PROJECT HELICARRIER

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THE CONTENT

ABSTRACT

This project presents the design and development of a custom hexacopter with a 2 kg payload capacity, powered by six brushless motors and LiPo batteries. The lightweight yet durable frame allows for efficient power distribution while maintaining flight stability under load. The hexacopter is built to achieve a balance between lifting power and energy efficiency, addressing the need for reliable performance in various real-world applications.

Designed for versatility, the hexacopter is capable of supporting multiple tasks, including aerial photography, small-scale delivery, and environmental monitoring. Its six-motor configuration provides redundancy, ensuring safe and stable flight even in the case of motor failure.

The integration of GPS and advanced flight control systems enables autonomous features such as waypoint navigation, automated takeoff and landing, and altitude hold, making it ideal for precise, repeatable operations.

Although the current design demonstrates successful flight and payload handling, challenges remain in optimizing power consumption and enhancing flight duration under maximum load. .

Future improvements will focus on refining the aerodynamic design, improving energy efficiency, and upgrading the propulsion and battery management systems to extend flight time and further increase operational reliability

WORKING PRINCIPLE OF DRONE

A payload carrying drone, consists of 6 copters, referred as Helicarrier. Working of drones is basically based on Newton's third law of motion, which states " For every action , there always exists an equal and opposite reaction".

When a drone's propeller spins, they push air downward. Using Newton's third law, this represents the action. For Newton's law to be true, there must be an equal and opposite reaction. This reaction is an upward force pushing on the copter. Once this force exceeds the force of gravity pulling the copter downward, the drone begins to move up.
Moreover, the subject of aerodynamics also plays an important role in deciding the forces acting on a body of a drone. The shape, size and speed of propeller and drone depends on the aerodynamics of the propeller or blades.

The construction of a drone is crucial for its stable flight, particularly in its multirotor configuration. Every drone typically consists of an even number of rotors which generate the thrust necessary for takeoff and maneuvering. To ensure stability and control, half of the rotors spin in a clockwise direction while the other half spin counter-clock size. This arrangement effectively cancels out the angular momentum of the drone's centre of gravity, preventing unwanted rotational motion and allowing precise control over yaw, pitch and roll. By balancing these opposing rotational forces, the drone maintains a steady and controllable flight, essential for both manual and autonomous operations.

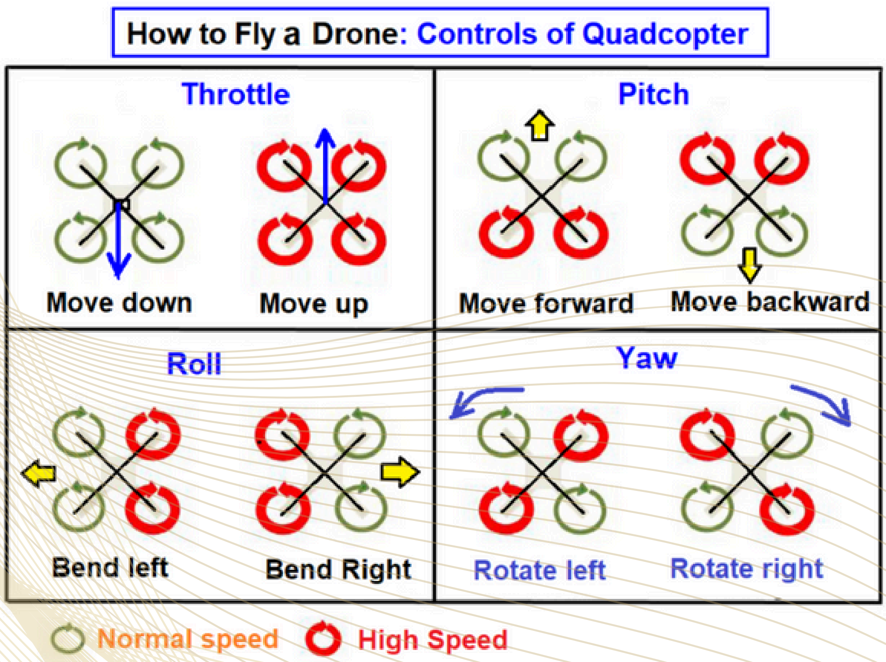
FOUR MAIN CONTROLS OF DRONE

1. ROLL

- It is basically the rotation of the drone around the x axis, which controls the drone's left and right motion.
- Tilting Left: Increase the speed of the right rotors and decrease the speed of the left rotors. This tilts the drone to the left, causing it to move left.
- Tilting Right: Increase the speed of the left rotors and decrease the speed of the right rotors. This tilts the drone to the right, causing it to move right.

