Assembly and Programming of Hexacopter Drone for Surveillance and Medical Kit Delivery Purposes

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Abstract
The project aims to assemble and program a hexacopter drone that can serve the purpose of surveillance in terrains and the delivery of medical kits in remote locations autonomously. Delivery of medical kits using drone technology resolves traffic issues faced by the ambulance during medical emergencies on the other hand drone technology also helps with surveillance in aerial monitoring, military, and agriculture. This Hexacopter drone is assembled by motors, 1045 propellers, Pixhawk flight controller, Electronic Speed Controller [ESC], S550 Frame, GPS module, 12 channel receiver, and transmitter. A Lipo battery is used for power supply power supply. An open-source mission planner software does the programming of the drone. Installation of a camera module for real-time footage during the drone's flight. delivery of the medical kit can be traced through the mission planner software. Technical data provided in this project is based on the parameters of motors and propeller specifications. At the final stage, the footage captured by the camera module during surveillance is stored in mobile phones, and delivery of the medicinal kit is done by autonomous flight without a pilot onboard.
Keywords: Autonomous flight; GPS Module; Hexacopter Drone; Pixhawk Flight Controller; Surveillance.

1. Introduction

Drones are unmanned aerial vehicles that can be operated by trained pilots with the help of a transmitter. As drone technology is growing day by day many applications are used for various types of purposes such as surveillance and product delivery. The healthcare industry is facing problems with the supply of medicines during disasters due to various types of factors such as heavy traffic so to overcome this problem drone technology has come into use for the delivery of medicine, blood, test samples, and medical kits in remote areas. These drones have tremendous potential to deliver vital medicines and other medical supplies to affected regions overcoming all the barriers and faster delivery of life-saving medicines. By locating the area with the use of a GPS module and camera on Board supplies medicine to the bedside of the patient directly from the pharmacy it will also play a vital role during road accidents by eliminating human and road transport interaction this will also help nurses and doctors to work more efficiently and save their time. Medical and antibiotics ordered by people can be delivered at home. The work involves the assembly work of a hexacopter drone along with essential components as well as the programming. Hexacopter drone has a total of 6 arms on which six motors can be mounted. The frame of the drone is an S550 frame this frame can carry a payload of around 1kg so this will help the drone for delivery purposes. A gimble can be attached at the bottom of the drone on which the camera can be mounted. The hexacopter drone can be programmed using mission planner software and, a battery of 5200Mah to provide a long endurance flight. Compared to the quadcopter drone this hexacopter drone achieves a perfect performance of flight and stability. The major use of this drone is for surveillance purposes and product delivery other than that hexacopter drones have a wide application for aerial photography, search, and rescue that can be used for military purposes and disaster zones.

1.1. Objectives

The project aims to build a hexacopter drone for surveillance and delivery by achieving the following objectives: Assembly of a hexacopter Drone to increase the stability and payload capacity during flight time. programming of the drone to fly

autonomously with self-awareness and situational awareness. Mounting of a Camera to get real-time footage from the Hexacopter Drone for Surveillance areas such as terrains. Installation of GPS Module to trace location for autonomous medical kit delivery in remote locations to serve the purpose of medical emergencies.

2. Literature Survey

Mishra, Balmukund, Deepak Garg, Pratik Narang, and Vipul Mishra. "Drone-surveillance for search and rescue in natural disaster." Computer Communications Datasets prepared in this paper are used for surveillance and human detection. The dataset which is been prepared has a wide variety in height, color, and actor [1]. Haritha, S. Anu Sri, N. Susmitha, P. Supriya, M. Nandini, Ch Anand Kumar, and B. Prasada Rao. "Hexacopter Surveillance for natural disaster search and medical Rescue. The work involved in the development of the hexacopter drone using an APM Flight controller to control the aircraft movement.in case of a natural disaster, it can scan affected regions and make search and rescue faster to save more human lives, and medical emergencies can be provided in affected regions [2]. Abdus, SM Anwarul Aziz, Muhammad Maruf Islam, Kh Md Faisal, and Md Arafat. "Design and fabrication of an Autonomous Surveillance Hexacopter. work includes the design and fabrication of a hexacopter drone for surveillance purposes. This hexacopter drone can be utilized in fields such as reporting and monitoring as well as land mapping. Also, this hexacopter drone is used to help the police capture evidence and report it to emergency services [3]. Pawar, Alipta A., Sanjay L. Nalbalwar, Shankar B. Deosarkar, and Sachin Singh. "Surveillance Drone." International Research Journal of Engineering and Technology (IRJET) 6, no. 07 (2019). Remote Controlled Surveillance Drone is used in places such as high temperatures, high working altitude, and poisonous gases which are unbearable for humans. This project plays a major role in border and defense for surveillance [4]. Stamate, Mihai-Alin, Adrian-Florin Nicolescu, and Cristina Pupăză. "Study regarding Flight autonomy estimation for hexacopter drones in various equipment configuration. the paper presents a schematic representation for selecting the proper combination of components for multirotor drones

