Physical Properties

Drones, also known as unmanned aerial vehicles (UAVs), have various physical properties that contribute to their design and functionality. Some key tentative physical properties of the drone being developed are:

- **Size and Weight:** The size and weight of a drone affect its maneuverability, flight stability, and payload capacity. Our drone has an expected mass of 1820 grams.
  This weight mainly came from the weight of the frame and battery. The battery itself can weigh upto 600 gms and the frame is around 500 gms.
  However this could be affected while being developed in real time.

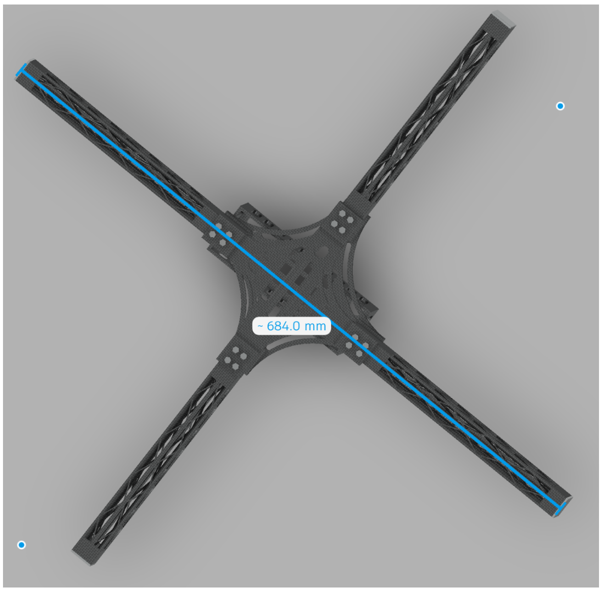
- **Weight Estimation**

Major Component	**Weight (in gms)**
Frame	482
Motor	32*4 = 128
Propeller	23*4 = 92
Landing Gear	172
Pickup Mechanism	106.808
Battery	515
ESC	14
Flight Controller	59.724
Camera	18.361
Camera Transmitter	20.5
Signal Receiver	15.559
GPS	92.036
Power Module	30.139
Telemetry	9.132
Other Components	68.9
Total	**1816 gms**

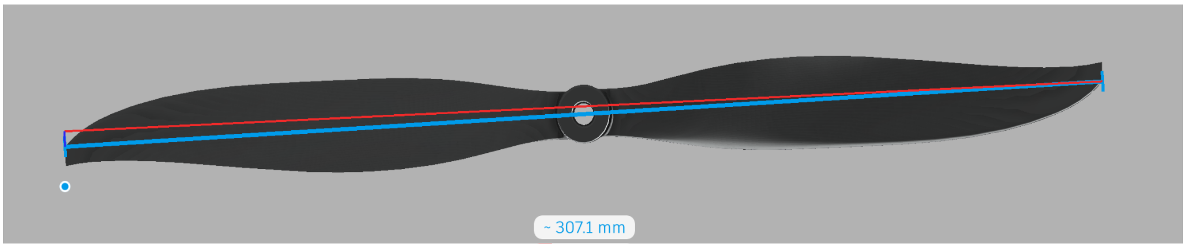
- **Frame:** The drone's frame provides structural support and houses the essential components. We have made Carbon Fiber as the base material for our drone frame. The size of the frame is 684 * 684 mm diagonally.

  This Size of drone would house all our electrical components. The motors would be mounted at the edges of the arm. The Distance between the motors is 330 mm.

  Internal support is provided in each arm to prevent it from breaking and give strength to the arms. Carbon Fiber plates are used in between the joints to make screw bonds tighter and reliable.



- **Propellers:** Drones generally have multiple propellers, usually two or more pairs, mounted on arms extending from the frame. Propellers generate lift and thrust to propel the drone through the air. Again we are going with Carbon Fiber Propellers with the size of 12 inches having 4.5 Pitch. The pitch defines the height the drone rises per revolution of the propeller. It contains a Pair of two different rotation orientations. One Rotates Clockwise, the other in Counter-Clockwise Direction.



- **Motors:** Electric motors power the propellers and generate the necessary thrust. Brushless DC (BLDC) motors with 1300Kv rating would be used for this project. This would keep the drone stable and also generate the required thrust to lift the payload.

