Design and Fabrication of Quadcopter Drone for Delivery

Dr. N.V.S Shankar
Associate Professor, Department of Mechanical Engineering
Vignan's Institute of Information Technology Visakhapatnam, Andhra Pradesh
shankar.publications@gmail.com

Dr. K. Srinivasa Naik
Associate Professor, Department of Electronics and Communication Engineering
Vignan's Institute of Information Technology Visakhapatnam, Andhra Pradesh
nivas97033205@gmail.com

Dr. B. Arundhati
Professor, EEE Dept., Vignan's Institute of Information Technology Visakhapatnam, Andhra Pradesh
b.arundhati@rediffmail.com

A. V. S. A. Vinay
B. Tech (Final Year), Department of Electronics and Communication Engineering
Vignan's Institute of Information Technology, Visakhapatnam, Andhra Pradesh, India
achallavinay@gmail.com

S. D. V. Sampath Kumar, R. Bala Bhanu Teja and Y. Sai Ganesh
Department of Mechanical Engineering
Vignan's Institute of Information Technology, Visakhapatnam, Andhra Pradesh, India
sdvsampathkumar12@gmail.com, ramineedibalabhanuteja@gmail.com,,
saiganesh.yallapu@gmail.com

Abstract

Drones are unmanned aerial vehicles (UAVs) that are used for various applications such as aerial photography, Mapping, Surveying, Payload carrying, agriculture, and Rescue missions. The main purpose of this paper is to describe the design and fabrication of the quadcopter drone for the delivery of goods. This drone can carry smaller payloads such as medical supplies, food items, and product deliveries from one location to another place. 3D printing process is used for fabricating legs. The body is made using sheet metal so that it can carry loads. Custom power distribution board is made. APM2.8 controller is used. The designed drone successfully operated and delivered the goods to specified location. This drone can be operated autonomously in autopilot mode with the help of GPS. Autodesk Fusion 360 software is used for the cloud-based 3D modeling of a quadcopter drone.

Keywords
Quadcopter, Autodesk fusion 360,3D modeling, Fused deposition modeling, 3D printing.

1. Introduction
Drone technology is now a big investment area where a successful project can easily attract investments. The application of the drones are in varied dimensions, which include videography, goods delivery, surveillance etc. Application of delivery drones right now can be clearly seen in international border scenarios. But use of drone for delivery of packages with in cities is till under investigation. Thus, this area is choosen as the problem in the current work. The aim is to design a drone that can deliver a package weighing around 3kgs. Drones are unmanned aerial vehicles (UAVs) and they are also called multirotor or multi-copter. There are different types of multi-copters or UAVs such as dual copters, tri-copters, quadcopters, and hex-copters. Due to their construction and ease-of-use drones can be easily deployable and deliver products to remote locations and they are widely used in many applications. A Quadcopter drone has four motors that are used to lift the drone and it uses fixed patch

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blades in its rotors. The roll and pitch of the quadcopter can be controlled by increasing the speed of the motors on one side and decreasing the speed of the motors on the other side.

2. Literature Review

Drones were introduced in twentieth century and they are developed for the specific applications to reduce the dependency on humans. The design of drone plays crucial role in the development of drone. Many works were done on designing of drone and it is presented in (Nithyavathy et al., 2020; Tatale et al., 2019). G. Ononiwu et al. (Ononiwu et al., 2016) worked on the quadcopter drone for payload delivery. A proportional integral derivative controller is used in this drone and the simulation was done using MATLAB. Many drones were developed based on the Raspberry Pi microcontroller and used for rescue and surveillance applications (Benhadhria et al., 2021; Brand et al., 2018; Chettri et al., 2021). A. Sai Kumar, et al (Kumar et al., 2019) and K.V.V. Mani et al (Mani Sai Kumar et al., 2018) worked on delivery drones. Asha Sanap et al. (Asha Sanap, Neha Dutte, Rohan Vijapure, Viraj Memane, Shivam Chavan, 2021)worked on the weather modification drone. APM flight controller was used in this drone and this drone is used for the cloud seeding purpose to tackle the water scarcity of an area. Tanmay Kumar et al. and M. Khan et al. worked on the physics and flight dynamics of quadcopters and their applications and it is detailed in (Khan, 2014; Kumar and Hasan, 2020). Nadia Nowshin et al. (2020) worked on the designing of drones using Arduino Uno. C. Rajath et al. (2018) worked on an agriculture drone where it is used for monitoring agricultural fields to detect pests and spray insecticides on it using the agro drone.

