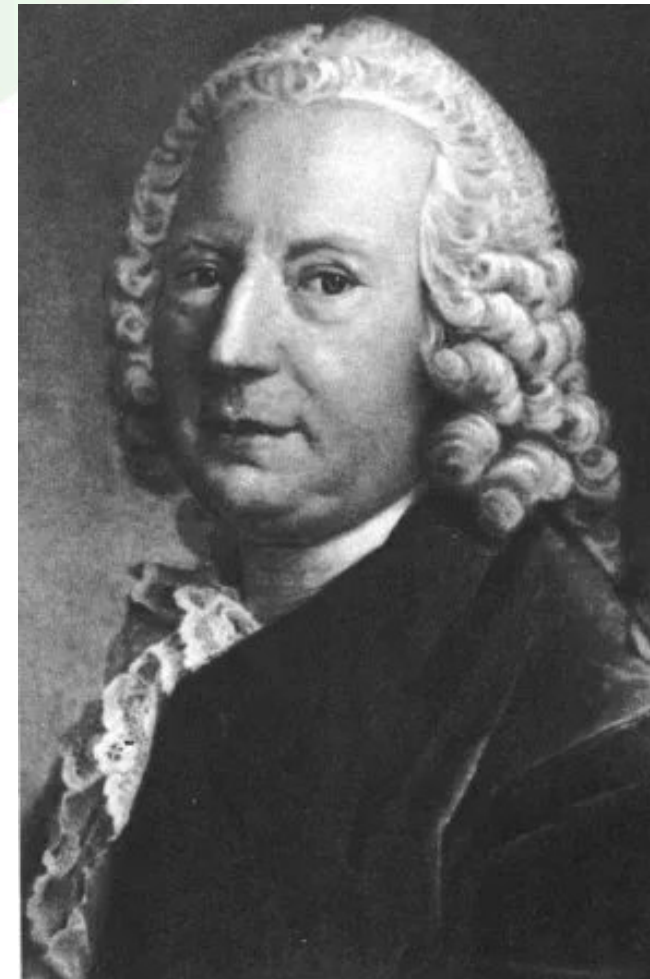
How Drones Generate Lift



$$L = \dot{m} \cdot \Delta v_y = \dot{m} \cdot w_{\text{downwash}}$$



Isaac Newton

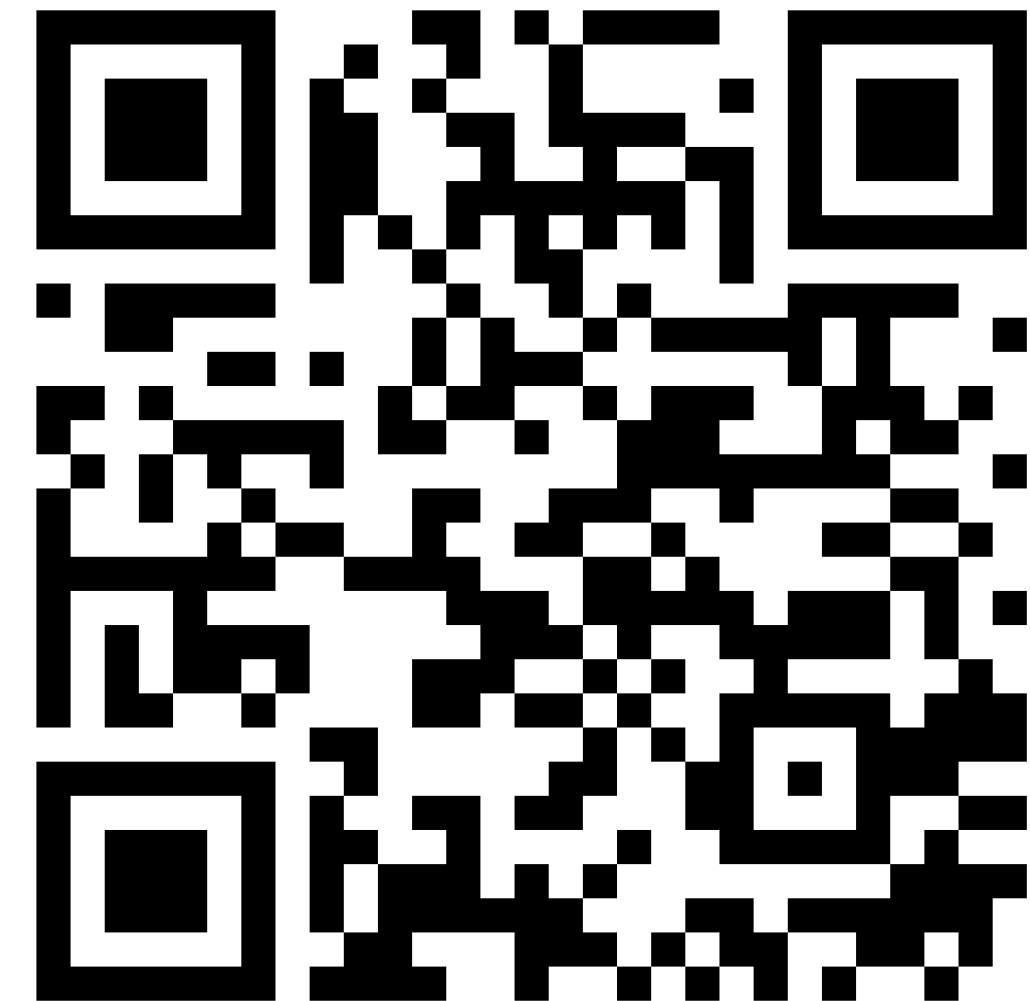
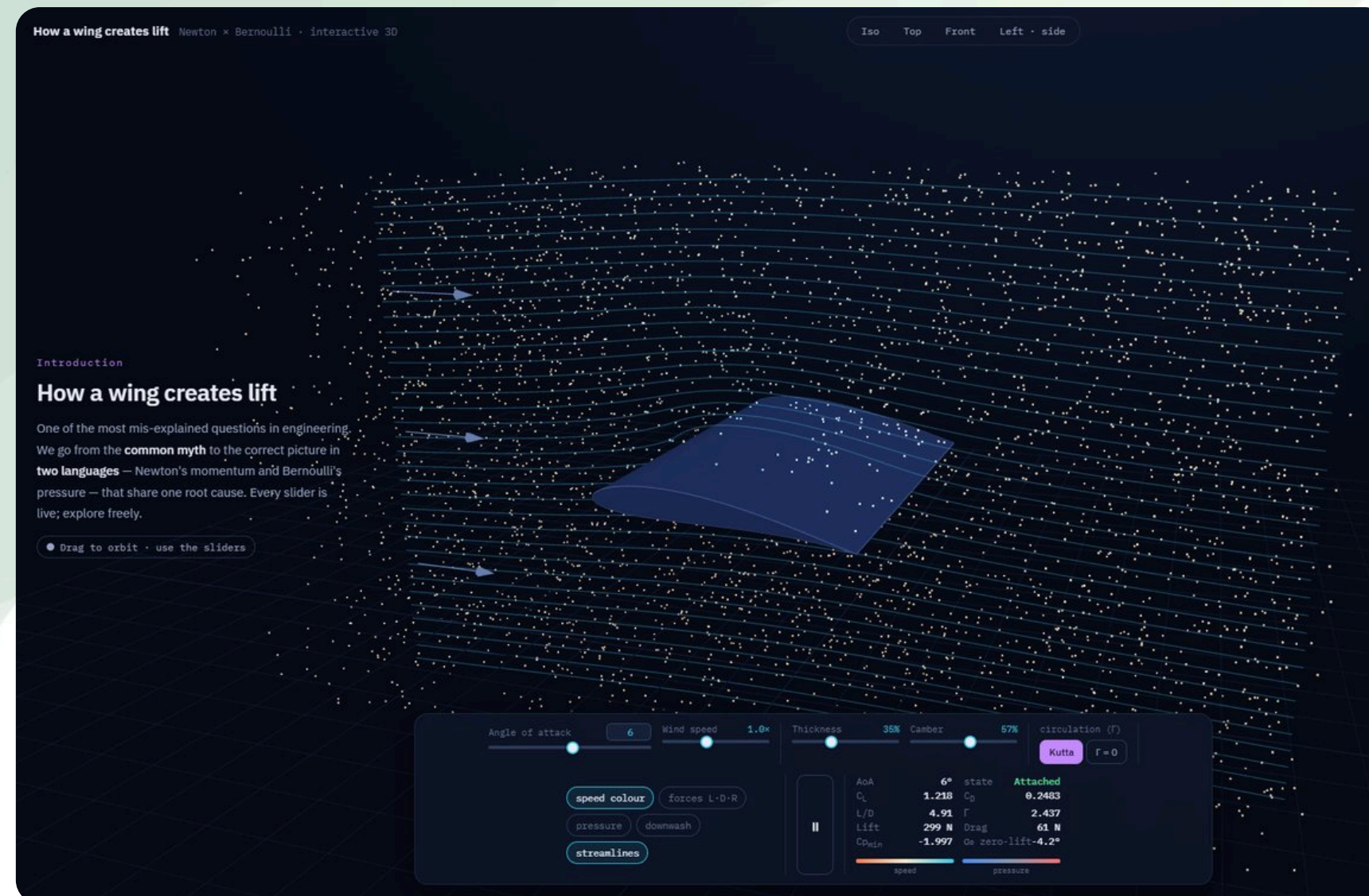


