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Toolkit Carrying Drone For Maintenance Of High Altitude Transmission Lines

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Abstract Research and analysis on drones is increasing rapidly nowadays in various fields of application. One of the major problem which arises in the drone application is its ability of lifting heavy loads when attached to it that requires proper design and selection of the required type of drone for its ability to carry out various missions including lifting a heavy load. One of the important type of drone that is widely used is hexacopter drone. This paper shows the design of hexacopter drone that lifts the toolkit which has to be delivered for maintenance of transmission lines at high altitude. It is designed with the help of calculation and analysis of the criteria and constraints by the aid of software. The calculations shows the ability of hexacopter drone of lifting a toolkit and delivering it to the location at higher altitude.

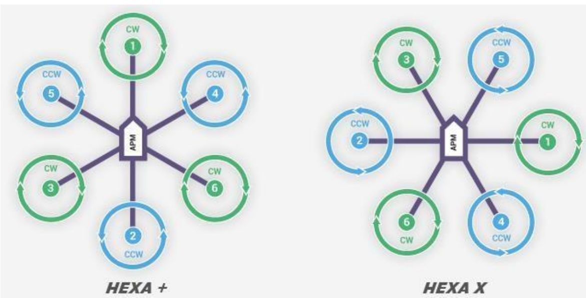
1. INTRODUCTION

Automated Aerial Vehicle or UAV acquired ubiquity in the universe of science and innovation in view of its different applications in different fields like hunt and salvage activity, farming tasks, ethereal photography, studying, reconnaissance reason, firefight, observing, and so forth [1,2]. Considering its process for lifting, the UAV are organized in two sorts, rotor wing and fixed wing. The wing rotor involve helicopter, tricopter, quadcopter, hexacopter and octocopter depending on the amount of stimulus motor. A critical examination has been done in this handle like independent helicopter control [1], disposition and elevation quadcopter development control [3, 4], tricopter displaying [5, 6], displaying and controlling hexacopter [7, 8], octocopter navigation control [9]. The main advantage of multi rotor is it do not require a runway to takeoff. It can perform vertical takeoff or landing (VTOL), it has the ability to hover and maneuver to perform a task. Different multirotors have different load lifting capability due to addition of extra motor however it becomes more difficult to control as the system becomes more nonlinear. Since our task is to deliver toolkit which can be called as a heavy payload, thus hexacopter and octocopter would be preferable which has six motors and eight motors respectively. Although octocopter can perform the same task as that of the hexacopter it costs more because it has two extra motors compared to hexacopter. Therefore we have selected hexacopter to deliver toolkit for maintenance of transmission lines at high altitude as it is further discussed in this paper.

2. DESIGN OF HEXACOPTER

2.1 Hexacoper configuration

Hexacoper consist of six motors which rotates the six propellers attached to them. The lifting movement of hecacopter utilizes the thrust produced by the six rotating propellers in combination of hexacopter frame. The hexacopter has two types of configuration based on the frame design which are plus configuration (+) and X-configuration (x) as shown in Fig. 1. The hexacoper has 6 levels of chance and which is affected by the rotational speed of every motor. Thusly both the casings will have different model of movement elements. In this we have utilized hexacopter with X arrangement (x). Fig. 1. Shows that each arm of the casing is associated with a DC brushless engine and has a propeller with fixed pitch. It makes the rotor to drive the wind stream downwards which creates the lift force. The rotor has two heading of pivot that is clockwise and counter-clockwise. Three rotors turns in clockwise bearing while other three pivots in counter-clockwise course fixed on the other hand. So we can obviously see the exclusively by the speed of motor pivot the unique movement of hexacopter gets affected.



Plus configuration X- configuration

Fig. 1. Hexacopter configurations

Fig. 2. Toolkit caryying hexacopter frame.

Lightweight material should be used to construct the frame but it should be strong enough so that it can withstand its operational weight along with the weight of the toolkit that is to be carried. Accordingly it is very essential to pick the making material out of the edge admirably by examining its adaptability and strength. The plan of this casing has six equivalent long arms that are appended to the focal point of a multiplied hexagonal plate as displayed in Fig. 2.

2.2 Thrust and Motors

The motor is the main part as it is the impetus component of the hexacopter. It is critical to know the hard and fast weight to be lifted and the push expected to lift the hexacopter before concluding the constraint of the motor used in the arrangement. Calculation for determining the thrust per motor can be done using following equation:

$$\text{Thrust} = \frac{Total\ Weight\ X\ 2}{Number\ of\ Motors} \qquad (1)$$

Moreover, following equation can be used to calculate static thrust [11]:

$$T^3 = \frac{\pi}{2} D^2 \rho P^2 \qquad (2)$$

In this situation T represents Push, D represents measurement of the propeller, β is the air thickness and P is the force of engine. We can as certain worth of RPM from the KV consistent and the voltage utilized by the motor. For a hexacopter framework the really main thrust is given by the motor. Thus we use a BLDC motor. The advantage of this motor is that it does not use the brush and commutator which increases the efficiency as compared to normal DC motor also it produces high RPM (revolutions per minute). KV (rpm/volt) is the principle boundary of worry for BLDC engine. The boundary which expresses the extent of rpm increment for every unit of voltage that is utilized is KV. In this hexacopter we have used 1000 KV BLDC motors.