2. PITCH

- It is the rotation of the drone around the y axis, which controls the drone's forward and backward motion.
- Tilting Forward (Nose Down): Increase the speed of the rear rotors and decrease the speed of the front rotors. This tilts the drone forward, causing it to move forward.
- Tilting Backward (Nose Up): Increase the speed of the front rotors and decrease the speed of the rear rotors. This tilts the drone backward, causing it to move backward.

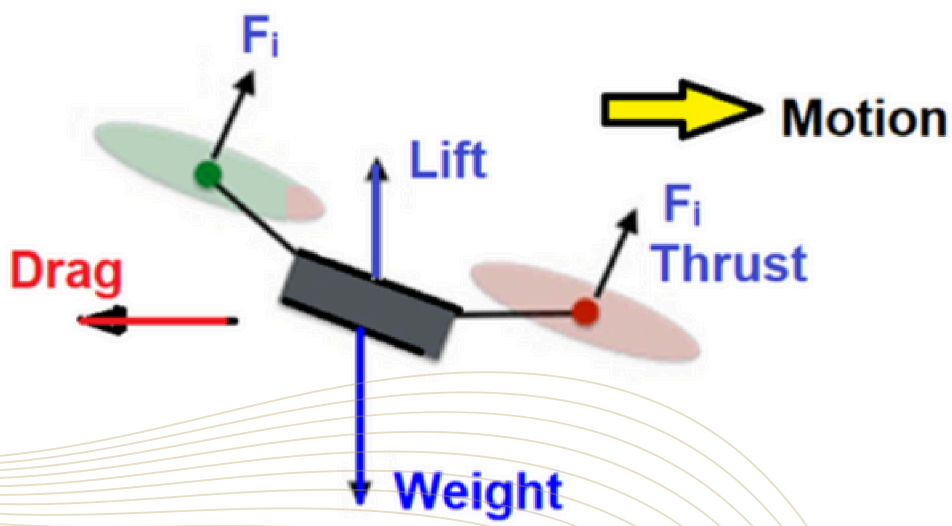


3. YAW

- It is the rotation of the drone around the z axis, which makes the drone move around its axis.
- Turning Left (Counterclockwise Yaw): Increase the speed of the CW rotors and decrease the speed of the CCW rotors. This creates a torque that rotates the drone to the left.
- Turning Right (Clockwise Yaw): Increase the speed of the CCW rotors and decrease the speed of the CW rotors. This creates a torque that rotates the drone to the right.

4. THROTTLE

- It basically refers to the up and down movement of the drone.
- If all propellers run at normal speed or lower than that , then the drone will move down.
- If all propellers run at a high speed, then the drone will move up.



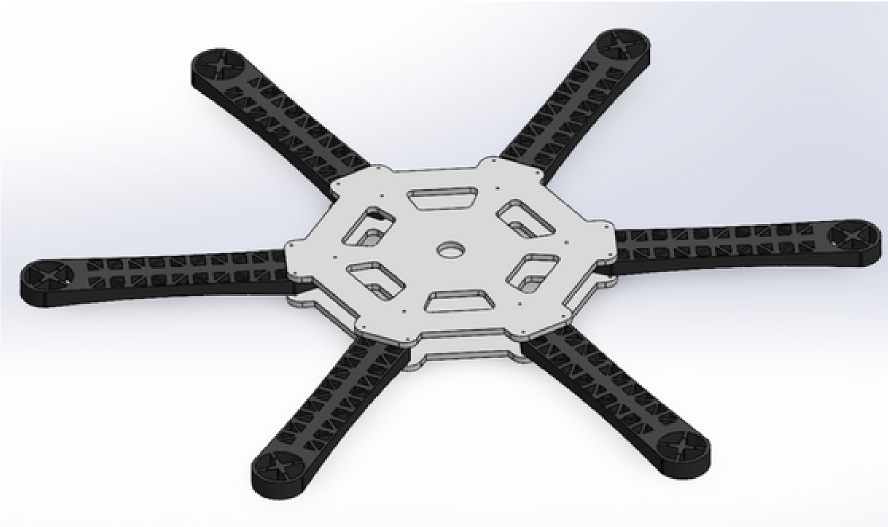
MATERIALS REQUIRED

1. Frame
2. Motors
3. Propeller
4. ESC
5. Battery- 10000mAh
6. Flight Controller
7. Piler
8. Cutter
9. Heat sleeve 8 mm
10. Heat sleeve 5 mm
11. Battery Strap
12. Screw Driver Set

STRUCTURAL COMPONENTS' DESIGN AND SPECIFICATION

The Helicarrier drone is a unmanned aerial vehicle (UAV) designed to perform autonomous operations with high maneuverability and endurance. The drone incorporates aerospace technologies to support surveillance, reconnaissance, and tactical missions. Its component design and specification emphasize efficiency, versatility, and reliability in diverse operational environments.

