Experiment - 7

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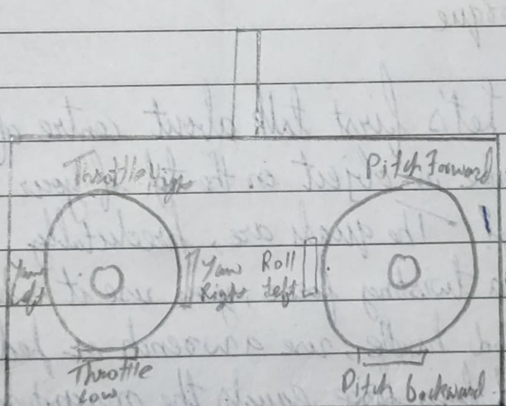
Title - Experimental Study of YAW and PITCH control in Quad Copter.

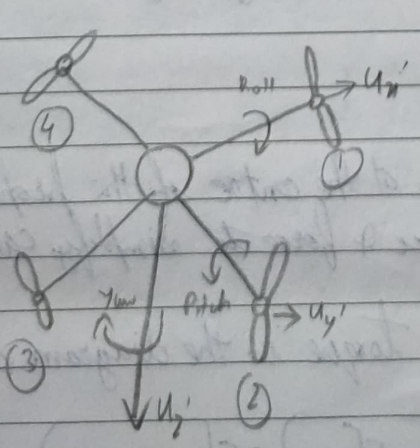
Introduction -

Quadcopters generally have two rotors spinning clock-wise (cw) and two counter clockwise (ccw). Flight control is provided by independent variation of the speed and hence lift and torque of each rotor. Pitch and roll are controlled by varying the net centre of thrust, with yaw controlled by varying the net torque.

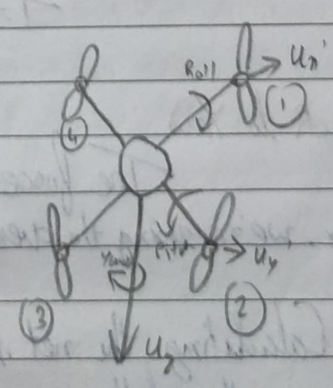
Yaw, Pitch and Roll control -



(a) Emitter & Receiver



(b) Yaw Control



(c) Pitch control.

Yaw Control to Rotate Your Quadcopter

Once at a comfortable hover, push the left stick in either direction. This will rotate the quadcopter in place. Rotate it 360 degrees. Then push the left stick in the opposite direction and rotate it 360 degrees the other way.
The yaw controller reads the commands received from the RC transmitter as angular velocities to improve the movement of the system & avoid oversensitivity with yaw movement. Thus, on the controller input there is an integrator which translates the angular velocity into an angular set point. Additionally, in yaw control, the discontinuities of the system in 360° & -360° must be taken into account and corrected to avoid misbehaviour of the system

Understanding Torque

Let's first talk about centre of gravity, have you ever tried to balance an object on the tip of your finger? That's a centre of gravity! The quads are, predictably, near its centre.
Torque (τ) is a twisting force, you use it when you do things like turn a door-knob handle, use a wrench or pedal a bicycle. Now, the torque produced by a force equals the magnitude of the force (F) times the radius (r), or distance from the centre gravity).

$$T = F \times r$$

Back to Yaw

The force is drawn at the centre of the propeller. In ex, we're using the average distance & force to simplify calculations.

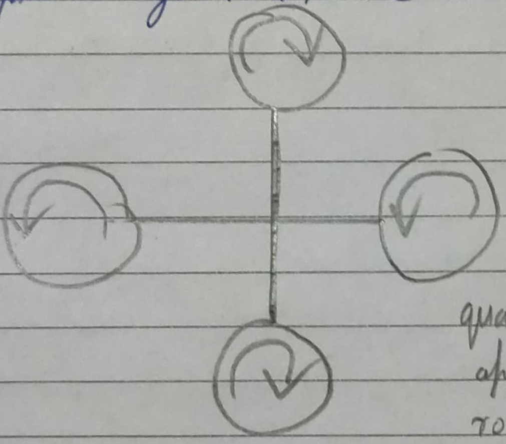
Calculating the net maximum torque in the diagram can be done using the following equations:

$$\tau = F(r1) - F(r2) = F(r1 - r2)$$

Were,
r_1 is the bottom (larger) radius, &
r_2 is the top (smaller) radius. The key takeaway here is for each propeller despite the force being equal, the raddi are not & because of that τ is a positive value

We endup with small amount of torque being created by each of the two active motors, these two amounts are in the same direction, & can be added together.

The combination of these two torque is sufficient to cause the quadcopter to yaw (twist) in the air.



quadrotor adjust its yaw by applying more thrust to rotors rotating in one direction

A quadrotor yaws in the anticlockwise direction by applying more thrust to the two clockwise rotors than the two anticlockwise rotors. A conservation of angular momentum causes the quadrotor to rotate as desired. In this diagram, the thickness of the arrows indicates the relative amount of thrust applied.

Summary - In this experiment Yaw & Pitch control have been studied.