Daniel Bernoulli

$$p + \frac{1}{2}\rho v^2 = p_{\infty} + \frac{1}{2}\rho V_{\infty}^2 = \text{constant}$$



How Drones Generate Lift

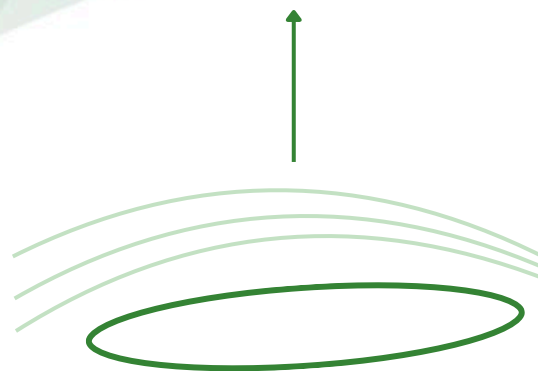




Force & Torque

Thrust

- Lift



Drag

- aerodynamic drag



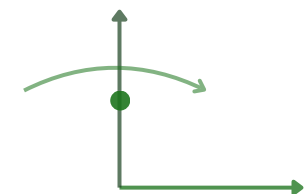
Gravity

- Weight

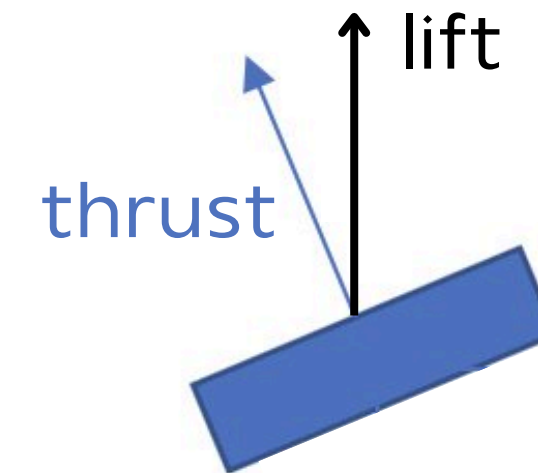
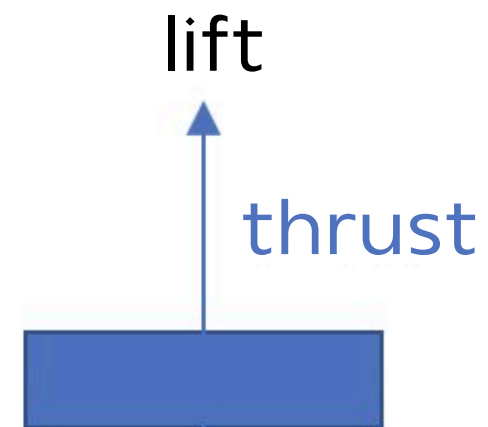
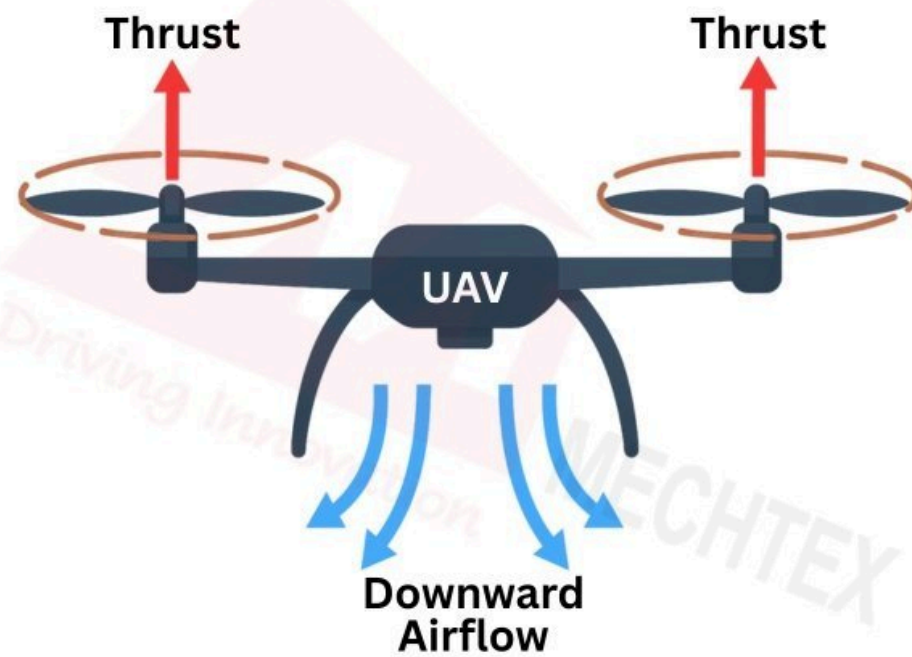