- **Battery:** Lithium Polymer LiPo Batteries are being used keeping in mind their higher current density and cost effectiveness. These batteries provide the electrical energy required to operate the motors, control systems, and other onboard electronics.

- **Sensors:** Drone would be incorporated various sensors, including accelerometers, gyroscopes, magnetometers, barometers, and GPS receivers. These sensors help the drone maintain stability, navigate, and gather data about its surroundings.

- **Camera and Gimbal:** This drone would be equipped with two cameras positioned at forward and downward direction. The forward one would be used to guide the drone in direction. The downward camera would guide the pickup and drop mechanism for the deliveries.

- **Control System:** Drones have flight control systems that include a flight controller, which processes sensor data and provides stabilization, control, and navigation commands. These systems can be autonomous or operated remotely by a human pilot using a controller or mobile device. We have decided to go with the advanced Holybro Pixhawk 6C. This flight controller is one of the best in today's market for drone development. It supports integration with a variety of sensors which provide crucial details and conditions for the flight. It also has an autopilot function which we are taking use in the automation of the drone.

These physical properties can vary depending on the availability of the parts and components during actual development of the drone.

Thrust Required Estimation

Estimating the required thrust for a drone depends on several factors, including the weight of the drone, desired flight characteristics, and any additional payloads or equipment it may carry. The basic principle is that the thrust generated by the drone's propulsion system should be greater than or equal to the total weight of the drone to achieve stable flight.

We have our drone estimated weight as 2050 gms (2 kg) including the payload. For this we would require a total of 2050 (2 kg) gms or greater thrust. The model we have generated and tested using simulation came out to withstand the thrust required with the proper use of the propellers.

Thrust to Weight Ratio

The thrust-to-weight ratio is an important performance metric for drones. It measures the ratio of the thrust generated by the drone's propulsion system to its weight. A higher thrust-to-weight ratio indicates a greater ability to accelerate, climb, or carry payloads.

Drones with higher thrust-to-weight ratios tend to have better maneuverability and agility. They can ascend rapidly, perform acrobatic maneuvers, and carry heavier payloads more efficiently. However, it's important to strike a balance, as an excessively high ratio may reduce flight endurance and efficiency.

Thrust-to-weight ratios vary among different drone models, depending on factors such as the type and power of their propulsion systems, their intended use (e.g., racing drones vs. camera drones), and design considerations. Advanced racing drones can achieve thrust-to-weight ratios greater than 5:1, while commercial camera drones typically have ratios ranging from 2:1 to 4:1.

Weight of the Drone = 1815.810 gm
Weight of the Payload = 200 gm

Total Weight of the Drone Including Payload = 2015.810 gm

Max Thrust Generated by each Motor = 2190 gm
Number of motors being used = 4
Total Thrust Generated by four Motors = 2190*4 gm = 8760 gm

Thrust to Weight ratio (T/W) = Total Thrust Generated / Total Weight
= 8760 / 2015.810
= 4.3

Mass	1815.810 g
Center of Mass	0.120

Bounding Box

Length	787.276 mm
Width	787.276 mm
Height	392.865 mm

Moment of Inertia at Center of Mass (g mm^2)

Ixx	4.108E+07
Ixy	56992.605
Ixz	-1.635E+05
Iyx	56992.605
Iyy	3.825E+07
Iyz	4.589E+05
Izx	-1.635E+05
Izy	4.589E+05
Izz	6.232E+07

Moment of Inertia at Origin (g mm^2)

Ixx	4.299E+07
Ixy	56592.221
Ixz	-1.564E+05
Iyx	56592.221
Iyy	4.015E+07
Iyz	5.665E+05
Izx	-1.564E+05
Izy	5.665E+05
Izz	6.233E+07

Component Tentative Specifications

Component	Specification
Motor	1300 Kv Max Power 1310 Watt Max Thrust 2190 gm on 6s Battery
Battery	4C 5200 mah 14.8 v 40c
Frame	682 * 682 mm Carbon Fiber Self Built
Propeller	12 inch with 4.5 Pitch
ESC	4 in 1 Max 60 A ESC
Radio Controller	Frequency 2.4GHz Range 1.5 km
Flight Controller	Pixhawk 6c
Gps	Pixhawk Gps

Battery

4s 5200 mah 14.8 volt 40c
Current = 40* 5200 = 20.8 A
Energy Stored = 14.8 * 5200 = 76.960 Wh
Run Time = 12 min