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Design and Implementation of Solar Powered Drone for Medical Emergency Applications

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ABSTRACT

In this paper an automated drone system is designed and implemented for medical emergency application. The proposed system has inbuilt GPS system to track the destination. The system is designed to access the medical products with minimum time frame. The proposed drone is designed in an approach to carry the medicinal products for first aid treatment, and also it is designed to carry the blood components for blood transfusion. The flight controller is designed in such a to take off up-to 100-meter high and GPS system is provided to reach up-to 2 km radius and return back safely to the desired location. In the proposed system four motors of the quad-copter is attached to carry 6 kg of medical products. In addition to this, flexible solar panels are attached to charge the battery banks. The entire system is designed to control both in manual and automatic modes using controller. The system is automated using Mission Planner software to formulate the system to reach the exact location automatically.

***Index Terms*— Flight controller, propeller, power module, GPS system, quadcopter, automated transportation**

I. INTRODUCTION

In a country like India where the per capita of vehicles is very less compared to other country due to the high population and poor infrastructure the traffic congestion has been a big concern [1-4]. This has a direct impact

on the delay in ambulance and first aid treatment in emergency situations. 30% of the accident deaths in India occur due to delay in Ambulance and 50% of the heart attack deaths in India occur due to the lack of first aid treatment in the initial hour of time known as Golden hour. To reach the patients in the initial golden hour and increase the survival rate an additional medical drones can make up the delayed ambulance time. These medical drones can reach the desired locations with the necessary equipment and medicines according to type of emergency.

They provide essential medicines that are needed to be given initially to stop the patient from reaching the critical condition. Blood transfusion has a major role to play in treatment for critical conditions, these drones have the capacity to carry the required blood and minimize the travel time and the risk of being delayed due to traffic. These initial treatments do not require a doctor any individual who can read and understand can treat the patient with the demonstration video played on the screen in the drone. Especially for heart attack cases the drones carry injections and tablets for mind cases and when the patient is serious and not able to be paralyzed defibrillator machine that provide electric shocks to the patient will be also attached with the drone. These first aid activities save the patient from reaching critical condition and get some more valuable time to reach the hospital [5-9]. The drones are built in such a way to carry 3-5 kg of weight which is more than sufficient to carry these equipment and medicines. The drones can be controlled both automatically and also manually to make the tit reach the precise destinations. It works on the GPS module and reaches the destination more precisely. They are also light weight and compact so they can move into smaller areas. These advancement technologies while in implementation can turn out to be lifesaving. The country is facing more traffic congestions due to the increased number of vehicles and also the poor infrastructure. This traffic congestion leads to delay in ambulance and first aid services to the patient by roadways. 30% of the road accident deaths are caused due to delay in ambulance service and 50% of the heart attack deaths occur due to lack of treatment in the initial hour. Rural areas and Primary healthcare centers lack proper treatment facilities and availability of medicines is also big concern. Transporting the patients has the possibility of delay in treatment. Blood transfusion is also a big concern to transport the blood from the nearest blood bank. Roadway transportation is facing a huge setback due to the unexpected traffic congestions and the delay in the complete progress. To overcome the above problems, the drone system is designed and implemented for medical applications. The main motivation of the proposed system is to develop a system that avoids the current traffic and infrastructural problems and to develop a prototype to reach the required destination as soon as possible and carry necessary products and details.

II. SYSTEM DESCRIPTION

The components used in making the drone with the mentioned specification and application are:

A. S500 Multi Rotor Air PCB Frame

The Multi Rotor Air PCB Frames are the upgrades of the early Quadcopter F450 Frame. It is built on as the succession of the F450 Frame and has all its merits. Its frames are upsweep slightly; this produces a dihedral effect that makes the quadcopter very stable especially when descending from higher altitude. The carbon fiber rod makes the structure strong by running through the center making it equally balanced

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B. T-*Motor 60A Flame ESC*

These motor drivers have special core multicolor controllers they improvise greatly on the response provided by the throttle. Consists of specialized optimized software for compatibility with disc type motors. They consist of all settings except timing which makes it more intelligent and adaptive. Especially compatible with various flight control system supporting up to 600Hz frequency

C. P*ropellers*

Orange HD Propellers Carbon Fiber Black is a specially designed high-quality propeller of multi-copter. These Propellers have a 15-degree angle and are light weight with high strength designed at the end of the propeller to avoid whirlpool during the flying of the multi-copter. These are used in multi-copters as well as drones. These propellers have high flexibility and endurance and they help to improve air-powered efficiency and stability.