Torque

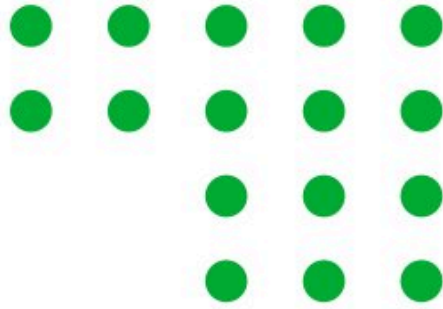
- Roll , pitch , yaw



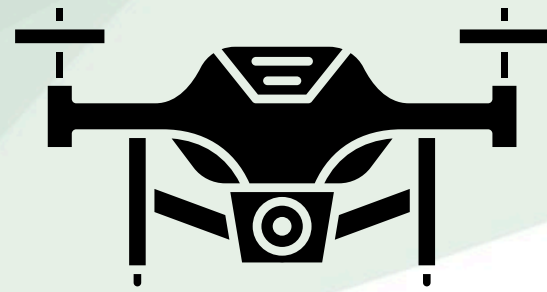
Lift Force



$$L = T \cdot \cos\phi \cdot \cos\theta$$



Weight



W

$$W = m \cdot g$$

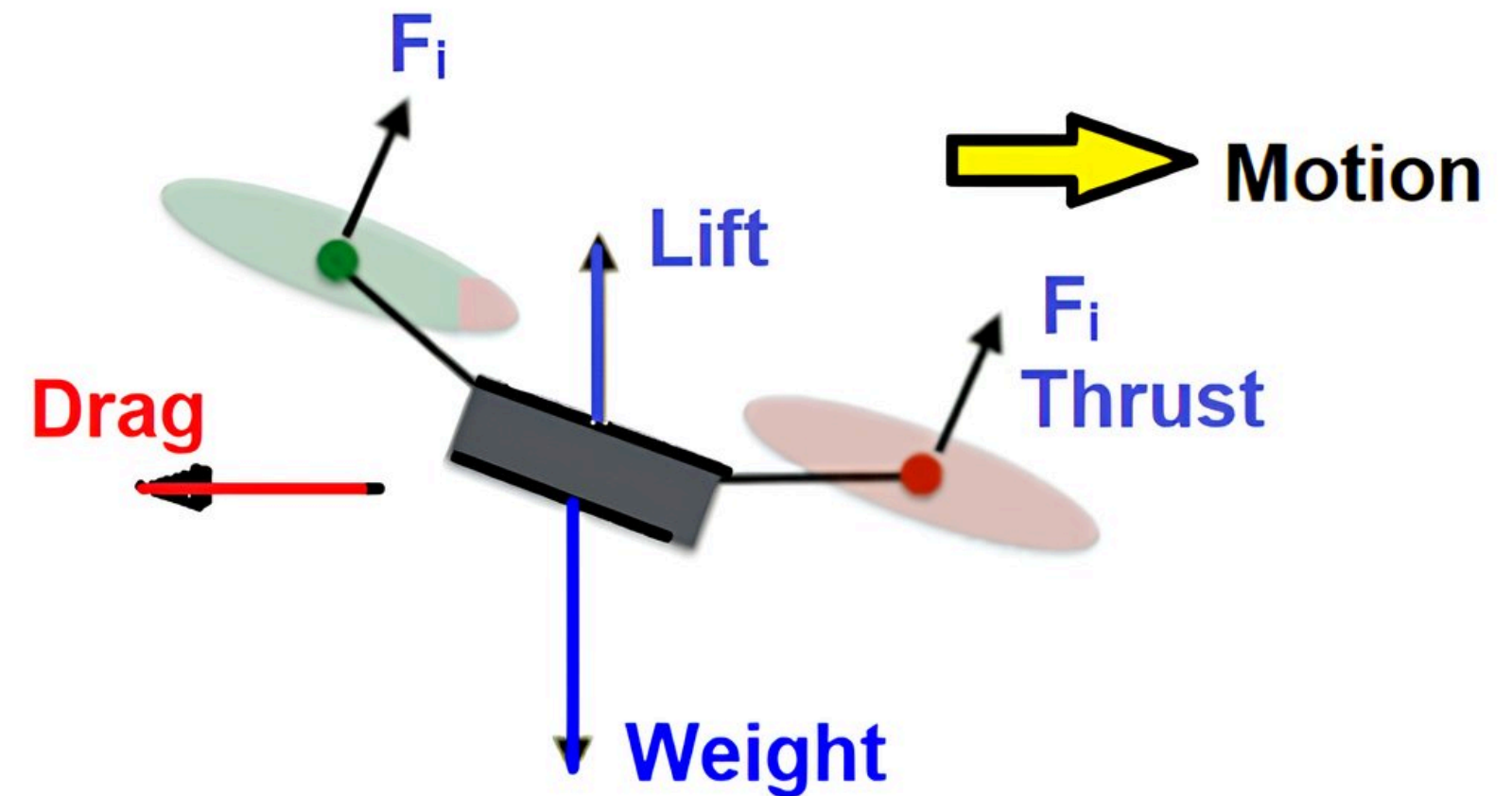


W



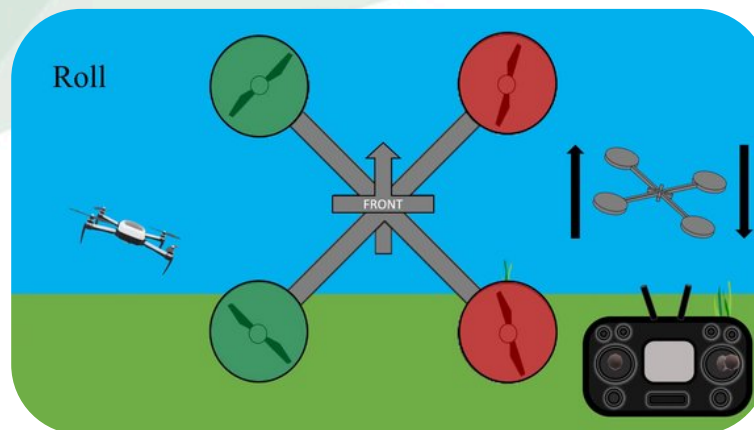
Drag force

$$F_D = \frac{1}{2} \rho v^2 C_D A$$

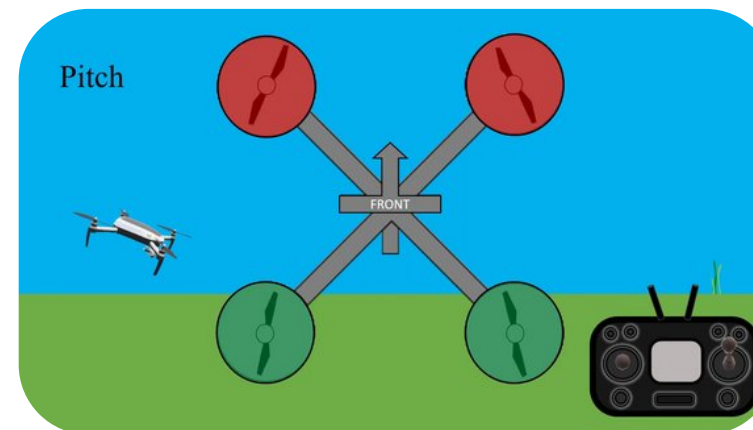


Torque

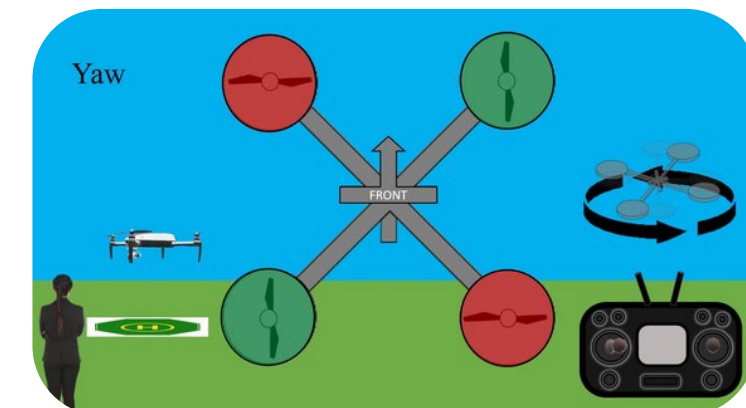
Roll Torque
(φ -X axis)



Pitch Torque
(θ -Y axis)

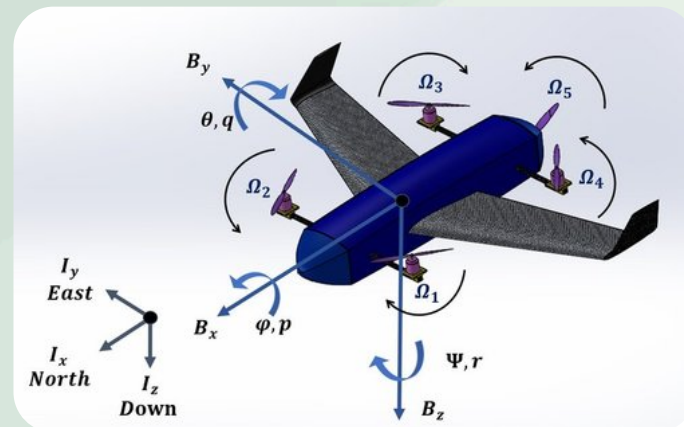


Yaw Torque
(ψ -Z axis)



Frames of Reference

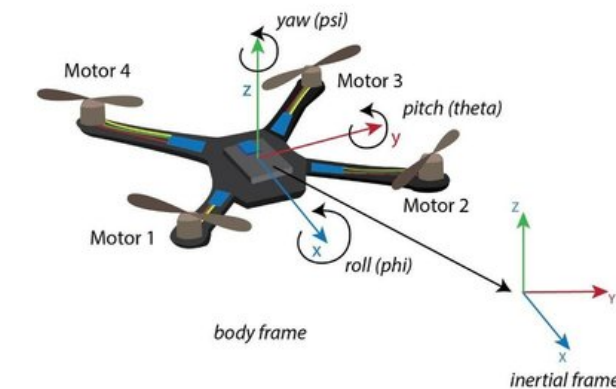
Inertial/Fixed Frame



Source: www.researchgate.net

Origin: launch location (on the Earth's surface).
Axes: fixed relative to Earth at that point in time (north-east-down, or some ENU/NED convention).
Use: good for describing trajectories in a "global" sense.

