Innovation 2020
Organised by
Computer Engineering Department, Dr. D. Y. Patil School of Engineering, Lohegaon, Pune, Maharashtra, India in association with
International Journal of Scientific Research in Science, Engineering and Technology

The MARK8 Drone : Smart Drone for Delivery Medicine

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ABSTRACT

Drones have the ability to gather real time data cost effectively, to deliver payloads and have initiated the rapid evolution in various scientific purposes, public safety, and in commercial industries. Ordinary drone applications in medicine include the assessments for delivering aid packages, medicines, vaccines, blood and other medical supplies to remote areas with the help of security by using QR Code scanning to open and place aids in container box;

Drones help provide emergency healthcare service to patients from a distance to a remote area where reaching by road or other means are either dangerous or not possible. Rapid and fast order deliveries make significant efficiency and early help to needy and avoid life threatening scenarios. Paramedics or health service staff can use drone to deliver required medical supplies to high altitude points or in hostile areas. Our systems include the most efficient and effective algorithms which make it very helpful for delivery medicines for people via drone.

Keywords: Drone, Arduino UNO, Barometer, Compass, Python, Camera Module, QR Code, Brushless motors, ESC, Propellers

I. INTRODUCTION

Increase in online shopping and need of the consumer is rapidly increasing. Thus, use of drone technology to deliver orders are now in consideration. The present automated drone delivery system has a few drawbacks like- The drone just drops the ordered package to the location without the concern of whether the customer is available there or not. There is no facility to change the location after ordering the package or verification of receiver. While taking emergency services in a focus it is highly recommended to use of proper secure delivery system to ensure package is deliver to rightful owner or destination security and intact. Which then This work focuses on the unmanned secure delivery system which will address the above-mentioned drawbacks.

A. The MARK8 Drone

By interfacing GPS/ Barometer and Compass to the drone, we initiated intelligence of reaching to the exact location of delivery can be inherited by the user.Secondly, once the drone reaches the location users must scan QR Code via order application as an authentication once QR is matched then drone drops the package if notthe drone will not release the package.

Although we are working on to create a feedback system where drone can signal as package is droped or not then system will send an SMS to the user about the Success or failure of deliver the package and will fly back to the vendor's control station.

The MARK8 Drone Droneis an unmanned aerial vehicle (UAV), which is also known as 'medicine delivery drone', is utilized to transport medical packages, essential food drugs or other medical or surgical goods, initially the attempts of using commercials UAV's (unmanned aerial vehicle).

B. Problem Overview and Scope of Work

Worlds leading online market company announce that they will use Air delivery systems to delivery each order to their respective customers. Air Vehicle (Miniature UAV, otherwise known as drone) technology to autonomously fly individual packages to customers' doorsteps within 30 minutes of ordering. But each type of drone having its carrying and lifting capacity. Like the order must be less than five pounds(2.26 kg), must be small enough to fit in the cargo box that the craft will carry, and must have a delivery location within a ten-mile radius of a participating.

The present automated drone delivery system has a few
downsides like:

- The drone just drops the ordered package to the location without the concern of whether the customer is available there or not.
- There is no facility to change the location after ordering the package
- What if at the landing of drone, if someone else picks up the package before the intended person comes out from inside home.

C. LITERATRE SURVEY

Mrs Wasim Fatima. S, "Unmanned Aerial Vehicles for space exploration", [10 October 2017]
This research paper was proposed for a system which provides the study of space is not only carried out by astronomers with telescopes but also the space exploration of space is conducted both by unmanned drones and human spaceflight. This paper content deals with the role of unmanned aerial vehicles on earth and the future directions for the use of UAVs in space for exploration and observation purpose.

Miroslav Kratky and Jan Farlik, "Countering UAVs – the Mover of Research in Military Technology", [September 2018]
This research paper was proposed for a system of the risk of misuse of UAVs by criminals, guerrillas or terrorists has compelled authorities, scientists and defence industry to face this threat. Organisations have launched crucial infrastructure defence programs to cope with UAV threat. To solve this problem, it is necessary to develop disciplines improving the air space surveillance and UAVs elimination techniques. The substantial aspects of the UAVs detection and elimination were analysed, being supported by a number of conferences, workshops and journals articles. The contribution of the study in the Counter–UAV area consists particularly in generalisation and evaluation of the main technical issues. The aim of this paper is to emphasise the importance of developing new scientific fields for countering UAVs, and hence it is directed firstly on the scientific audience.