Raffay Rizwan, Muhammad Naeem Shehzad, et al.(2020) developed a health monitoring drone. The drone consists of the emergency medical kit and live streaming is done to the main control station so that the patient's condition can be directly known to the doctor and first aid can be easily done (Rizwan et al., 2019). Ashish Kumar and Sugjoon Yoon (2020) developed a solution for the landing problems of the drone. They developed a Fuzzy logic to make a soft landing. This is achieved by using an ultrasonic sensor, the Raspberry pi. This logic also reduces the time for landing the drone. The use of Kalman filter for the controlling quadcopter is discussed in (Bauer et al. 2008).

3. Methodology

In a quadcopter drone, two of the motors rotate in a clockwise direction and the other two motors in an anti-clockwise direction. The speed of the motors is controlled by the electronic speed controller. If the two motors on the rear side of the drone rotate at high speeds, then the drone moves in a forward direction. If the two motors on the front side of the drone rotate at high speeds, then the drone moves in a backward direction. If the two motors on the left side of the drone rotate at high speeds, then the drone moves in a rightward direction. If the two motors on the right side of the drone rotate at high speeds, then the drone moves in a leftward direction. The transmitter sends the desired signal to the receiver and the flight controller sends the corresponding signals to the ESC. The navigation of the drone can be done by connecting the GPS to the flight controller.

4. Components

4.1 Flight Controller

Ardupilot Mega version 2.8 is used as a flight controller in this drone. Ardupilot Mega flight controller takes the signals from the radio receiver and outputs the corresponding signals to the electronic speed controller. It has a GPS port for the GPS module. APM flight controller can be used for autonomous missions using GPS.

4.2 Electronic speed controller:

Electronic speed controllers are used in quadcopter to change the speed of the brushless DC motor. It is powered by a 3S LiPo battery and a battery eliminator circuit is present in the electronic speed controller.

4.3 Brushless DC motor:

Brushless DC motors are used in this drone as they have better performance and efficiency. The life expectancy of the BLDC motors is higher and it makes less noise. BLDC motor does not contain brushes instead it has a permanent magnet at the center. The rotation is due to the change of magnetic field direction. BLDC motors with a 2200kv rating are used in this drone.

4.4 APM Power module:

APM Power Module is to power the flight controller from the battery and it sends the required amount of power to the flight controller. it supports 2 cells to the 6-cell battery and its maximum input voltage is 28V and its maximum current sensing is 90A.

4.5 Battery

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A lithium polymer (LiPo) battery is used to supply power to the drone. The capacity of the battery is 5200mah, the output voltage is 11.1v. It is a 3-cell battery and it can sustain high current loads.

4.6 Global positioning system (GPS)

GPS is used to track the drone carrying the payloads. The path of the drone can be set up in the APM flight controller and the drone goes on the defined path with the help of the GPS.

4.7 Transmitter and receiver:

A Radiofrequency transmitter and receiver are used for the control of the drone. A transmitter sends a signal to the radio receiver where it receives the signal and works accordingly. Flysky-CT6B transmitter and receiver have a radio frequency range of 2.4 GHz to 2.45 GHz and the number of channels is 6.