Body Frame



Source: www.researchgate.net

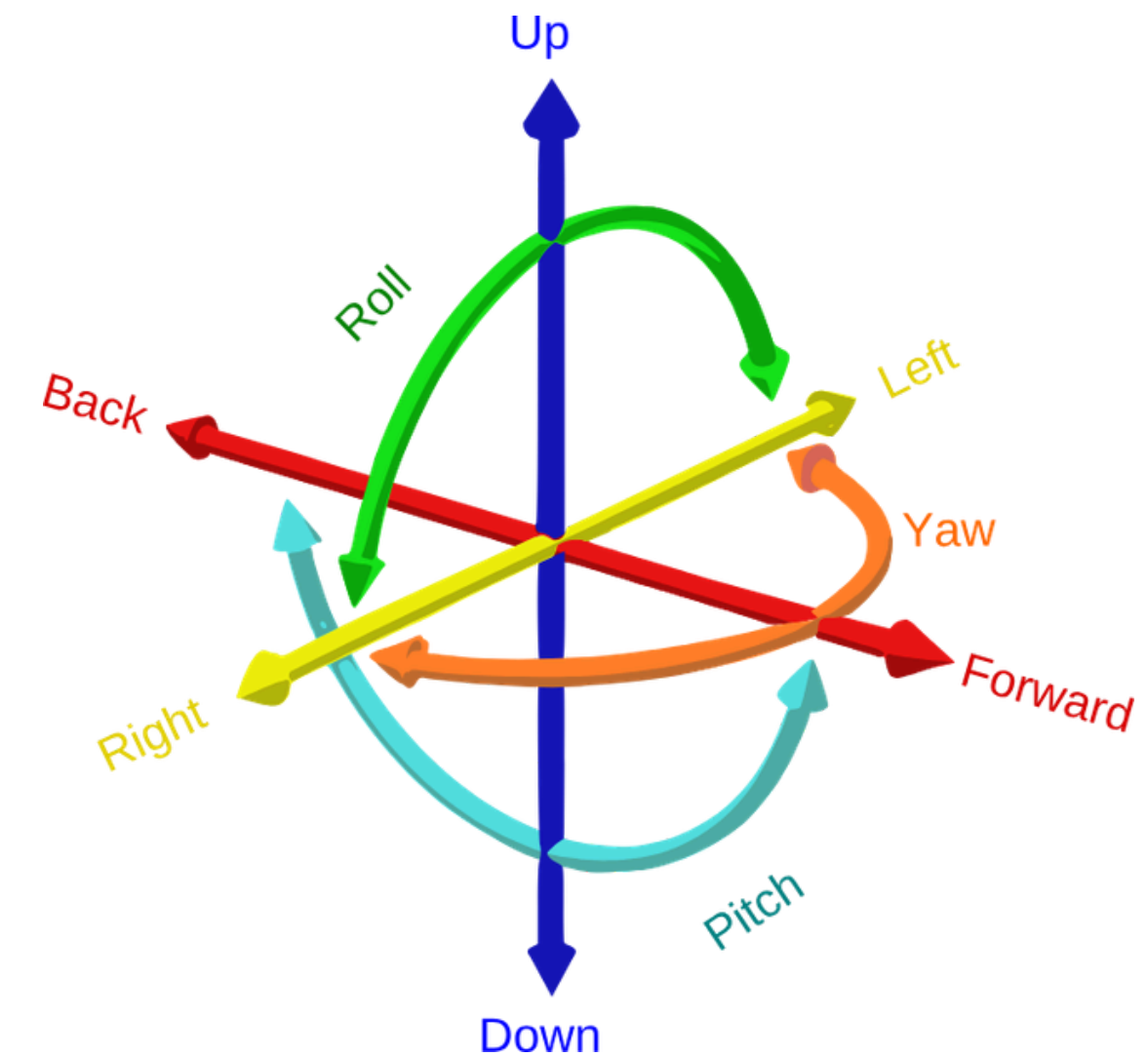
Origin: the vehicle's center of gravity (CoG).
Axes: aligned with the actual vehicle geometry — typically x forward, y right, z down (aircraft convention) or z up (spacecraft sometimes).
Use: sensors (IMU, gyros, accelerometers) and control forces naturally live here.



Degrees of Freedom (DOF)

6 DOF

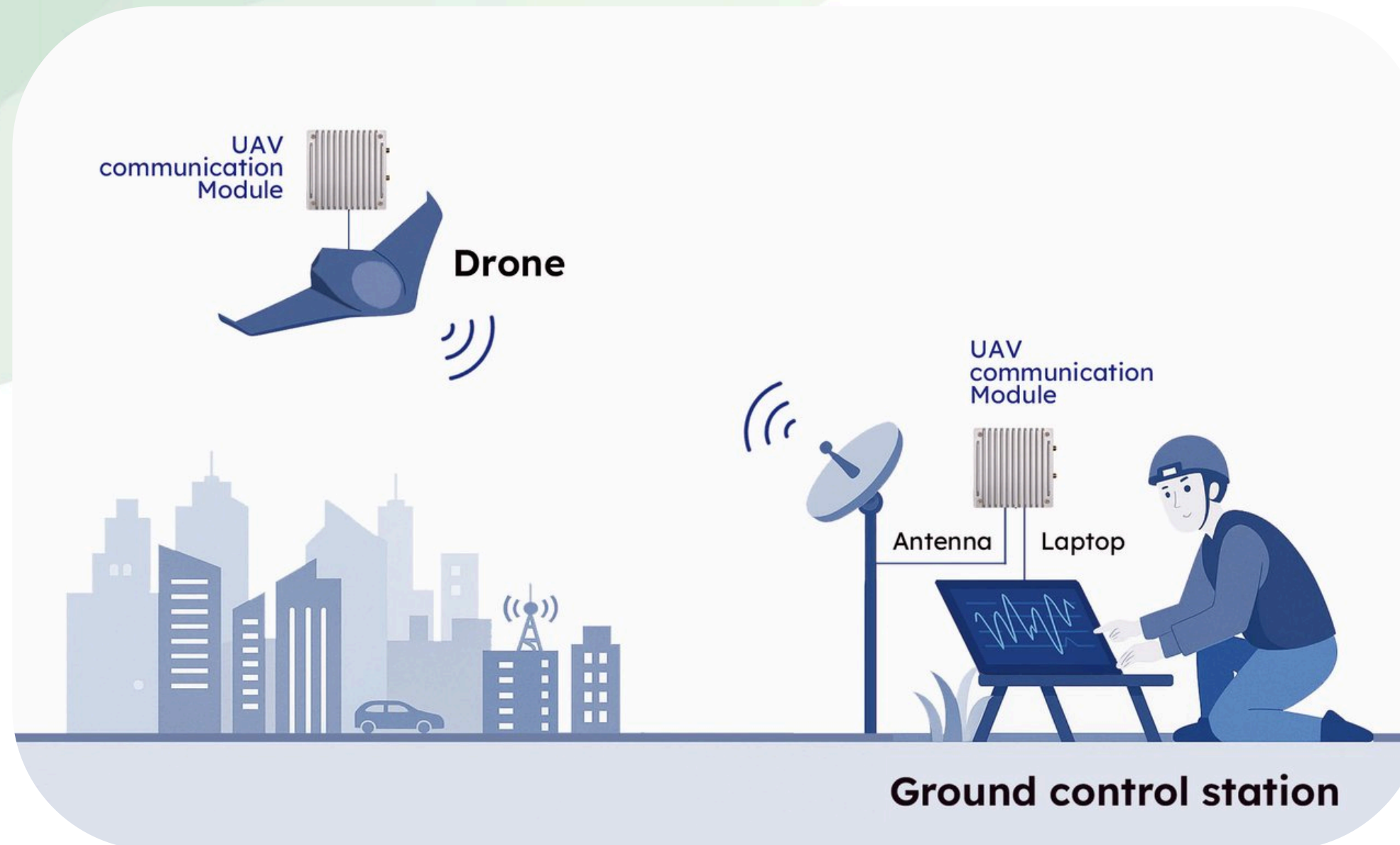
- Translational : x, y, z
- Rotational : roll (ϕ), pitch (θ), yaw (ψ)