S. G. S. Fernando, "CarryMe: Drone Delivery System for Flooded Area", [December 2017]
In this article, "CarryMe" is the drone delivery system which can be used to provide better disaster recovery by resolving these issues. Collision avoidance algorithm, obstacle detection algorithm, video streaming and autopilot are the main functionalities

of this implemented system. A flooded area can be identified using a map through the web application of CarryMe and the drone controlling interface which user- friendly and it can serve several people using several drones at the same time.

Guang Yang and Xingqin Lin, "A Telecom Perspective on the Internet of Drones:From LTE-Advanced to 5G".

In this article, they elaborate how the drone ecosystem can benefit from mobile technologies, summarize key capabilities required by drone applications, and analyse the service requirements on mobile networks. It present field trial results collected in LTE-Advanced networks to gain insights into the capabilities of the current 4G+ networks for connected drones and share our vision on how 5G networks can further support diversified drone applications.

Lawrence G. Muchemi, "An Autonomous Unmanned Aerial Security Surveillance System to Enhance Security in Remote Territories", [December 2017]

In this article, With the use of Unmanned Automated Aerial surveillance vehicles, we can be able to curb the criminals by surveying the security prone territories where it is not safe for a human to go and report in advance. The implication of the study is that it will provide a basis for further development, automation and adoption of UAV in aerial security surveillance and reporting to authorities the information that will be used to raise alarms and enhance security.

Michael K. McCall, "Small Drones for Community-Based Forest Monitoring: An Assessment of Their Feasibility and Potential in Tropical Areas,[24 June 2014]

In this paper they assess: (1) the feasibility of using small, low-cost drones (i.e., remotely piloted aerial vehicles) in CBFM programs; (2) their potential advantages and disadvantages for communities, partner organizations and forest data end-users; and (3) to what extent their utilization, coupled with ground surveys and local ecological knowledge, would improve tropical forest monitoring. Use of small drones can help tropical communities to better manage and conserve their forests whilst benefiting partner organizations, governments and forest data end-users, particularly those engaged in forestry, biodiversity conservation and climate change mitigation projects such as REDD+.

Burchan Aydin and Emre Selvi, "Use of Fire-Extinguishing Balls for a Conceptual System of Drone-Assisted Wildfire Fighting ,[12 February 2019]

This paper examines the potential use of fire extinguishing balls as part of a proposed system, where drone and remote-sensing technologies are utilized cooperatively as a supplement to traditional fire fighting methods. The proposed system consists of (1) scouting unmanned aircraft system (UAS) to detect spot fires and monitor the risk of wildfire approaching a building, fence, and/or fire fighting crew via remote sensing, (2) communication UAS to establish and extend the communication channel between scouting UAS and fire-fighting UAS, and (3) a fire-fighting UAS autonomously traveling to the waypoints to drop fire extinguishing balls (environmental friendly, heat activated suppressants).This concept is under development through a trans disciplinary multi- institutional project.

D. METHODOLOGY

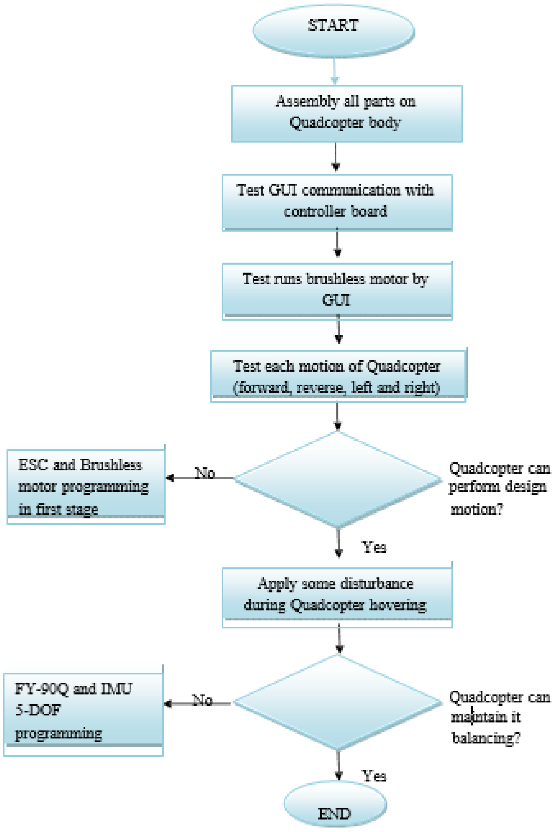
In The MARK8 Drone Dronewe implemented high performance drone spears with properly aligned and balanced drone frame. Which is 3D printed.The drone is interfaced with GPS, Barometer and Compass, Mini servo, Internet facing transceiver and QR Code display camera and output screen. Top of that a secure container to hold medical supplies. Thus, the drone is properly programmed with sophisticated software programming using Python to define its flight path do roll, pitch and yaw. Stabilizing it self in high wind and air pressure to maintain current altitude and speed with rapid command control to deliver packages while authenticating user or receiver of the package. A predefine flight path guides drone for the location where it supposed to go. On board flight controller and microcontroller takes the command from command and control device and then GPS and barometer will start tracing the location of the drone and stores the QR code to be scanned at delivery location. If the scanned QR is matches it releases the packages and return to location from where it started.

