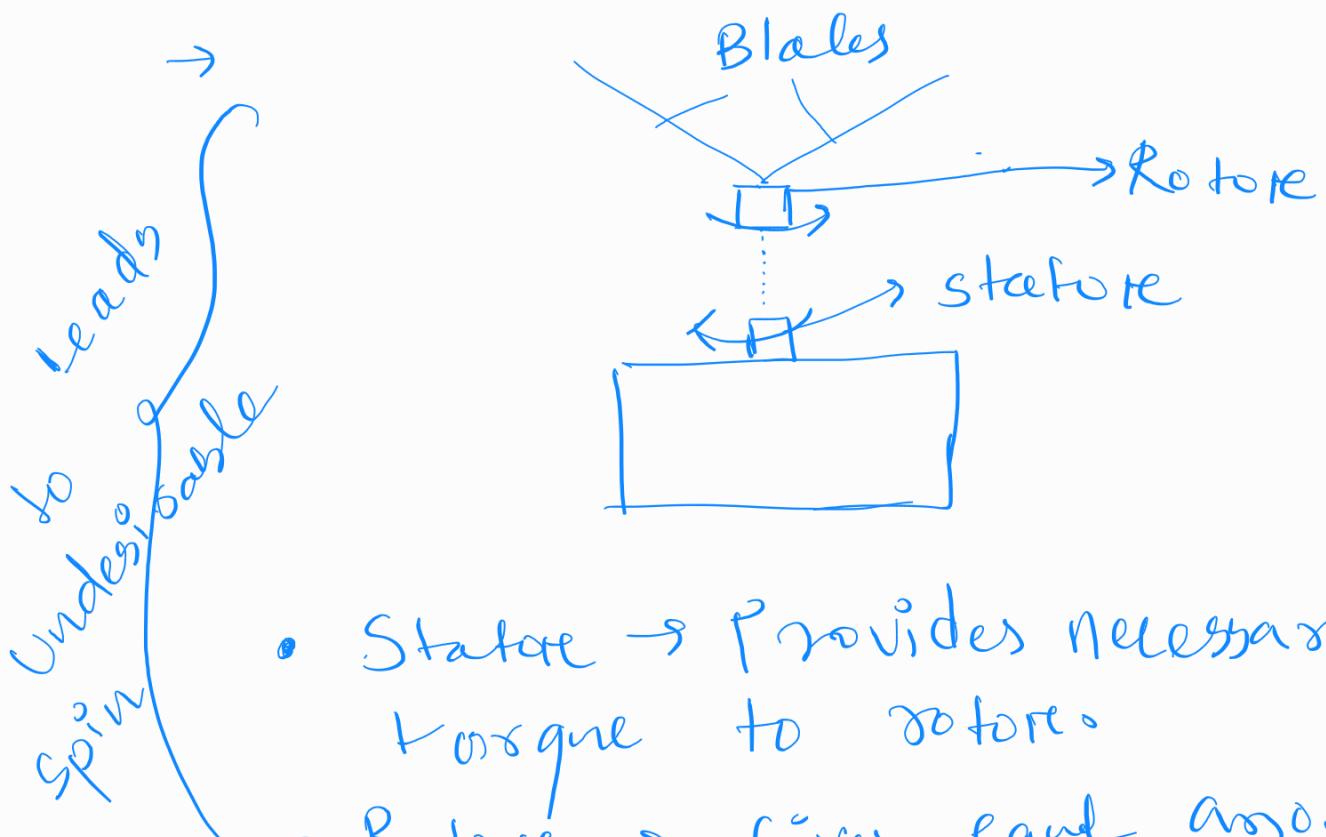


Drones

Design → Permitted drone

① Single propeller Design

- Provides enough lift force to keep the drone hovering in air, but can't control.
- Goes vertically up and down.
- Body keeps rotating opposite to the propeller. (Newton's 3rd law of motion).



- Stator → Provides necessary torque to rotate.
- Rotor → Gives equal amount of torque back to stator

2

2 Propeller drone

[company → Zero Zero Robotics]

Note :- Fewer the no of propellers, lesser the energy consumed by the drone, and longer it can stay in the air.



→ ~~Blades rotate in opp. dirⁿ,~~ the motor's reaction torque gets cancelled out, and undesirable spin can be avoided.

③

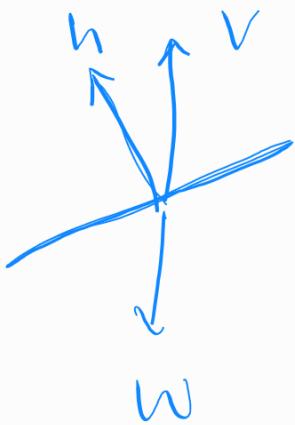
3 Propeller drone

- Rarely used.
- Problem: Motor's Beach'an torque and gyroscopic precession create unnecessary complications in the design and algorithms.

④

4 propeller drone / Quadcopters

- "X" shape or "H" shape.
- Hovering → Weight of the drone is balanced by the thrust produced by the propellers.
- Forward Motion: front propellers speed is slowed down and rear propellers speed is sped up
- Cyclic pitch Motion



$V \rightarrow$ Vertical component of resultant propeller force

$w \rightarrow$ Wt. of the drone. ($V=w$)

$h \rightarrow$ Unbalance horizontal force,
Makes the drone move forward.