through online references that come up with methods based on mathematical mode, theoretical tests, and a different variant of the propulsion system, frame size, and configuration. This will help to build a safe operating multirotor drone [5].

3. Method

3.1. Assembly of Hexacopter Drone

Hexacopter Drone Involves an S550 frame along with six arms and landing gear (Figure 1). Clockwise and counterclockwise motors are mounted on the arms alternately and clockwise and anticlockwise Propellers (10× 4.5) are fixed on the motor. The electronic speed controller [ESC], Flight controller, and power module along with the receiver are mounted on the power board distribution. The safety switch, GPS Module, and buzzer alarm are connected to the flight controller [6-9]. The Servo motor is connected to the Pixhawk flight controller. The camera module is installed using a camera gimble to get real-time footage [10].

Figure 1 Assembly of Drone

3.2. Components

3.2.1 Hexacopter Frame

The S550 hexacopter frame has a total of 6 arms, so six motors can be used for the frame [11]. hexacopter frame kit is a strong lighter-in-weight Hexacopter frame with a landing gear of carbon fiber and a printed circuit board (PCB) for neat and easy wiring purposes (Figure 2). The frame weight is 550 gm and it is highly flexible for the mounting of batteries, flight controllers, motors, etc [12-15].

Figure 2 Hex copter Frame

3.2.2 Motors

Clockwise and Counterclockwise motors are mounted on the frame of the hexacopter drone [16]. The motor used is 935kv and the maximum thrust is 840gm. A 10-inch propeller is mounted on the drone motor (Figure 3). A total of 6 motors are mounted on the drone so that maximum thrust is produced to lift the drone at a certain altitude [17-20].

Figure 3 Motor

3.2.3 Electronic Speed Controller [ESC]

A 30A ESC is connected to the drone motors and flight controller in total 6 ESCs are used these ESCs allow the flight controller to control and adjust the speed of the motor (Figure 4).

Figure 4 Electronic Speed Controller

3.2.4 Pixhawk-Drone Flight Controller

The drone flight controller is the main brain of the hexacopter drone. ESCs are connected to the main outport of the flight controller [21-23]. It supports 8 RC channels with 4 serial ports. Firmware is installed using Misson Planner software. The model used in this project is pix 2.4.8 32-bit. The flight controller takes input from the GPS module, compass, and another sensor after it processes this information that is given to the ESCs to control the motors. Along with this flight controller buzzer and safety switch are connected to the ports of the flight controller (Figure 5) [24-27].

Figure 5 Flight Controller

3.2.5 Power Module

The power module is mounted to the printed circuit board of the hexacopter frame this power module monitors the amount of power coming from the battery connected to the power module and distributes it to the drone ESCs and the flight controller (Figure 6). The maximum voltage of the power module is 30v and the maximum current is 90A [28-31].

Figure 6 Power Module

3.2.6 Propeller

A pair of two ABS material propellers clockwise and anticlockwise is mounted over the clockwise and counterclockwise motor (Figure 7). Here, a 1045 propeller is used which is a 10×4.5 propeller (diameter-10inch and pitch-4.5inch) [32].

Figure 7 Propeller

3.2.7 Receiver

A 2.4 GHz RC receiver of 12-channel SBUS supported is used to produce a highly constant and

stable transmission signal [33-36]. Distance controlled by the receiver is up to 2.4 miles in the air and 45mA of max operating current (Figure 8).

