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Design and Fabrication of Ambulance Drone with Navigation

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ABSTRACT: The first few minutes during any medical emergency are essential to provide the right care and to prevent escalation of any disease. Speeding up emergency response can prevent deaths and accelerate recoveries dramatically. Particularly for heart failure, traumas, snake bites, diabetes and respiratory issues. With ever increasing traffic and growing population the only possible way to speed up the process of providing medical aid is through air transport and particularly with the help of quadcopters.

With our Ambulance drone we can provide lifesaving technologies and medicines like Automated External Defibrillator (AED), EpiPen, Insulin Pen/ Insulin Cartridge, Anti venom, First aid kits and much more. This technology is economical and with a network of such drones we can cover entire cities and can save thousands of lives.

We aim to develop an autopilot drone that can lift a total payload of medical equipment up to 2 Kg. Our vision is to develop a drone with GPS navigation and auto pilot system so that it can take autonomous flight to the desired destination with minimum manual input.

KEYWORDS: Autopilot, GPS, Save lives, Quad copter, 2Kg Payload

I. INTRODUCTION

The purpose of making a quadcopter for the medical and health care industry is to speed up the response time and increase the reach of medical aid in all areas. India is the second largest in terms of population but ranks 112th in terms of healthcare. Being a developing country with excess population and limited resources it is the need of the hour for India to adapt to a more advanced alternative for medical assistance. Unmanned Aerial Vehicles are an excellent way to modernize the last mile in medical deliveries and bridge gaps in access. Drones can provide just-in-time resupplies of key medical items, regardless of location. Since some health systems can't afford to keep cold-chain products such as platelets or blood on-site, drones can ensure these supplies are available on demand.

II. RELATED WORK

In [5] The paper indicates that the system is a flexible and computationally strong research platform for autonomous micro air vehicles. Especially if a fast on-board computer is needed. The system design was so efficient that it is unmatched in the class of small scale MAV's. In [6] The review explored how drones are being studied in healthcare and health-related applications in North America. Studies predominantly focused on population segments in the medical community and paid limited attention to how patients and communities interacted with and perceived the use of drones for health-related applications. In [9] The Quad X structural model was used to enable the Quadcopter to gain more speed over a short period of operation, it gave insights on how to increase the efficiency and speed as timely delivery of payload was an important factor. In [12] The study focused on delivering an AED in the rural areas of OHCA may be safe and feasible. By using GIS models suitable placement of drone systems can be designed. The



use of an AED equipped drone may have the potential to reduce time to defibrillation in OHCA. In [16] Health care drone was designed and developed with implementation of navigation system to deliver the healthcare items. It had high stability because of the APM Control Board. It gave insights to enable features like return to home and way point navigation.

III. PROCESS AND WORKING

1) Calculations

Perform calculations for finding appropriate components for the drone. Calculations are made such that a drone that could lift 2 Kg could be made.

2) Assembly

All the basic parts required for initial flight-testing stage will be carefully assembled.

3) Flight testing

- Flight testing will begin with a basic setup without payload.
- Flight testing with 1 Kg payload in payload delivery box.
- Flight testing with 2Kg payload in payload delivery box.
- Autonomous Flight testing without payload delivery box.
- Autonomous Flight testing with 1 Kg payload in payload delivery box.
- Autonomous Flight testing with 2 Kg payload in payload delivery box.

4) Making the drone Autonomous drone with GPS and Autopilot

GPS module will be connected to the drone and autopilot features will be incorporated with the drone. Testing autopilot features by way points in different conditions will be performed. Ardupilot's Mission Planner and Tower will be used to make the drone Autonomous. As both the Software being used are Open Source if required changes will be made in the Autopilot system for better results.