1. Interfacing of GSM to Arduino and Flight controller

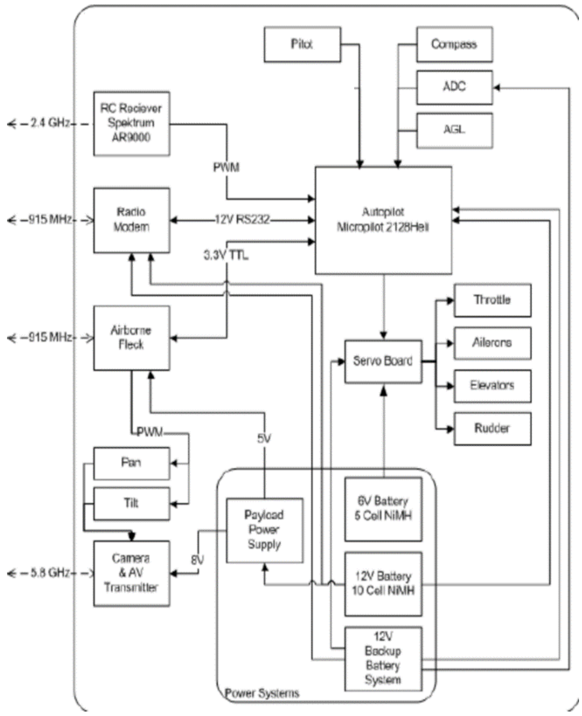
In this work the GSM module used is GSM 900, which is used for transmitting and receiving the data services.

This GSM provides the speed of data transmission of rate 9.6kbps. Three pins of GSM module, namely TX, RX, and GND are interfaced with Arduino by GPIO hardware pins and make these pin as a software serial virtually. GSM module supports the SIM card , having a frequency of 900Mhz. GSM uses the 890-915 MHz frequency band to send data for the mobile station to the base station (uplink) and 935-960 MHz frequency band to receive data from the base station to the mobile station (downlink) while interfacing Arduino with GSM module we used hardware serial pins on the development board. To make GSM stand alone and attached to drone base, it needs a minimum of 7v and 2amp of battery. The interface on the GSM side needs only TX, RX, GND and supply pin.

2. Flow chart



3. System Architecture



4. Algorithms used

Improved Altitude Control Algorithm for Quadcopter Unmanned Aerial Vehicles

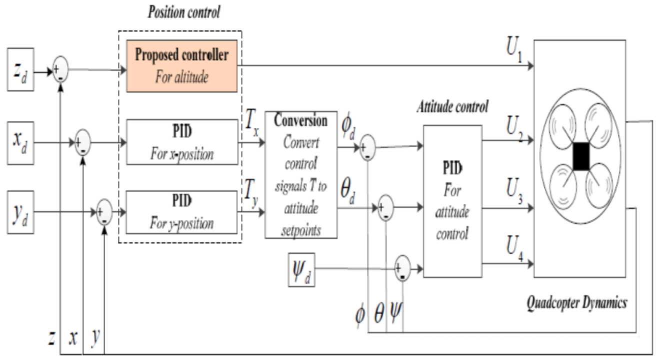


Figure : Full quadcopter controller scheme. The proposed is applied to the altitude control while conventional proportional-integral-derivative(PID) controllers are used for horizontal position and attitude control.