Figure 8 R12DS Receiver

3.2.8 Transmitter

A 12-channel transmitter is provided with a throttle stick to the left which gives enough power to the drone to go airborne when flying you must engage the throttle stick constantly along with yaw which helps rotate the drone in a clockwise and anticlockwise direction (Figure 9). Pitch and roll are at the right stick of the transmitter where the pitch is used for the forward and backward motion of the drone and the roll is used for left and right movement [37].

Figure 9 Transmitter

3.2.9 Battery

A 5200 Mah battery is used which is connected to the power module to supply power to the ESC and the motor output voltage is 14.8v. 5200 Mah capacity increases the flight time (Figure 10) [38].

Figure 10 Battery

3.2.10 GPS Module

The GPS Module is connected to the Pixhawk flight controller and provides a high position accuracy and positioning of 50 centimeters (Figure 11). 20 satellites can be searched within a few seconds at open ground [39].

Figure 11 GPS Module

3.2.11 Servo Motor

The Servo Motor is used to release the payload and it is connected to one of the auxiliary ports of the Pixhawk flight controller (Figure 12).

Figure 12 Servo Motor

3.2.12 Camera Module

The camera is mounted with the help of Gimble to get real-time footage. The camera records 4K 30fps video (Figure 13).

Figure 13 Camera Module

3.3. Programming of Drone

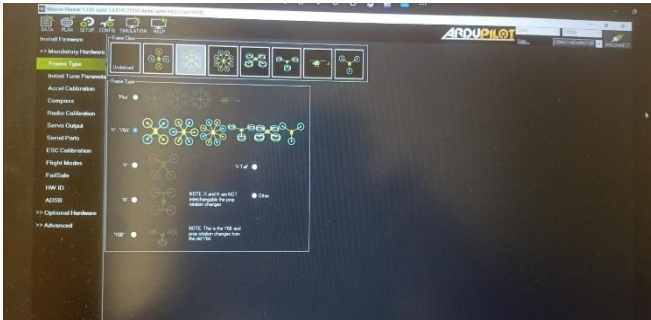1. Select frame Type for this project is a hexacopter frame. The selected frame is a hexa X (Figure 14).
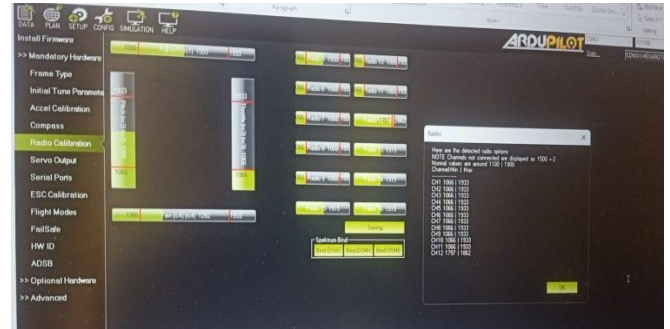
Figure 14 Frame Type

2. Calibrate the accel by leveling the hexacopter drone and moving in right, left, nose up, and nose down positions (Figure 15).

Figure 15 Calibrate Accel

3. Compass calibration is done by rotating the drone at 360 degrees which involves every direction [40]. This provides stability to the drone in any condition and the drone can move in the required direction. GPS is also calibrated by selecting two compasses into the mission planner software at a time (Figure 16).

Figure 16 Compass Calibration

4. Radio calibration is done by turning on the transmitter and it is connected to the receiver. all 12 channels are calibrated by the movements of sticks simultaneously (Figure 17).
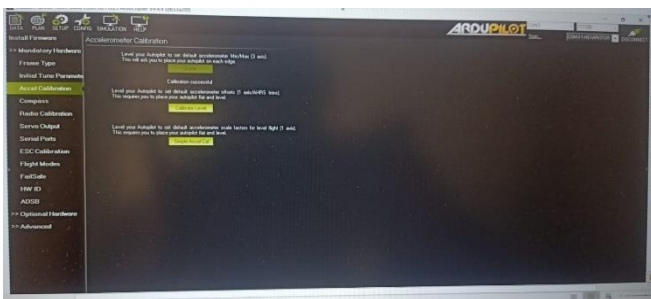