Source: en.wikipedia.org



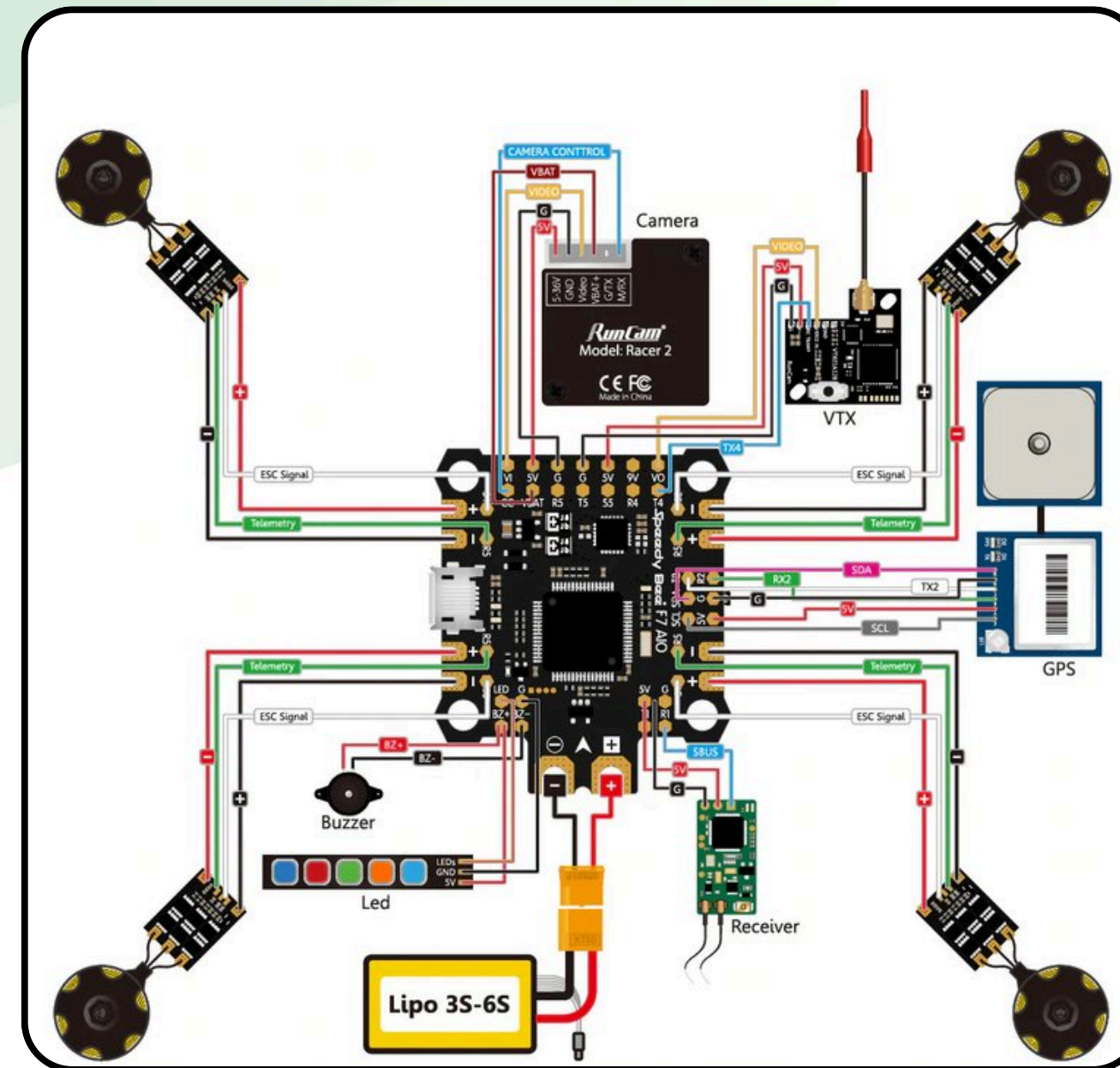
Communication System



Source : <https://cfdflowengineering>

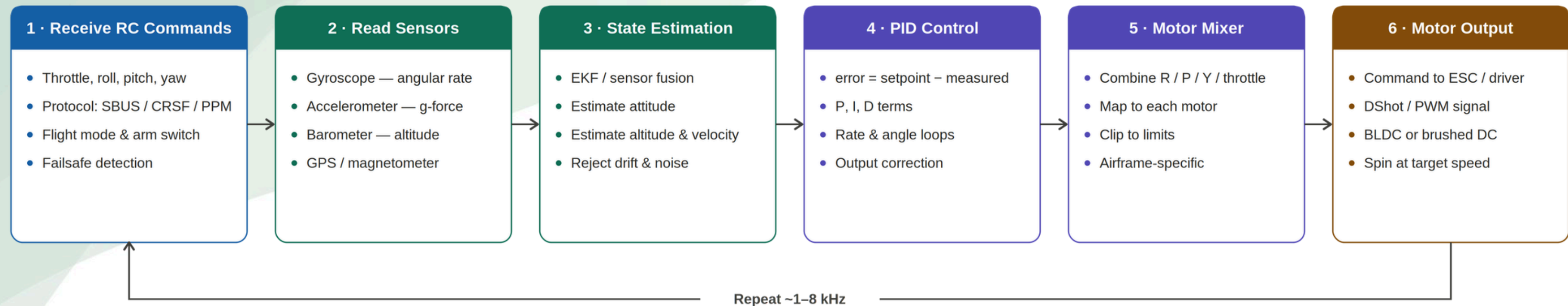


Flight Controller

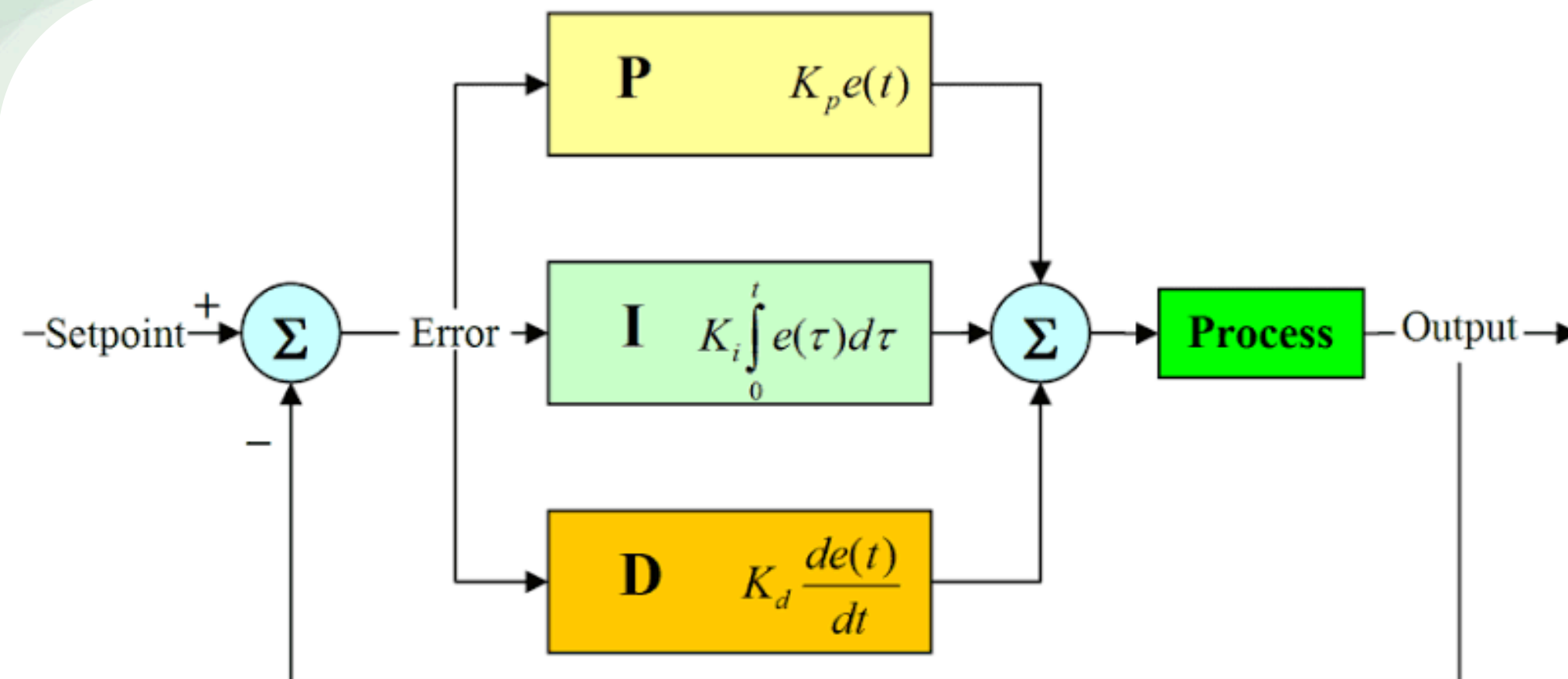


Source : <https://dronewolf.darkwolf.io/>

Flight Control Loop



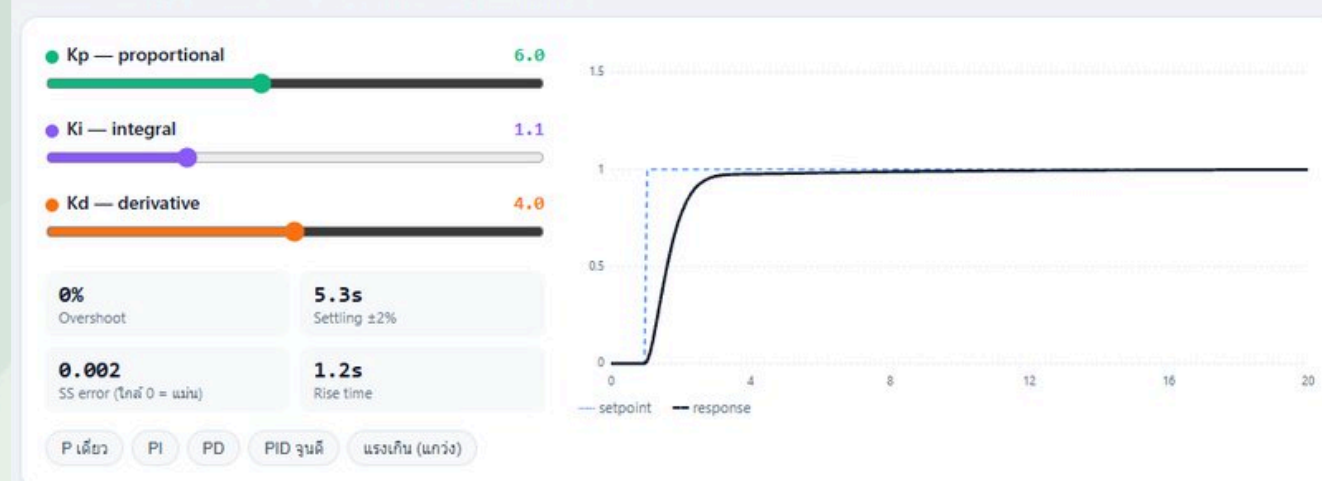