1. FRAME



Specifications:

1. Wheelbase: 550 mm
2. Weight:
- Without gimbal: 550 g
- With gimbal: 720 g

Design Features:

1. Upward Tilt Arm Design:
- Adopts S800 upward tilt arm design
- Constructed using plastic injection molding for enhanced hardness and reduced weight

2. Gimbal Compatibility:
- Compatible with brushless gimbals for FPV

3. PCB Center Board:
- Comes with a PCB center board with pre-soldered connections

4. Arm Features:
- Support ridges on arms to ensure better and faster forward flight

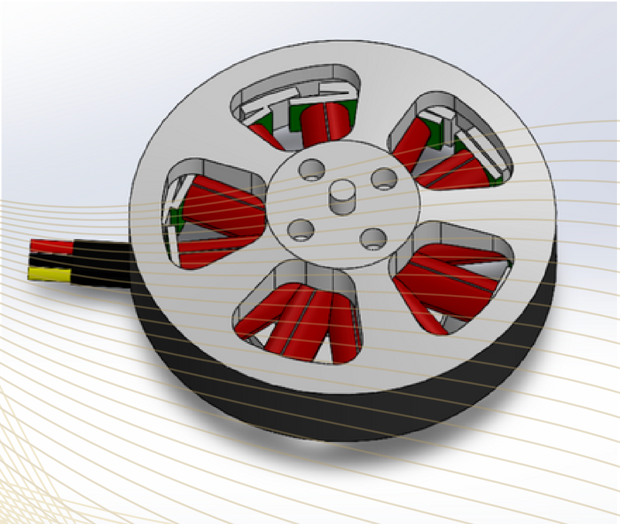
5. Brass Sleeves:
- Features pre-threaded brass sleeves for easy assembly

STRUCTURAL COMPONENTS' DESIGN AND SPECIFICATION

2. MOTOR

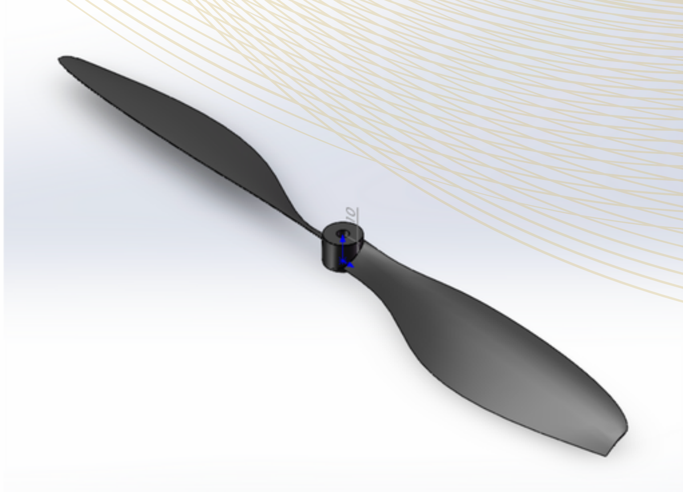
Motor Features:

- **Cooling System:**
  - Equipped with four fan-style cooling holes that pump air through the motor while it runs
- **Mounting Options:**
  - Rear threaded mounting holes with both 16 mm and 19 mm hole spacing to fit a variety of applications
- **Magnets:**
  - Uses NdFeB magnets with a high-temperature rating for trouble-free operation
- **Wiring:**
  - 140°C high temperature-rated wire is used for winding the motors
- **Coating:**
  - Epoxy coating applied on the inner surface of plates to prevent winding shorts
- **Bearings:**
  - Supported by lubricated ball bearings for smooth motor operation
- **Stator Winding Security:**
  - High-temperature adhesives used to secure the stator windings, preventing them from shifting, getting pinched, or shorting out