Figure 17 Radio Calibration

5. ESC calibration is done by following the steps included in the Misson planner software. The minimum and maximum PWM values should be between 1000 and 2000 for one-shot ESC (Figure 18).
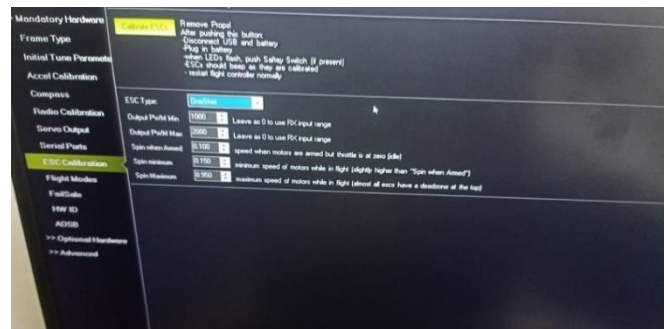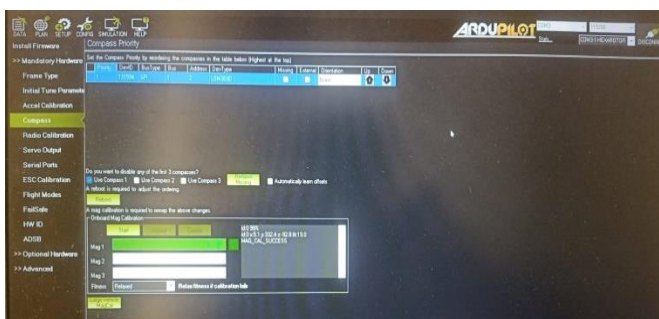

Figure 18 Esc Calibration

7. To plan the advanced mission for delivering medical kits waypoints should plotted on the mission planner software along with servos command. The altitude of the drone should be 20m and other important commands such as takeoff waypoint, delay, servo open, and close. Save these commands and upload them. Once the commands are uploaded start the mission by taking action (Figure 19).

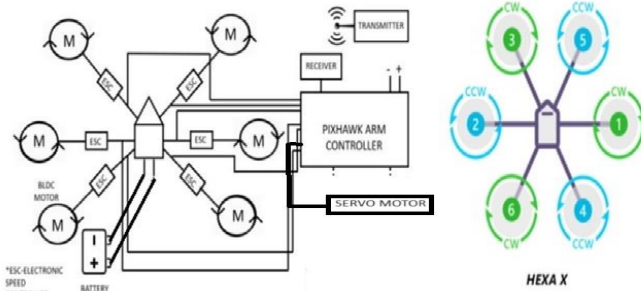**Figure 19 Advance Mission Planning**

3.4. Circuit Diagram

Figure 20 Hexacopter Circuit Diagram and Motor Layout

3.5. Physical Configuration

Figure 21 Physical Configuration of Hexacopter Drone

3.6. Working Principle

(Refer Figure 20 & 21) A total of six BLDC motors are fixed on the arms of the hexacopter drone one motor each. The propeller and motors are mounted alternately clockwise and anticlockwise to achieve stability, and the propeller rotates at high speed to produce thrust. The speed of the motor is controlled with the help of the ESC (Electronic speed controller). The Pixhawk flight controller is the main brain of the drone used to program by open-source mission planner software. GPS module is installed for the autonomous flight to provide high accuracy and positioning. servo motor is connected to the auxiliary port of the flight controller for pick up and place during the delivery of the kit. The drone can lift 2kg of payload to the desired location at a higher altitude of 200-300m. the movement of the drone can be traced with the help of mission planner software through the waypoints. battery is connected to the power module and binds the receiver and transmitter.

Push the throttle stick downward position for the arming of the drone once the drone is armed all the motors start to spin. Slowly move the throttle stick in an upward direction above 50 percent drone will start to lift once the drone starts to fly control the drone with the right roll and pitch stick. Newton's second law of motion states that when the drone hovers at a constant altitude, the motors of the drone generate upward thrust, which equals the downward gravitational force (Table 1).