PID Control



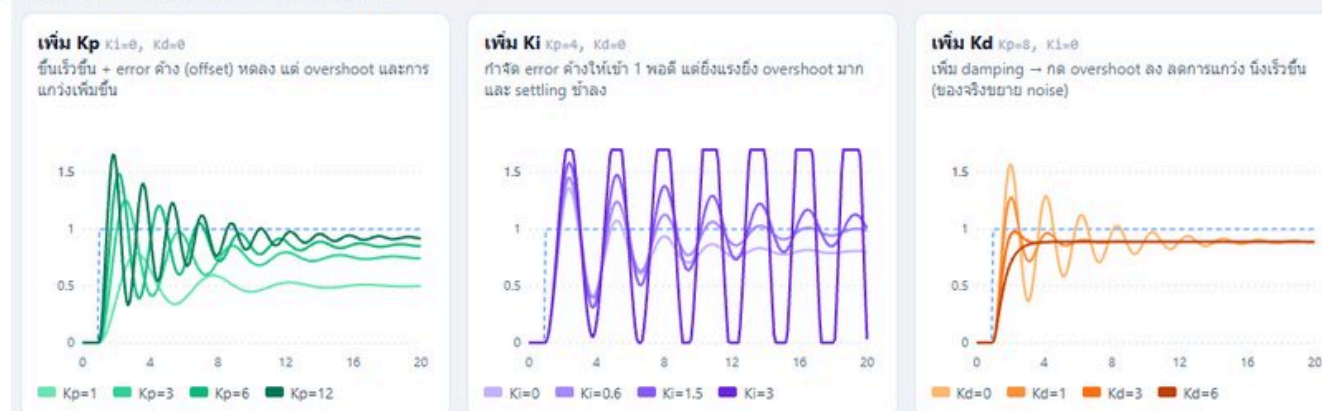
PID Control

PID Tuning Lab

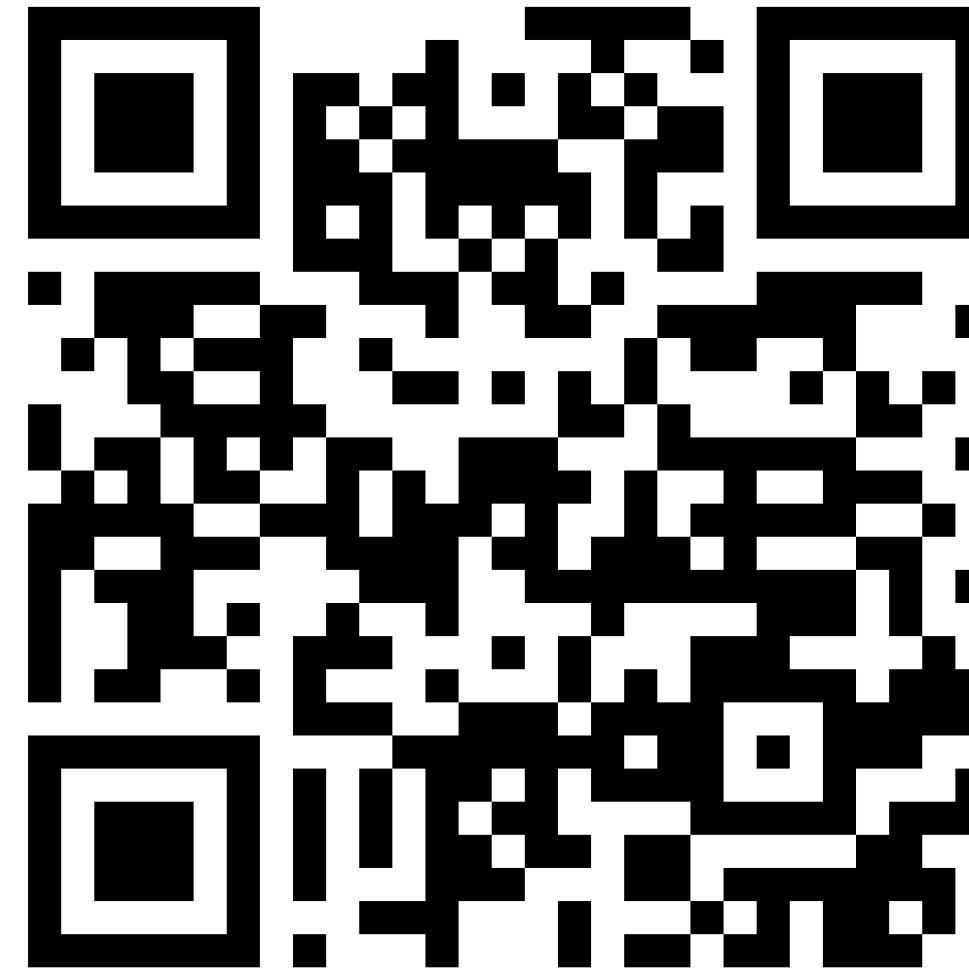
Plant = mass-spring-damper · step response ที่ $t=1s$ · เลื่อน gain แล้วดูผลสด



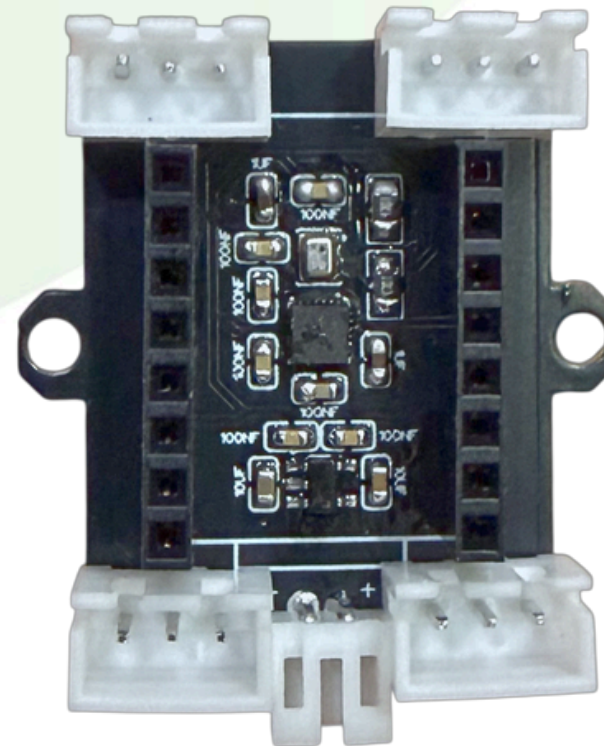
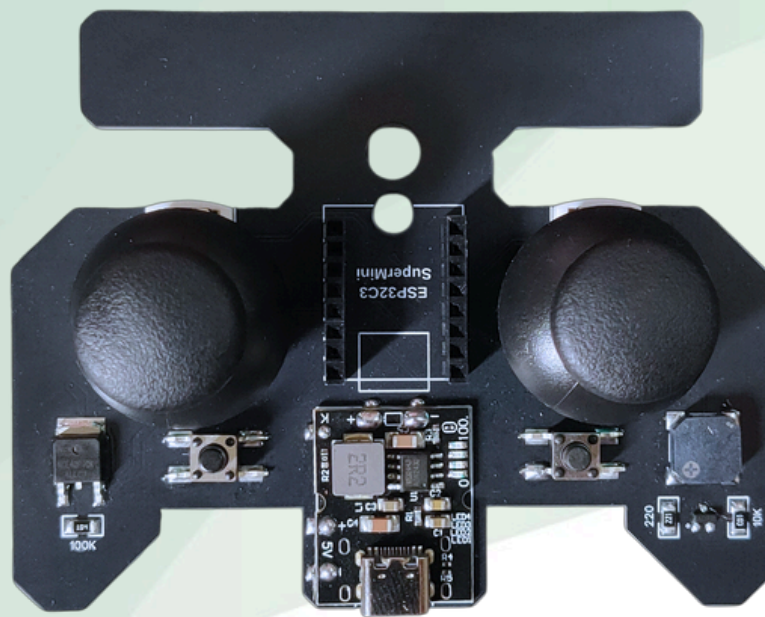
เพิ่มค่าแต่ละตัวขึ้นทีละขั้น - เกิดอะไรขึ้น