D. *Flight Controller*

The latest upgrade of the flight controller is designed and developed to optimize the full drone code stack. It features a smaller form factor, computing more power and with high RAM feasibility. It is also equipped with sensors with higher temperature stability, integrated vibration isolation and extra ports for better integration and expansion.

E. T *Motor U Power U5 400KV*

This U5 400KV T motor is waterproof and dustproof and ideal for 3 to 8 kg multi-copter. Its unique side whole design provides swift airflow and cools 2.5 times faster than other motors. It is equipped with a oxygen-free copper coil that can withstand up to 180 degree Celsius to enhance short circuit resistance. Silicon steel sheet precision at 0.2mm standard height reduces heat and eddy and improves efficiency. The service life is over 1600 hours trouble free.

F. *Gps Module* 4

GPS Module as the route and location indicator for the designed model for accurate movement and precise landing. This is designed in the way to ensure continuous connectivity of the drone to the controller and influence in the decision making. This stand as the core feature in autonomous operation as the complete operation is dependent on the signal received by the GPS Module.

G. *Power Module*

It is the component that is used to provide clean power from the designated battery to the components. In this drone application the power module takes and delivers the power from Lip- Battery to all the components that require input voltage for operation. The maximum input voltage is 28V and the current sensing can be expanded up to 90 A. It can be used across 65 batteries at the maximum extent to deliver power at a particular time of operation.

H. *Lithium Polymer Battery*

It is 5200 mAH battery packs with lithium polymer composition which can withstand high current loads with minimize resistance. This is the best low weight battery at the particular specification so it does not add extra weight while flying. It is one of the best temperature controllers as it will withstand and does not let the temperature rise over a particular limit. They have a very high discharge capacity so high input effective components can be used so the limitation of the system can be minimized. The rechargeable type of battery with fast charging method and better withstand ability makes the battery more as compatible for this specified drone.

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III. MEHODLOGY

The system of operation is segmented in to two namely the Transmitter section and the receiver section. The transmitter section consists of device for the signal transmission that controls and varies the operation of the drone according to the command given by the operator. The receiver section makes u the body of the drone where the flight controller act as the main component to which all the other components like GPS module, Motor Driver and Battery. The GPS module is connected with the application to make the system automated. The location chosen on the application directs the drone in which the flight controller commands the motor driver and motor to control its rotational direction. The rotation of the motor for uplift, left and right direction will be already programmed and the flight controller implements according to the command given. The manual control operation of the drone will be done using the remote controller with the view provided by the camera over the head of the drone. The block diagram of the proposed system is shown in Fig. 1.

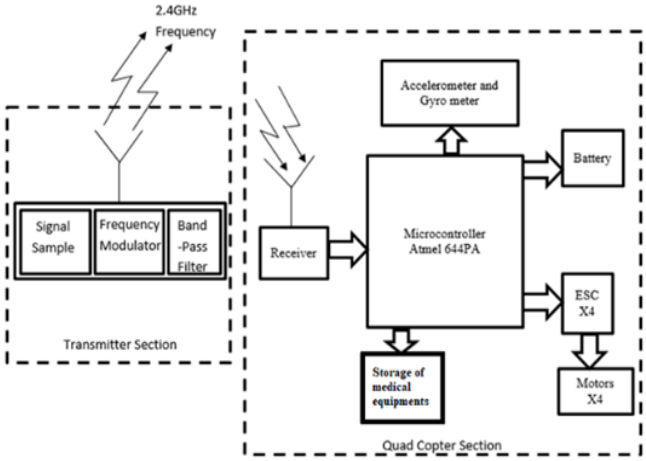

Fig. 1 Block diagram of the proposed drone system

The rotation of motor at initial conditions is shown in Fig.2. The storage unit for medical equipment has been attached to this drone. The storage unit can carry Red Blood Cells, Plasma, Platelets, Vaccines and Injections which required particular temperature storage unit. The other section of the storage unit contains emergency medicines according to the need. Medical equipment named Defibrillator is the main component attached to the drone which can be used as first aid treatment during heart attacks.