3.7. Calculation

Table 1 Specification of the Hexacopter Drone

Weight	Thrust
Drone weight – 1200gm	1. Power-to-weight ratio-2.9:1
Battery weight- 488 gm	2. Total thrust- 5040gm
Total- 1688	3. Thrust per motor-840 gm

3.7.1 Motor and Thrust Parameter

$$1. Thrust\ per\ Motor = \frac{Total\ weight}{No\ of\ motors}$$

$$= \frac{1688*2}{6}$$

$$= 562.66 gm \sim 5.519 N$$

$2. Required\ Power\ by\ the\ motor$

$$T^2 = \frac{\Pi}{2} \times D^2 * \rho * P^2$$

$$5.519^2 = \frac{\pi}{2} \times 0.254^2 * 1.225 * P^2$$

$3. Optimal\ Rotational\ speed$
$power = Kp * D^2 * pitch * n^3$
$n = 29.834\ rev/sec$
$n = 187.452\ rad/sec$

$4. Total\ Thrust = thrust * 6$
$$= 562.66 * 6$$
$$= 3375.96\ grams$$

3.7.2 Propeller Specification

$5. Power\ Coefficient$
$PP = \rho * Cp * n\^3 * D\^5$
$$CP = \frac{P}{\rho} * n3 * D5$$

$CP = 0.0018$

6. $Required\ Torque\ on\ the\ Propeller$

$$Tq = \frac{Pp}{\omega}$$

$$Tq = 0.0835 Nm$$

7. $Measuring\ Pitch$

$$Pitch = 2.36 * \frac{Diameter\ height}{width}$$

$$Pitch = 2.36 * \frac{254}{5.24}$$

$$Pitch = 114.34 mm$$

4. Results and Discussion

4.1. Results

Table 2 Results of the Selected Motor and Propeller

Parameter	Minimum Value (Calculated)	Component Selected	Available Value
Thrust Per motor(T)	562.66 gm	935 KV BLDC Motor	840 gm
Required Power by the Motor(P)	15.67 watt	935 KV BLDC Motor	23.39 watt
Optimal Rotational Speed of the motor (n)	187.452 rad/sec	935 KV BLDC Motor	214.225 rad/sec
Total Thrust	3375.96 grams	6 BLDC Motor	5040 gm
Power Coefficient (Cp)	0.0018	1045 Propeller	0.0018
Required Torque on the Propeller (Tq)	0.0835Nm	1045 Propeller	0.109Nm
Measuring Pitch	114.34mm	1045 Propeller	114.34mm

4.2. Discussion

As discussed in the above result data the component selected 935 KV BLDC motor produces a thrust of 840 gm which is higher than the minimum calculated value (Table 2). So, the total thrust produced by the 6 motors is 5040 gm greater than the minimum calculated total thrust i.e. 3375.96 gm. The optimal rotational speed of the motor should be a minimum of 187.182 rad/sec and the obtained value of the optimal rotational speed is 214.225 rad/sec. power coefficient remains the same for 1045 propeller components i.e. 0.0018. required torque on the 1045 propeller for the selected component is 0.109Nm which is more than the minimum calculated value i.e. 0.084Nm whereas the pitch of the propeller remains the same i.e. 114.34mm. above data shows that the selected 935KV BLDC motor and 1045 Propeller are appropriate for the hexacopter drone as they produce a maximum thrust for the required hexacopter drone to lift the drone along with payload at a certain altitude.2kg of payload was carried by the hexacopter drone with the help of servos and the payload was released to the desired location at time delay of 10 sec. The altitude height of the drone was 10m while carrying out the delivery mission. Taking off from waypoint one and following the whole path planned by the mission planner, the total distance covered was 98m. Once the payload was released the drone returned to the home location.

Conclusion

The work represents the assembly of a hexacopter drone for surveillance and product delivery. The hexacopter drone serves both surveillance and advanced missions for delivering medical kits to desired locations. this hexacopter drone can be utilized in fields such as road monitoring, and terrain as well as any industrial inspection and military. Surveillance with hexacopter drones also serves the mission of patrolling to capture various types of suspicious evidence. Also, it resolves emergency medical issues by delivering medical kits to remote areas and those affected by natural disasters.

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