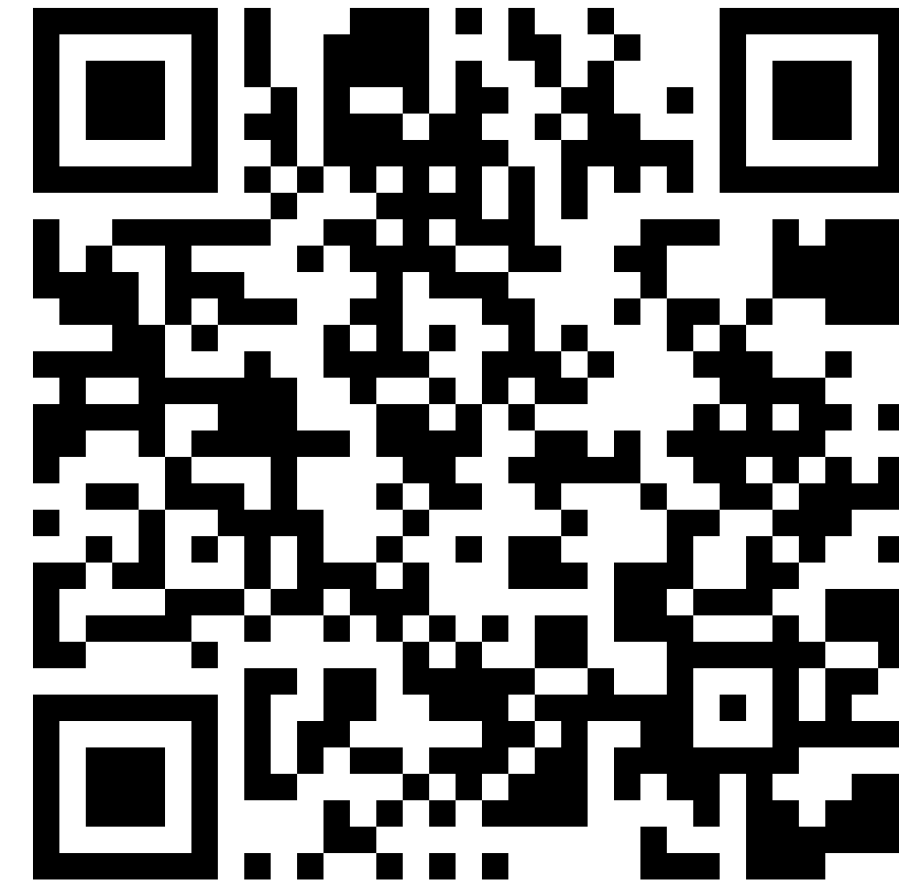
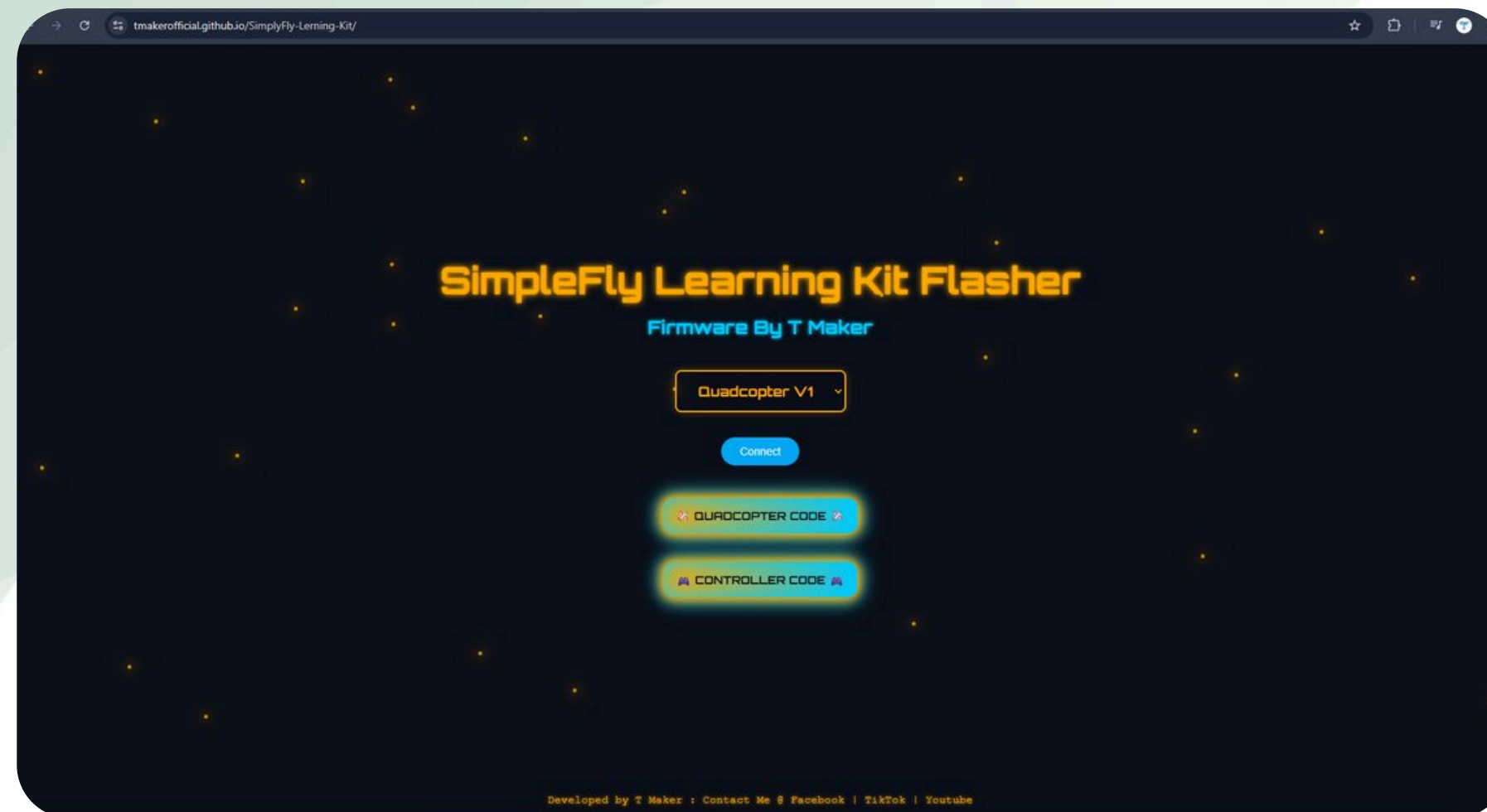
จำลองด้วย derivative-on-measurement (กัน derivative kick) เหมือน flight controller จริง · ไม่มี noise / anti-windup เพื่อให้เห็นผลของแต่ละ term ชัด