5. Block Diagram of Control System

Figure 1 shows the Block diagram of the quadcopter drone, In the block diagram electronic speed controllers, GPS, and Radio receivers are connected to the Ardupilot Mega flight controller. Flight controllers, electronic speed controllers, and Brushless DC motors are powered with LiPo Battery using a power distribution board. The radio transmitter sends the signal to the receiver that is connected to the flight controller and the receiver receives throttle, yaw pitch, and roll signals from the transmitter and sends the corresponding signals to the flight controller. The flight controller sends the electronic signals to the speed controllers accordingly. ESC manages the speed of the motors based on the signals received from the Ardupilot Mega flight controller. GPS is used for navigation purposes.

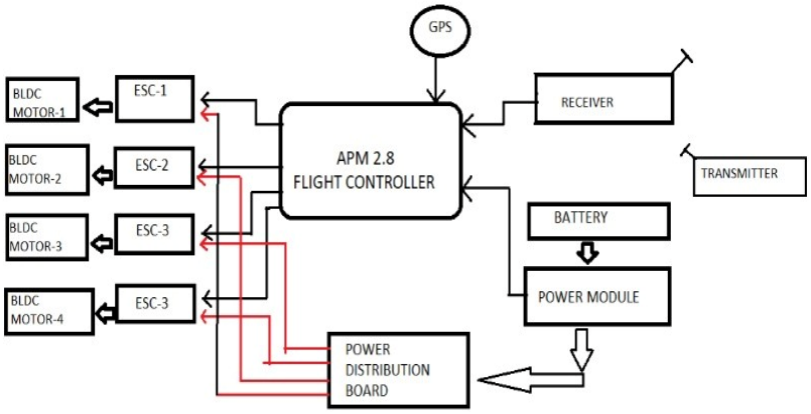

Figure 1. Block diagram of a quadcopter drone

6. Design and Fabrication

6.1 Designing of quadcopter drone body

A quadcopter is a multi-rotor drone that has four arms having a brushless dc motor on each arm. Quadcopter drone arms are designed in fusion 360 software. Hence this is a delivery drone, the middle part of the body has to be strong to carry the loads. so, a sheet metal body has to be used for the upper and bottom parts of the drone connecting four arms. The drone planned for the current work is initially modeled in fusion 360 software. Figure 2 shows the design frame of the drone in fusion 360 software.

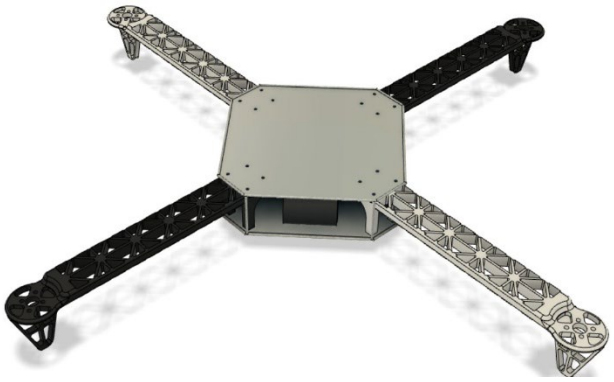

Figure 2. Modeling and rendering of a quadcopter drone in fusion 360

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6.2 Fabrication and Assembly of quadcopter drone

In this section, the fabrication and assembly of the quadcopter are discussed

6.2.1 Fabrication

3D printing is also known as additive manufacturing and it is the process of building a 3d object from a CAD model. The arms of quadcopter drone designed in fusion 360 software, Additive manufacturing of quadcopter arms by using PLA (Polylactic Acid) Filament in 3D printing. Repetier Host software is used for slicing and Creality Ender 3.0 is used for printing parts. Table 1 show the parameters used for 3D printing. Figure 3 shows the slicing of the quadcopter drone arm in repetier host software. Figure 4 show the 3D printing and printed legs of quadcopter.