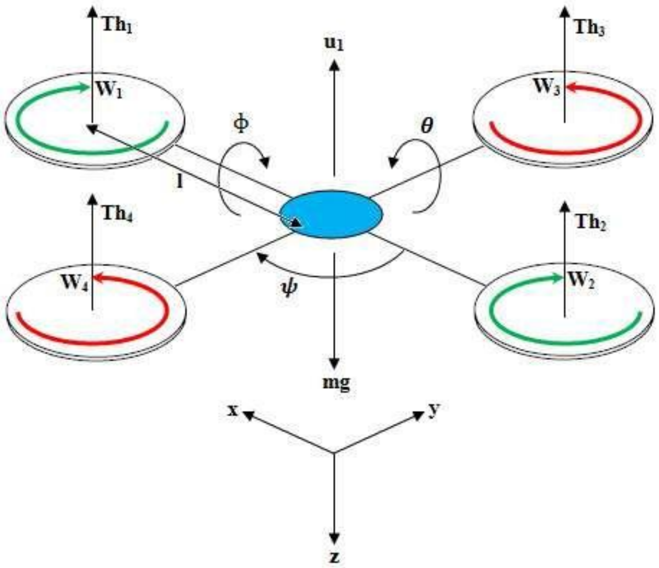
Kalman Filter

If a linear state space model of a system is available, a Kalman filter can be used to obtain optimal estimates of the states from observations. A discrete model with the states X, input signals and observations Y can be written as:

$$x[k + 1] = F[k]x[k] + G[k]u[k] + G,[k]v[k],$$
$$y[k] = H[k]x[k] + D[k]u[k] + e[k],$$
$$cov(e[k]) = R[k], cov(v[k]) = Q[k],$$

5. Mathematical model

The schematic movement of drone is represented in Figure and based on this schematic, the drone mathematical model is derived as below



Where,

U1 = sum of the thrust of each motor
Th1= thrust generated by front motor
Th2= thrust generated by rear motor
Th3= thrust generated by right motor
Th4= thrust generated by left motor
m = mass of Drone
g = the acceleration of gravity
l = the half length of the Drone
x, y, z = three position
θ, ϕ, ψ = three Euler angles representing pitch, roll, and yaw

The dynamics formulation of Drone moving from landing position to a fixed point in the space is given as

CϕC8 CϕS8Sl/J – SϕCl/J CϕS8Cl/J + SϕSl/J
Rxyz = CϕS8 SϕS8Sl/J + CϕCl/J SϕSϕCl/J – CϕSl/J
–S8 C8Sl/J C8Cl/J

Where,

R = matrix transformation
S8 = Sin (θ), Sϕ= Sin (ϕ), Sl/J= Sin (ψ)
C8 = Cos (θ), Cϕ= Cos (ϕ), Cl/J= Cos (ψ)

By applying the force and moment balance laws, the Drone motion equation are given in Equation

(3.2) till (3.4) and Pythagoras theorem is computed as Figure

X.. = u1 (CosϕSinθCosψ + SinϕSin) – K1x/m

y.. = u1 (SinϕSinθCosψ + CosϕSin) –K2y/m

z... = u1 (CosϕCosψ) -g- K3z'/m

Where,

Ki = drag coefficient (Assume zero since drag is negligible at low speed)

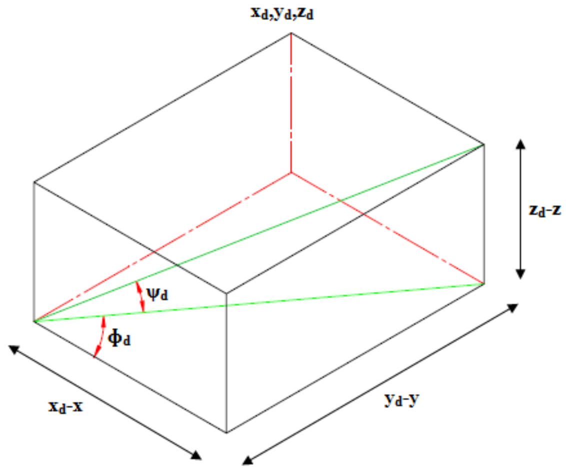


Figure : Angle movement of Drone

The angle ϕd and ψd in Figure are determined using Equation

ϕd = $\tan^{-1}$(xu-x)

