Robotics: Aerial Robotics

→ emphasis on Quadrotors.

→ predicted to be a $10 B industry
   → military: surveillance, warfare
   → civilian commercial: Transport, filming ok
   → civilian private: DIY drones

Terms used to describe Aerial robots ~~with~~

  Remotely piloted vehicles (RPV) (military)

  Drones.

→ Aerial Robotics is an evolving technology.

Types of micro UAVs

1) Fixed wing   (disadvantageous
                      since they can't stop
                      and hover in place)

2) flapping wing   (can hover in space
                       but the fluid mechanics
                      is very complex and
                      hence difficult tomodel)

3) Rotor crafts.

Rotor crafts have different geometries like
- → Helicopter
- → Ducted Fan
- → Co-axial.

simplest geometry is the multirotor aircrafts like hexa rotors, Quad rotors.

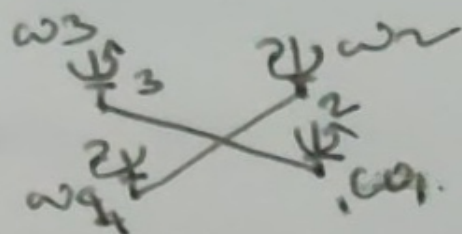Vehicle of choice in this course is

__Quadrotor__.

→ The geometry is very simple.

→ consists of 4 independently controlled rotors mounted on a rigid frame.

→ mechanical simplicity

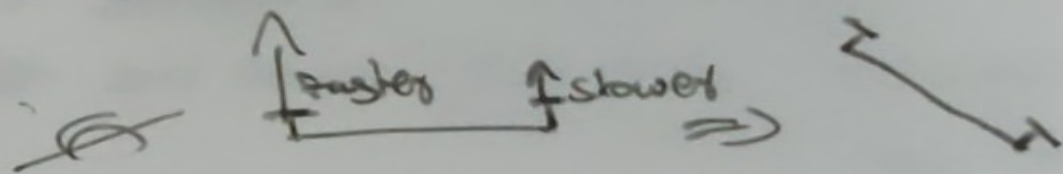→ since blades are short and stubby the gyroscopic movements of the robot doesnot cause the blades to flap

when we look at the geometry we can
see that rotors 1 &3 and 2&4
are pitched in opposite directions

ω_1 & ω_3 → +ve counterclockwise... from top

ω_2 & ω_4 → +ve counterclockwise from bottom

when we vary the speeds of these rotors
we are able to control the position &
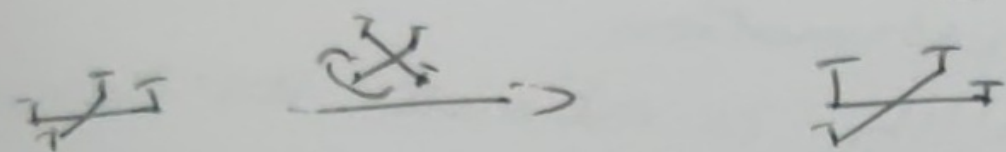orientation

Roll & Pitch

when we increase the speed of one
rotor then the robot will pitch
into ~~that~~ that direction.
when this is done and the pitch is high
the robot will even roll in that direction

how to steer / yaw ?

to translate horizontally.

$\frac{1}{4}$I $\quad$ $\overset{\nwarrow}{\underset{\searrow}{\times}}$ $\rightarrow$ $\quad$ I $\underset{\downarrow}{\diagup}$I

pitch the robot forward to that direction
this causes the Thrust vetor points
more horizontal direction.

Now to stop at destination pitch in
opposite direction so that the
thrust vector cancels out

$\rightarrow$ Quadrotors have six degrees of
freedom.

$\quad$ $\rightarrow$ translate in 3 directions (x, y, z)

$\quad$ $\rightarrow$ also rotate (x, y, z).

$\rightarrow$ how many different ways can we
rotate / translate the robot ?

→ Key components of autonomas flight?

1) state estimation
   → ability to estimate position, orientation and velocity.

2) control
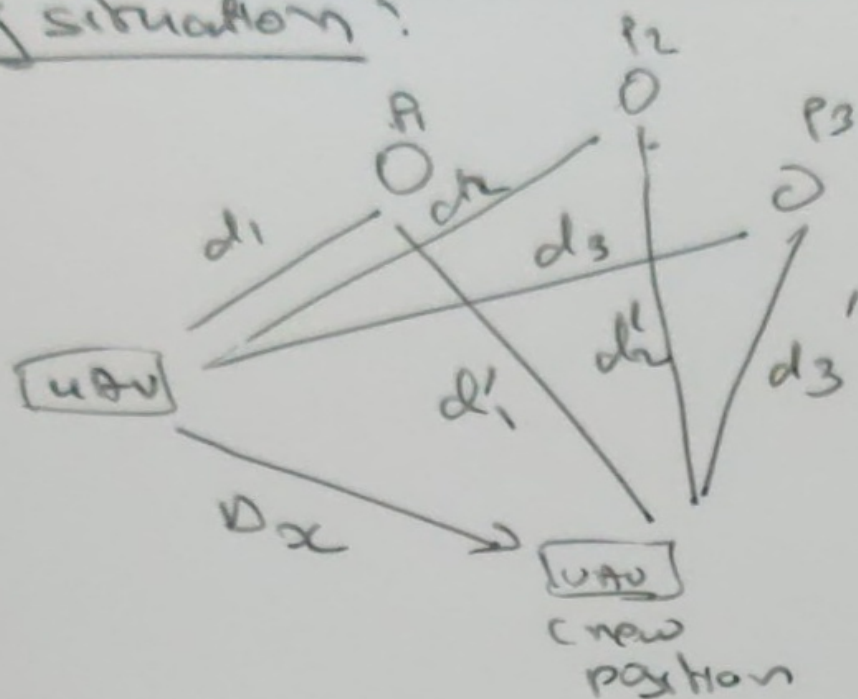   → ability to compute control commands to perform desired actions.

3) mapping
   → ability to map its environment.

4) planning
   → ability to plan a safe path arround obstacles.

State Estimation

→ sensors like, cameras, RGB-D cameras, LIDAR etc enables the microuavs to determine their location in space without the help of external appliances.

eg situation:

★ Real time state estimation allows to concurrently estimate location of Pillars and displacement of the robot.

This is SLAM.

Applications & Drivers

→ Agriculture (targeted farming)
→ construction
→ Archeology
→ photography
→ Robot FIRST responders.

II A typical IMU with an accelerometer and rate gyro directly measures

1) Linear acceleration (accelerometer)

2) angular velocity (rate gyro)