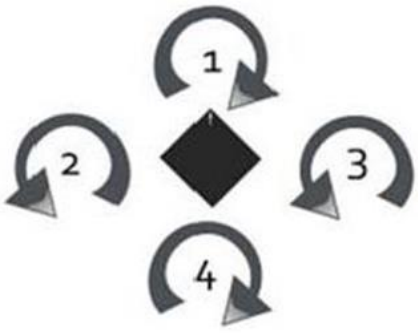

Fig. 2 Initial rotation of wings

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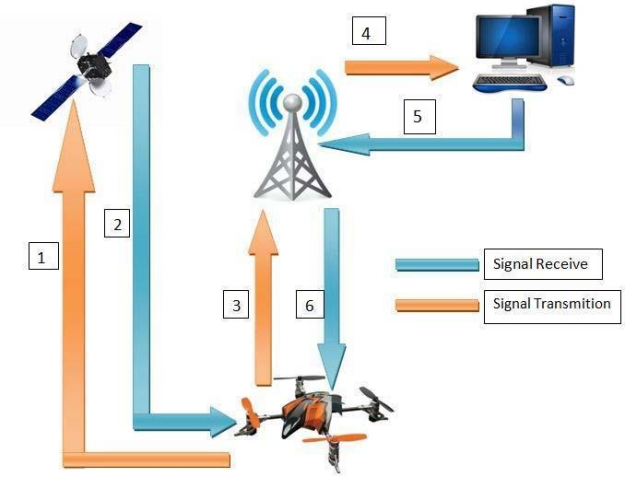

Fig. 3 Signal Model

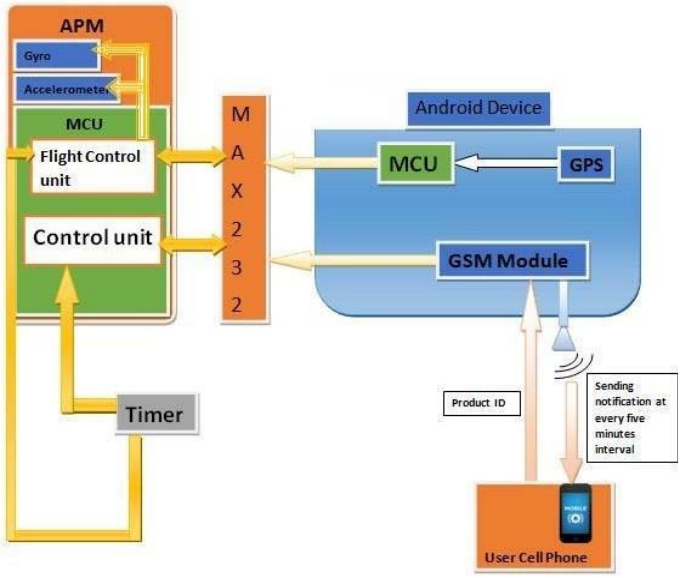

Fig. 4 Control unit

Off board control system consists of a computer of the control room of the local office and receiving message from mobile of the user. The incoming and outgoing signals are represented in Fig. 3. The computer of the control room provides necessary data to the GPS in the QC after arming the QC. Computer of the control room will also monitor the position of the QC during transportation via GPS with the help of internet. The android device interfaced with MCU of the QC will send continuous notification to the user mobile after every five minute interval. The control unit of flight controller is shown in Fig. 4.

IV.MISSION PLANNER

The whole system is run on both automated and manual control. The automated model needs to be connected to the GPS module and be programmed and connected to the application to make automation possible. Mission planner is the software used to program the flight controller and the location set on the application will be

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directed by the flight controller to reach the location. The change in location or destination can be controlled by the application and the operator will be able to terminate the application and also control it manually using the remote controller. The direction, time and distance can also be traced. It is a open source community web application that can operation on computer and mobile which works on the specified application according to the system at which it is used. In this the drone information and the specifications with the necessary detains are taken into account and the progress of the application to deploy the equipment is done.