STRUCTURAL COMPONENTS' DESIGN AND SPECIFICATION

3. PROPELLER



Propeller Specifications:
- Length: 12 inches (30.5 cm)
- Pitch: 3.8 inches
- Weight: 44 g
- Shaft Diameter: 7.86 mm

4. BATTERY

Specifications
- Capacity - 10,000 mAh
- Nominal Voltage - 14.8V
- Configuration - 4S 1P (4 cells in Series)
- Discharge Rate - 25C
- Max Burst discharge Rate - 50C

Dimension
- Net Weight(±2%) - 844gms
- Dimensions - 81mm x 60mm x 42mm

5. ELECTRONIC SPEED CONTROLLERS (ESCs)

Specifications
- Burst Current (A) - 40
- Constant Current (A) - 30
- Brushless ESC

Dimension
- **(L x W x H) -** 52 x 26 x 7

STRUCTURAL COMPONENTS' DESIGN AND SPECIFICATION

6. FLIGHT CONTROLLER

Processor:

- 32bit STM32F427 Cortex M4 core with FPU.
- 168 MHz.
- 128 KB RAM.

Sensors:

- ST Micro L3GD20H 16 bit gyroscope.
- ST Micro X4HBA 303H 14-bit accelerometer/magnetometer.
- Invensense MPU 6000 3-axis accelerometer/gyroscope.
- MEAS MS5607 barometer.

APM 2.5.2/2.6/2.8 Pixhawk Power Module V1.0:

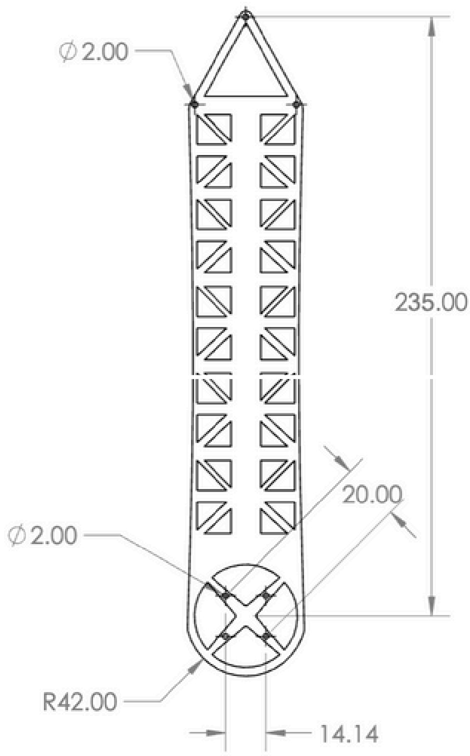
- Max input voltage: 28V
- Max current sensing: 90A
- Voltage and current measurement configured for 5V ADC

NEO-M8N GPS Module:

- Receiver type 72-channel Ublox M8 engine.
- GPS/QZSS L1 C/A, GLONASS L10F, BeiDou B1.
- SBAS L1 C/A: WAAS, EGNOS, MSAS.
- Galileo-ready E1B/C (NEO-M8N).
- Nav. update rate1 Single GNSS: up to 18 HZ.