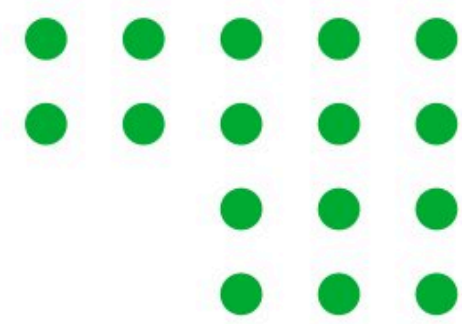


SimpleFly Learning Kit



Firmware Installation





Setup & Calibration

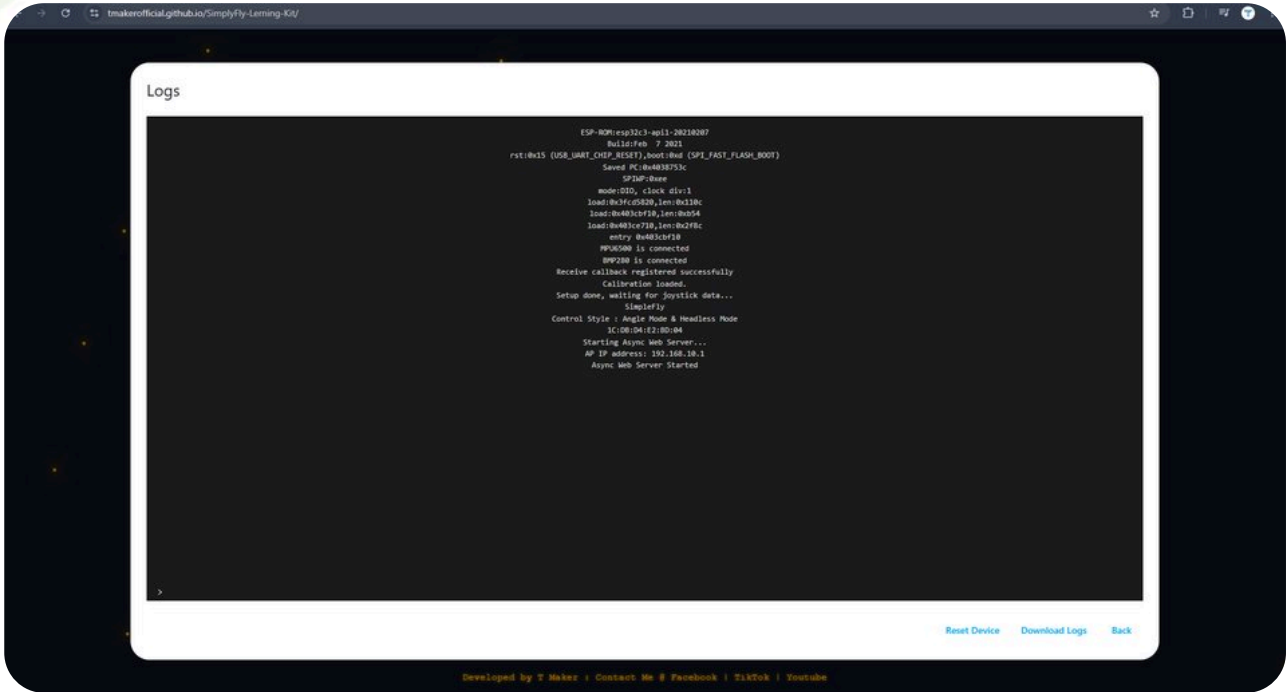


calibrate sensor



calibrate minmax
save minmax

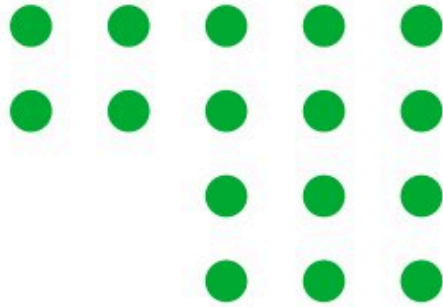
calibrate center
save center



set max = " MAC Address"



Tuning



PID Roll Rate

Kp: 1.00

Ki: 0.00

Kd: 0.05

PID Pitch Rate

Kp: 1.00

Ki: 0.00

Kd: 0.05

PID Yaw Rate

Kp: 3.00

Ki: 0.00

Kd: 0.03

PID Altitude Rate (m/s)

Kp: 70.00

Ki: 0.00

Kd: 3.50

PID Roll Angle

Kp: 7.00

Ki: 0.00

Kd: 0.00

PID Pitch Angle

Kp: 7.00

Ki: 0.00

Kd: 0.00

PID Yaw Angle

Kp: 4.00

Ki: 0.00

Kd: 0.00

PID Altitude

Kp: 1.00

Ki: 0.00

Kd: 0.00

Trim

Trim Roll: 0.30

Trim Pitch: 0.40

Trim Yaw: 0.00

Trim Altitude: 0.00

Base Speed

Base Speed: 1400

UPDATE SETTINGS

Calibration

CALIBRATE ACCEL & GYRO

RESET CALIBRATION



Tuning



min value of **XL** | Yaw rate

min value of **YL** | Altitude rate

min value of **XR** | Roll angle

min value of **YR** | Pitch angle

Save Min/Max

Calibrate Center

Reset All

Mapping Parameters

→	-20	20	←
→	-50	50	←
→	-15	15	←
→	15	-15	←

Save Mapping

Set Receiver MAC Address

Save MAC

max value of **XL** | Yaw rate

max value of **YL** | Altitude rate

max value of **XR** | Roll angle

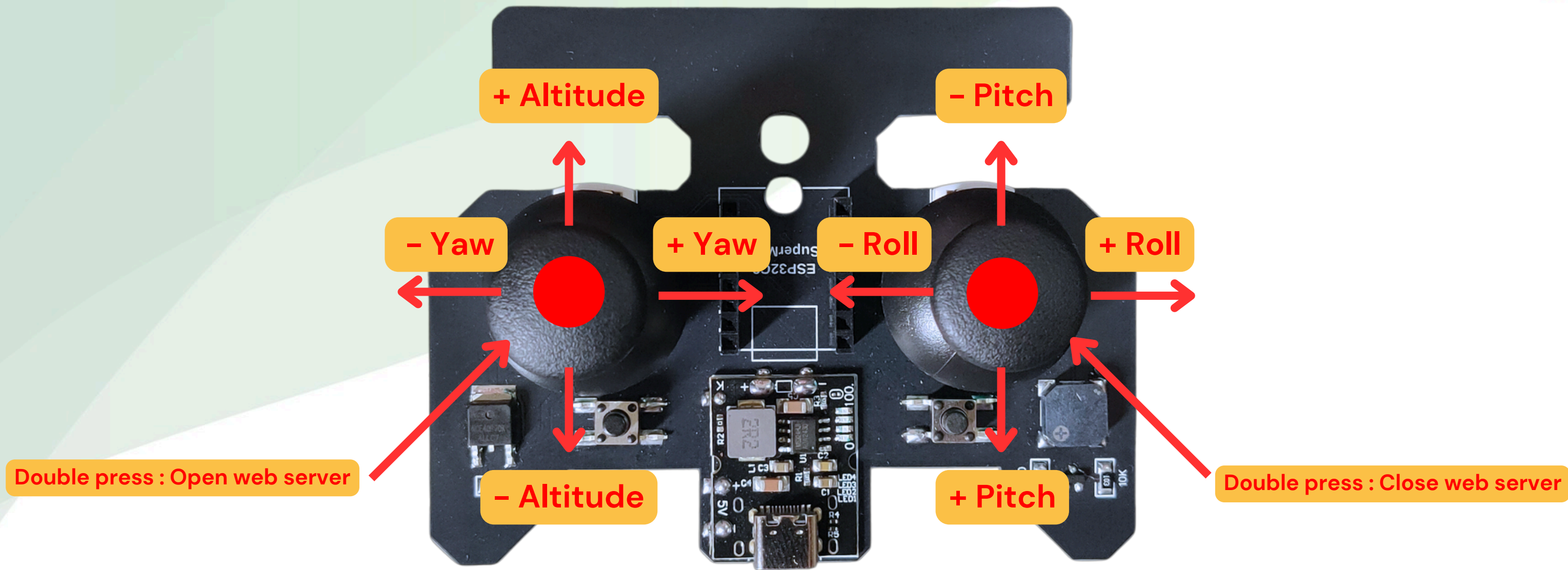
max value of **YR** | Pitch angle

Unit

- XL : deg/s
- YL : cm/s
- XR : deg
- YR : deg



Manual Control



Back side : single press ==> power on | double press ==> power off

Press both the left and right joysticks simultaneously to toggle between Armed and Disarmed modes.





THANK YOU
T MAKER