IV. COMPONENTS

1. Flight controller – APM V2.1 Flight Controller
2. Glass Fiber Flight Controller Anti-vibration/Shock absorber Set
3. GPS - NEO-M8N GPS Module
4. Antenna - GPS Folding Base Antenna set
5. Telemetry- 915MHZ Radio Telemetry
6. Propellers - 1238(12X3.8) x 4
7. Frame -500 Glass Fiber Frame ESC Power Distribution Board
8. ESC - 40A 2-6S Brushless Electric Speed Controller
9. Remote Controller - FlySky FS-i6 2.4G 6CH PPM RC Transmitter with FS-iA6B Receiver



- 10. Motor- EMAX MT3515 335KV Brushless DC Motor
- 11. Battery - 8000mAh 6S 35C/70C Lithium polymer battery Pack (LiPo)

V. CALCULATIONS

4.1 Motor calculation:

- Drone weight = 5618 gm
- Power -to- weight ratio= 3
- Number of motor = 4

Equations:

$$\begin{aligned} \text{Thrust requirement} &= \text{drone weight} \times \text{Power -to- weight ratio} / \text{Number of motor} \\ &= 5618 \times 3 / 4 \\ &= 4213.25 \end{aligned}$$

➤ 4200 Battery calculation:

1. Battery discharge

Convert mAh to Ah

$$4200 / 1000 = 4.2 \text{ Ah}$$

2. Determine the maximum discharge of the battery to stick to the 80%

$$\begin{aligned} \text{Efficiency capacity} &= 4.2 \times 0.8 \\ &= 3.36 \text{ A} \end{aligned}$$

3. AAD

If you know each motor draws 1 amp to produce 106g of thrust

Total weight = 5205 gm

$$\begin{aligned} \text{Thrust to be generated by each motor} &= 5205 / 4 \\ &= 1301.25 \text{ gm/ motor} \end{aligned}$$

$$\begin{aligned} \text{Average Amps calculation} &= 4 (\text{motor}) \times 934.75 / 106 \\ &= 36.29 \text{ Amp} \end{aligned}$$

4. Flight time (T)

$$T = \text{capacity} \times \text{discharge} / \text{AAD} \times 60$$

$$T = 4.2 \times 80\% / 36.29 \times 60$$

$$T = 5.55 \text{ minutes}$$

Flight time for 4200mAh is 5.71 minutes.

Now we will calculate flight time with an 8000 mAh battery to compare if the flight time with higher weight of the battery increases or decreases.

➤ 8000 Battery calculation:

1. Battery discharge

Convert mAh to Ah

$$8000 / 1000 = 8 \text{ Ah}$$

2. Determine the maximum discharge of the battery to stick to the 80%

$$\begin{aligned} \text{Efficiency capacity} &= 8 \times 0.8 \\ &= 6.4 \text{ A} \end{aligned}$$

3. AAD

If you know each motor draws 1 amp to produce 143.37g of thrust

Total weight = 5313 gm

$$\begin{aligned} \text{Thrust to be generated by each motor} &= 5313 / 4 \\ &= 1404.5 \text{ gm/ motor} \end{aligned}$$

$$\text{Average Amps calculation} = 4 (\text{motor}) \times 1404.5 / 106$$



= 39.18 Amp

4. Flight time (T)

$$T = \text{capacity} \times \text{discharge} / \text{AAD} \times 60$$

$$T = 2.2 \times 80\% / 39.18 \times 60$$

$$T = 9.80 \text{ minutes}$$

Flight time for 8000mAh is 9.80 minutes.

From this comparison we conclude that flight time with 8000 mAh battery is 76.5% higher than 4200 mAh battery. Hence, we choose 8000mAh battery.

Tower Version 4.0.1 Beta 1

Tower is a powerful and intuitive flight control program that we are using for enabling autopilot features. It provides everything we need to plan, fly and track any ArduPilot powered drone. Tower delivers a simple but feature-rich flight experience. It's also an open-source app, which means the code is available to us if we want to build new features into Tower or customize existing ones.