Fig. 5 Mission Planar

The Software is designed and telecasts the starting and ending point of the transportation and with the current location of the drone and the shortest route the transportation is taking place. The complete action can be controlled with the application itself. Moreover, it is a open source application making it easy to access. The snapshot of the mission planar is shown in Fig.5.

V. MODELING AND ANALYSIS

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Fig. 6 Experimental setup

This is the prototype model designed as shown in Fig. 6 is executed in the way to lift 3kg of weight excluding the drone's components weight. The model is complete with all structural and program modifications and is ready to carry and fly.

The model is made of fiber body so it can be able to carry the required amount of weight and also be weight less. The motors are capable of producing torque to carry 6kg of weight. The flight controller can reach up to 100-meter high and can have a GPS signal that can reach up to 2km radius and return back safely to the desired location. The battery capacity is matched to complete the action specified above and prolong it. This system can be controlled both manually and automatically using the flight controller that is connected to remote operation and also programmed to the Mission planar software. The manual operation takes place according to the operation of controller on the ground; each specified action is controlled by the controller manually. The autonomous operation of the system has specified according to the system while the start and end are initiated and the remaining travel direction are guided by the system and no manual control is needed. This is the designed specification and task of the drone that is mentioned on paper theoretically. The practical application is done as the prototype for this same application purpose.

VI. MODELING AND ANALYSIS

The result of the test analysis shows that the drone can fly both automatically and manually and can reach the precise location within 2km radius. The drone can fly approximately 70 - 100-meter high with the speed of 80-100km/h at the maximum. The 4 motors of the quadcopter produce a torque of 6000 that can carry 6kg of weight. The drone weights about 1.6kg and it is noted that drone takes twice the amount of torque of its weight to lift itself. So out of the torque produced for 6kg 3.2ks is taken up by the drone itself and it can carry external weight of 2.7 kg. The result has also confirmed that the autonomous and manual operation of the system is both working according to the specified instructions. The software application can radiate and command properly up to 1.5 km radius with the specified GPS module. The manual control can be made easily operated within

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eyesight radius for further transport camera operation has to be used that had been fixed on the head of the drone. The time taken to reach the saturation point with the payload is shown in Fig. 7.

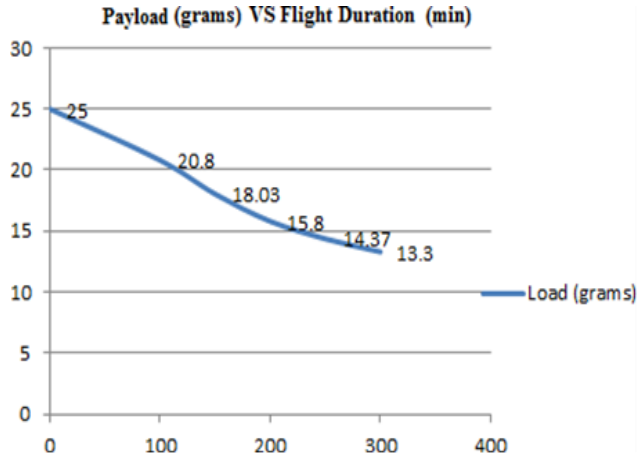

Fig. 7 Payload vs Duration graph

VII. CONCLUSION

Drone is all set to revolutionize the transport and delivery system in the near future. It is estimated to be 45-billion-dollar industry in 2025. Medical sector is set to see huge transitions as the not contact treatment and social distancing as become a part of life. To reduce the human efforts in complex irrigation, the proposed system is utilized for spraying pesticides. The roadway delay and the quick availability of the system will be more favored and a proper systematic format for running these under control can revolutionize the future of delivery and transportation of light weight objects. The plan and transportation of the model drone is made with superior and light weight components with the carrying capacity of 3-5 kg so that the medical equipment can be carried. The system is automated using Mission Planner software to make the drone reach the precise location automatically.

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