2D DESIGNS

ARM DESIGN OF FRAME

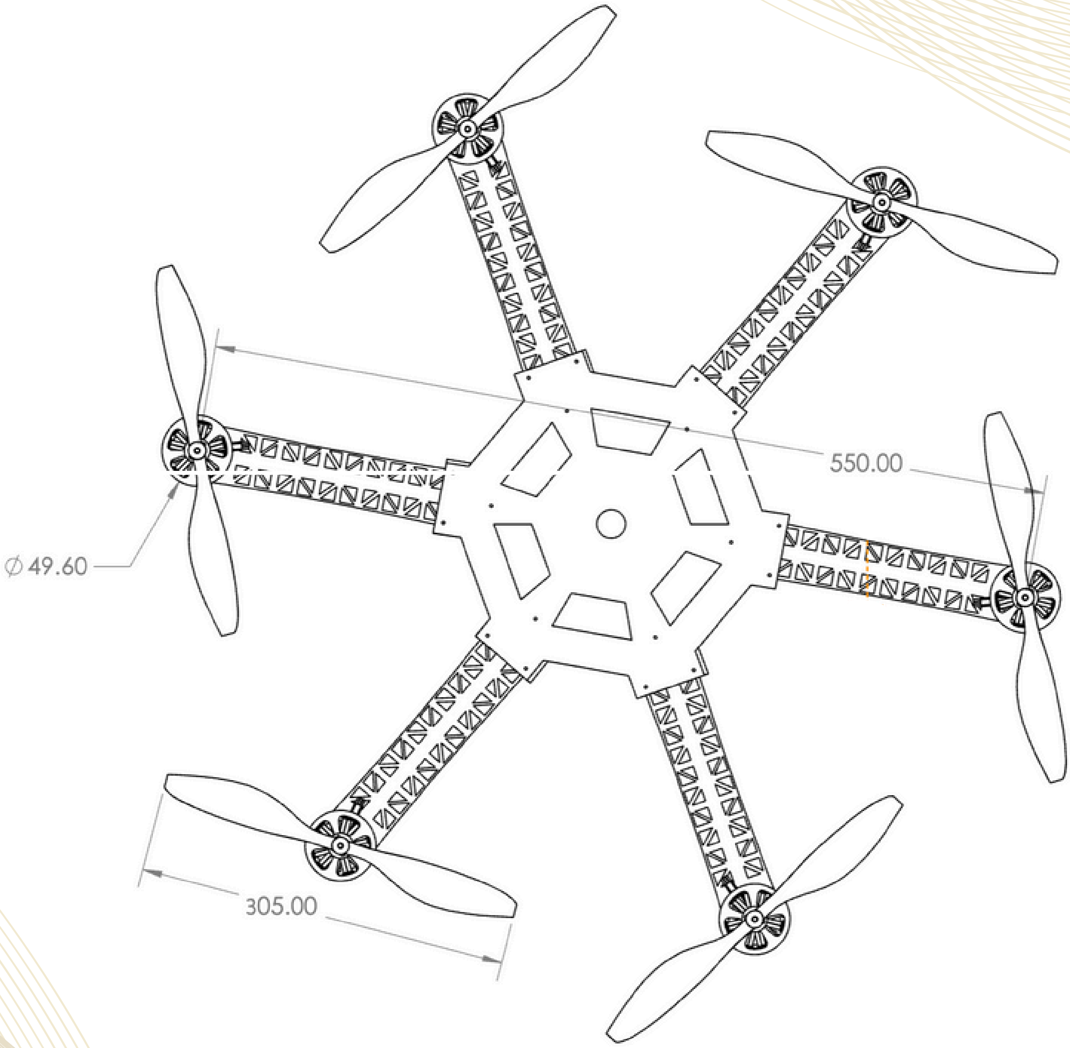


Specification

Arm Size (L x W) mm - 235×42

2D DESIGNS

DESIGN OF FRAME

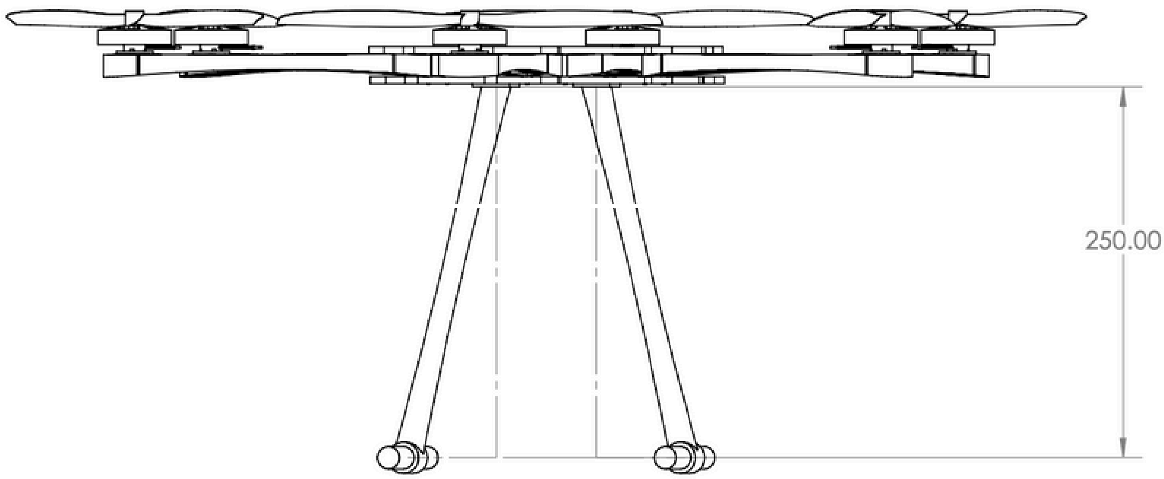


Specification

Wheelbase (mm) - 550

2D DESIGNS

DESIGN OF FRAME



Specification

- Landing Gear Height (mm)-250
- Landing Gear Color - Black
- Landing Gear Weight (gm)-100 (both)