Table 1. 3D printing parameters

Parameter	Value
Shell Thickness	2 mm
Top and Bottom Thickness	2 mm
Infill Patern	Grid
Support Pattern	Grid
Fill Amount	15%
Print Speed	25 mm/s
Travel Speed	60 mm/s
Layer Thickness	0.2 mm

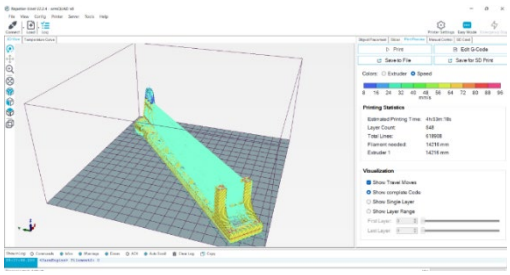

Figure 3. Slicing of quadcopter drone arm in repetier host software

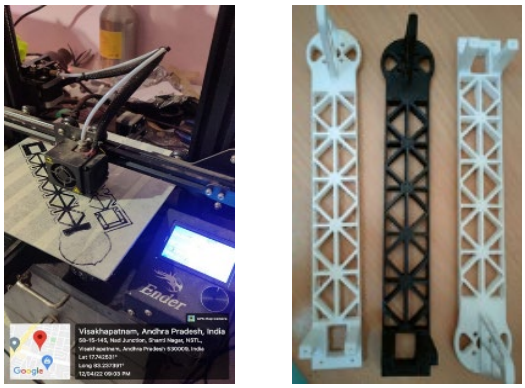

Figure 4. 3D Printing of components and 3D Printing arms

6.2.2 Assembly and Flight Testing

3D printed arms of quadcopter drone assembled to the sheet metal body of the drone. Figure 5 shows the fabrication of the sheet metal body. A Brushless DC motor is connected to the electronic speed controller (ESC). Motors are

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placed on edge of the arms and ESC is placed in the middle of the arms. A power distribution board is used to distribute the power to all components. APM flight controller is placed in the middle of the drone and it's connected to the receiver, ESC, GPS module, and power module. Assembled drone is shown in figure 6. The drone is flight tested. With the designed drone, a weight of 3Kg has been lifted successfully.

Figure 5. Fabrication of metal body for the drone

Figure 6. Final Assembly of the robot

7. Conclusion

The use of light materials in the device's design allows the quadcopter drone to fly fast to its goal. The design and assembly of a quadcopter are explained in depth in this publication. Additive manufacturing is used to create quadcopter components. The components were designed in Fusion 350 and then 3D printed. The document includes a list of electronic components and their specs that were used in the fabrication process. An APM flight controller provides control. The drone is more stable, and it can also fly on its own and use GPS to return to its launch location. The quadcopter can deliver tiny items such as drugs, food, and other supplies to remote locations.

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Biographies

Y. Sai Ganesh is currently pursuing his final year B.Tech. in Mechanical Engineering, Vignan's Institute of Information Technology Visakhapatnam, Andhra Pradesh, India.

R. Bala Bhanu Teja is currently pursuing his final year B.Tech. in Mechanical Engineering, Vignan's Institute of Information Technology Visakhapatnam, Andhra Pradesh. India.

S. D. V. Sampath Kumar is currently pursuing his final year B.Tech. in Mechanical Engineering, Vignan's Institute of Information Technology Visakhapatnam, Andhra Pradesh, India.

A. V. S. A. Vinay is currently pursuing his final year B.Tech. in Electronics and Communication Engineering, Vignan's Institute of Information Technology Visakhapatnam, Andhra Pradesh, India.

Dr. N.V.S. Shankar is currently working as Associate professor in Department of Mechanical Engineering, VIIT (A). He has published multiple articles in various journals of international repute. He has good expertise in CAD/CAM/CAE and IoT.

Dr. K. Srinivas Naik is currently working as Associate professor in Department of Electronics and Communication Engineering, VIIT (A).

Dr. B. Arundhati is currently working as professor in Department of Electrical and Electronics Engineering and is principal of VIIT (A). She is currently heading IDEA lab in which this project is executed.

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