→ Roll Movement: Created by
Imbalanced lift force in the
left and right pairs of propellers

→ Yaw Motion: One diagonal
pair of propellers is spun
opp to the other

- Cancells the reaction torque completely.
- For spinning or yaw motion \rightarrow Reaction torques should get cancelled.
- Can be achieved by reducing the speed of one diagonal pair.
- Reaction torque of propellers \propto Speed
- Net reaction torques \rightarrow causes yaw/spinning motion
- Most stable drones
- High speed
 - Takes sharp turns swiftly

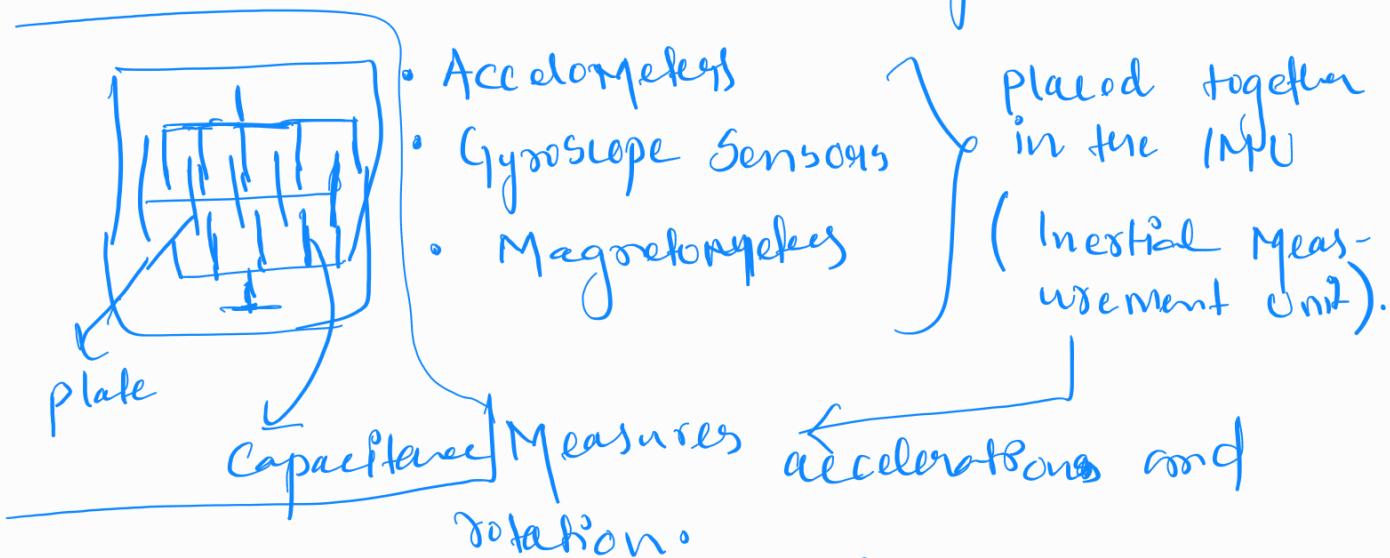
⑤ Brain of the drone

- If hit by a sudden gust of wind, the operator has to control and adjust each propeller's speed and rotation direction in less than a second.

i) Flight controller / Processor : Tiny intelligent pilot, enables the operator to use simple controls like up, forward, yaw etc.

- Requires signal from various sensors

ii) Drone Sensors : MEMS technology is used. (Microscale machines with actual moving parts).



→ As the drone experiences a force, movement occurs b/w the plates → Capacitance is present, as distance b/w the plates varies, the capacitance varies too, thus variation is converted to electrical signals and fed to the controller for calculations.

→ A 3-axis accelerometer is required to achieve acceleration in all 3 dim.

- Gyroscopes along with the force value can measure the rotations in diff'nt planes.
- MEMS-based barometer Sensors is used to detect the drone's altitude.
- Noise affects the signal's accuracy
Cause Interference of:
 - Defects → by the Mechanical Vibrations of the drone propeller and magnetic interference.
- Sensor fusion is used to overcome defects

e.g.: LPS sensor along with IMU can provide basic inf. about the altitude of the drone → Accuracy can be achieved by incorporating RADAR technology into it.

→ Diffⁿt Sensors Working together
to produce More accurate measure-
ments → Sensor Fusion

→ Controller Part / Decision
Making Part :-

Includes Control logic :- Algorithm
that reduces the ~~in~~ errors further
and Makes decisions. → Kalman filter
(KF algorithm)

→ KF → Reads Past and present data to
know the State of the drone and
utilizes it's logic for GPS Navigation.
(for driving back home) or Stabilizing
the drone after the disastrous effect of
winds

• KF fed in the processor having logic
gates and transistors etc makes smart
decision to control speed of (BLDC
Motors):

- COMPANY → DJI use advance flight control algorithms, dual IMUs for more reliability and vibrations dampening systems to reduce ~~the~~ noise in sensor output.
- Companies like Parrot, Aerial and Unique → Drones lack refinement and fitness.
- Power reqd by BLDC Motors → electronic circuits, antennas and sensors are supplied by lithium ion battery.
- Drone receives the control signal from the user by ~~the~~ Radio frequency technology.
- Range of communication → $(1 - \alpha)kr$ for consumer drone
- If the drone gets out of the communication range → GPS along with internet technology operator can set home location;