3D MODELLED DESIGNS

DESIGN OF FRAME

Specification

Wheelbase (mm) - 550

3D MODELLED DESIGNS

DESIGN OF FRAME WITH LANDING GEAR

Specification

- Landing Gear Height (mm)-250
- Landing Gear Color - Black
- Landing Gear Weight (gm)-100 (both)

FLIGHT ANALYSIS

FLIGHT TIME

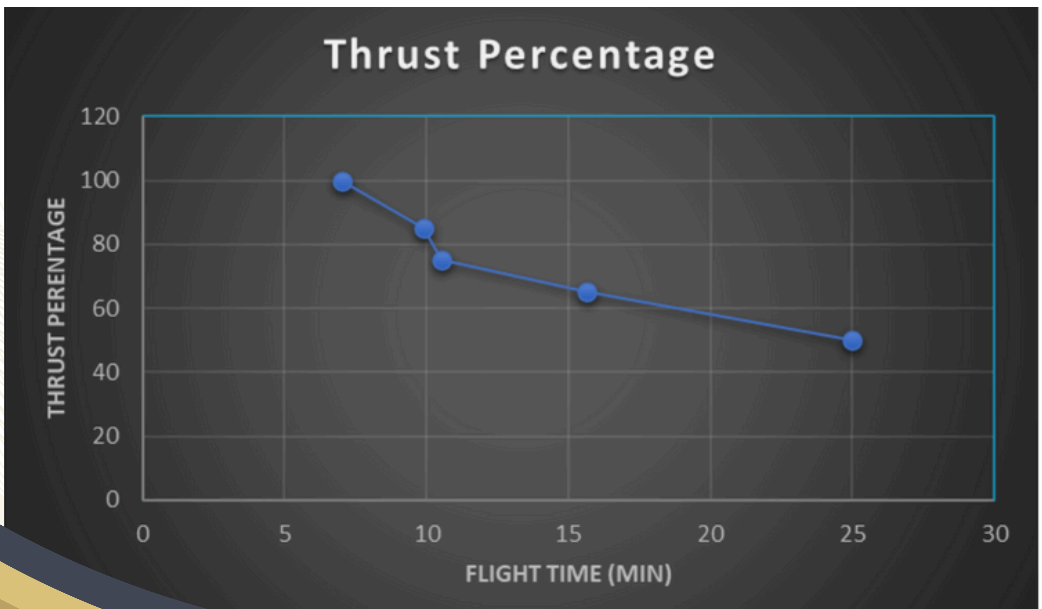
At full thrust of motor:
- Current drawn by motors = 14.2*6 = 85.2 Amp
- Flight time = 10*60/85.2 = 7.04 min

At 85% thrust of motor:
- Current drawn by motors = 10.1*6 = 60.6 Amp
- Flight time = 10*60/60.6 = 9.90 min

At 75% thrust of motor:
- Current drawn by motor = 9.5*6 = 57 Amp
- Flight time = 10*60/57 = 10.52 min

At 65% thrust of motor:
- Current drawn by motor = 6.4*6 = 38.4 Amp
- Flight time = 10*60/38.4 = 15.625 min

At 50% thrust of motor
- Current drawn by motor = 4*6 = 24 Amp
- Flight Time = 10*60/24 = 25 min



FLIGHT ANALYSIS

Thrust percentage	Current Drawn	Flight time	Thrust to weight ratio	
			Without Load	With Load(2kg)
100%	85.2	7.04	2.468:1	1..48:1
85%	60.6	9.90	2.156:1	1.29:1
75%	57	10.52	1.636:1	-
65%	38.4	15.625	1.354:1	-
50%	24	25	1.022:1	-

The data derived for the flight time is calculated using the datasheet given by the motor manufacturer. The data used is standardized for 11 inch propellers. But for the Helicarrier, a 10 inch propeller is used hence observations were interpolated from it.

The current drawn by the motor would reduce, thus increasing the flight time but it would result in decrease of thrust to weight ratio for the drone.

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FLIGHT TEST VIDEO LINK

https://drive.google.com/drive/folders/1KWDl0BhEg0MnttREhZzeeXfhTKOUXWpM?usp=drive_link