Fig. 3. BLDC Motor

2.3 Propeller

While selecting the propellers, pitch parameter is often noticed. The distance gushed by the liquid because of one turn of propeller's edges is called as pitch boundary. Assuming that the measurement and pitch of the propeller are huge the lifting power will be high however the turn of the motor will be more slow. Accordingly to lift a weighty burden the pitch and measurement of the propeller should be enormous. In this hexacopter model, to lift a tool stash we have utilized 1045 propellers where 10 is the width of the propeller in cm and 4.5 is the pitch of the propeller.

Fig 4. Propeller

2.4 Battery

Batteries can be called as the power house of the system. It gives the necessary ability to run every one of the parts that we have utilized on the hexacopter. The flight time of the hexacopter is affected by the battery, hence to produce optimal result proper calculations are must. Thusly to get ideal power and burden mixes, the motor current should be not exactly the current of the battery that is being utilized.
Number of cells, release and limit are the most extensive boundaries while choosing the battery. The voltage of the battery in an unfilled not permanently set up by the amount of cells while how much current rating/current speed can be not totally settled by the delivery. How lengthy the battery can chip away at specific amperes is the limit of the battery.

For this hexacopter model we have used 2200 mah battery which has a discharge rate of 30C.

Fig 5. Battery

After assembling final drone is as shown below.

Fig 6. Drone

3. SOFTWARE

To make our toolkit carrying hexacopter drone ready to fly we have to do various calibration. Mission planner is the software that is used to do these calibration. It is like a ground control station. With the help of mission planner we can do accel calibration, compass calibration, radio calibration, ESC calibration, flight modes, etc. Mission planner is more like a dynamic control supplement for our drone.

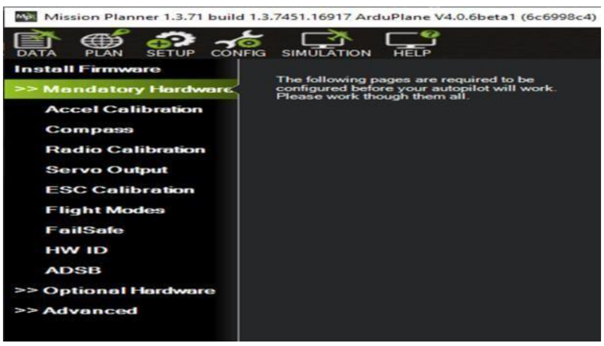


Fig. 7. Mission Planner

We can configure total 23 flight modes to our drone. There are 10 flight modes which are mainly used. However for this model and application we have equipped our hexacopter drone with three flight modes and they are stabilize mode, Alt hold mode and land.

Fig. 8. Mission Planner

4. RESULT

The weight of each part is according to the accompanying:

Table No. 1

No.	Item	Unit	Weight (Grams)
1.	Frame	1	424
2.	Motor	6	390
3.	Propeller	6	42
4.	APM Flight Controller	1	80
5.	ESC	6	138
6.	APM Pix-Hawk Power Module	1	24
7.	Battery	1	170
8.	Shock Absorber	1	20
9.	Delivery Rope And Steel Hook	1	47
		Total	1335

With a full scale weight of 1335 grams , the push of each motor is determined as follows:

$$\text{Thrust} = \frac{Total\ Weight\ X\ 2}{Number\ of\ Motors}$$

Thrust = (1335 X 2) / 6

Thrust = 445 Grams

Thus, all six motors combined produce a thrust of 445 x 6 grams that is equal to 2670 grams. This much pushed will have the choice to lift Hexacopter which has a flat out weight of 1335 grams and on the off chance that the apparatus compartment that will be lifted is of 1000 grams, the by and large of full scale weight is 2335 grams. Consequently we have saved 335 grams for wellbeing. From the estimation, hexacopter can lift it and can fly with practically no issue and effortlessly.

5. CONCLUSION

The venture has option to plan, investigation and build toolbox conveying hexacopter drone that is fit for flying and lifting the tool compartment. With the battery provided, the drone can fly for a sufficient time period to perform the delivery of toolkit when fully charged. With the help of Flysky FS-i6S remote controller the drone can hover and can fly within the range of 1 km. The powerful motors of the hexacopter drone makes it capable of lifting a toolkit which has a weight between the range of 1000 grams to 1300 grams without any problem and with ease. As it is a tool stash conveying drone it can convey different payloads as well. So it has a future extension for conveying different things of weight under its functional cutoff points. It tends to be made do by adding more highlights like camera and GPS. With this highlights it be followed and controlled without any problem.

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