VI. DESIGN

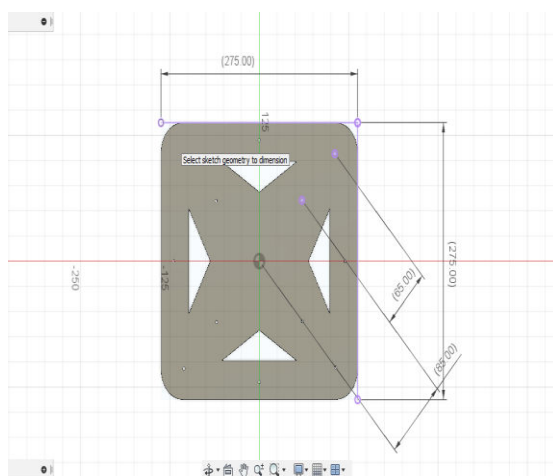


Figure 1 - Upper Base Plate

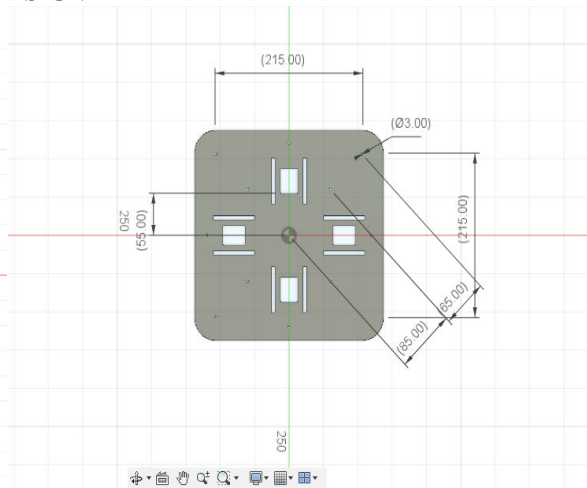


Figure 2 - Lower Base Plate

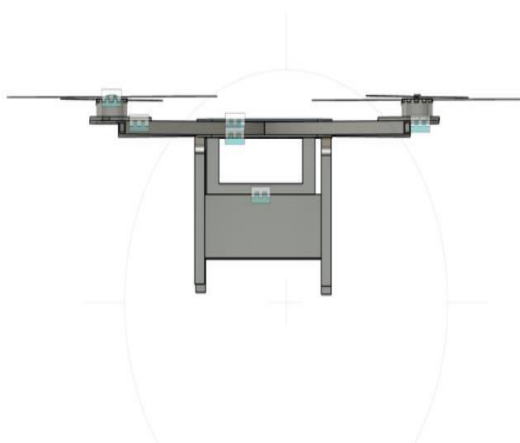


Figure 3 - Drone design (Side view)



Figure 4 - Drone design (Isometric view)



Figure 5 – Drone (Isometric view)



Figure 6 – Drone (Top view)

VII. EXPERIMENTAL RESULTS

Types of Flight Testing	Result
Flight testing without Payload	Successful
Flight testing with 1Kg Payload	Successful
Flight testing with 2Kg Payload	Successful
Autopilot Flight testing without Payload using Tower	Successful
Autopilot Flight testing with 1Kg Payload using Tower	Successful
Autopilot Flight testing with 2Kg Payload using Tower	Successful
Autopilot Flight testing with 1Kg Payload using multiple waypoints in Tower	Successful
Autopilot Flight testing with 1Kg Payload using spline in Tower	Successful



VIII. CONCLUSION

The drone successfully passed all the tests with both autonomous and manual configurations. With this ambulance drone medical equipment up to 2Kg can be conveniently transported. Our Ambulance drone can make it possible to deliver blood, vaccines, birth control and other medical supplies to rural areas and have the ability to reach victims who require immediate medical attention within minutes, which in some cases could mean the difference between life and death. They can transport medicine within hospital walls and courier blood between hospital buildings, as well as give elderly patients tools to support them as they age in place. Our Ambulance drone offers a variety of exciting possibilities to the health care industry, possibilities that help save money as well as lives.

The applications of such an efficient medical supply transportation are many including Automated External Defibrillator (AED), EpiPen, Suturing kit, First-Aid kit, Insulin Pen/ Insulin Cartridge, Analgesics, Gauze or bandages, Ambu Bag, Lorazepam for Seizures, Injectable Anti-histamine, Nitroglycerin for heart attack patients and Anti-venom to name a few.

Our Drone will decrease the reliance on human beings that provide care and decrease the cost of assisting people, being able to cross long distances at faster speeds with minimal human input will change the entire healthcare system. With a network of such drones in cities and rural areas India can climb up the ladder from 112th to the top position in healthcare system. With growing population and increased traffic, ambulance drone is the future of healthcare

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