ψd = $\tan^{-1}$(zd-z)

J(xd-x)^2-(xd-x)^2

Drone have four controller input forces U1, U2, U3, and U4 that will affects certain side of Drone. U1 affect the attitude of the Drone, U2 affects the rotation in roll angle, U3 affects the pitch angle and U4 control the yaw angle. To control the Drone movement is done by controlling each input variable. The equations of them are as below:

U1 = (Th1 + Th2 + Th3 + Th4) /m

U   U2 = 1 (-Th3-Th2+Th3+Th4) / I1

U3 =1 (-Th1+Th2+Th3-Th4) / I2

U4 = 1 (Th1+Th2+Th3+Th4) / I3

Where,

Thi = thrust generated by four motor

C = the force to moment scaling factor

Ii = the moment of inertia with respect to the axes

Then the second derivatives of each angle are:

8 = U2 - IK48'/I1

1/J- = U3 - 1K5I'/I2

ϕ = U3 – IK6I ϕ' /I3:

6. Drone movement mechanism

Drone can describe as a small vehicle with four propellers attached to rotor located at the cross frame. This aim for fixed pitch rotors is use to control the vehicle motion. The speeds of these four rotors are independent. By independent, pitch, roll and yaw attitude of the vehicle can be control easily. Pitch, roll and yaw attitude off Drone

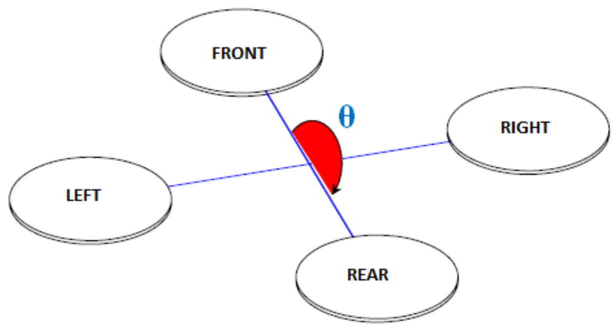


Figure Pitch direction of Drone

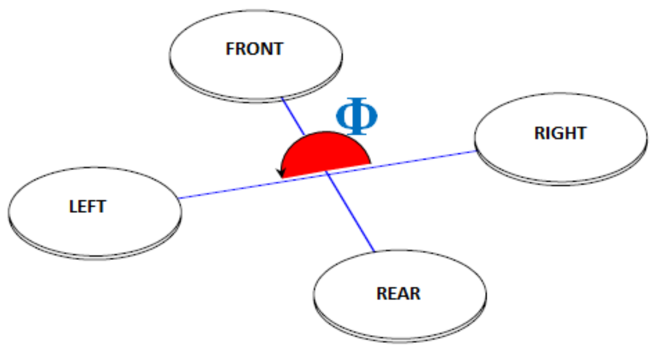


Figure: Roll direction of Drone

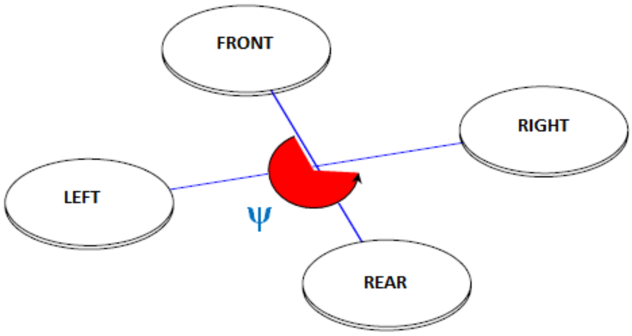


Figure : Yaw direction of Dron

7. Essential parts of the Drone

ESC Controller

An electronic speed controller (ESC) is an electric device to monitor and very the speed during the operation.

A brushless DC Motor

A brushless DC electric motor (BLDC motor or BL motor), also known as electronically commutated motor (ECM or EC motor) and synchronous DC motors, are synchronous motors powered by direct current (DC) electricity via an inverter or switching power supply which produces electricity in the form of alternating current (AC) to drive each phase of the motor via a closed loop controller. The controller provides pulses of current to the motor windings that control the speed and torque of the motor.

Propellers (Clock wise and Counter-Clock wise)

A propeller is a device with a rotating hub and radiating blades that are set at a pitch to form a helical spiral, that when rotated performs an action which is similar to Archimedes' screw. It transforms rotational power into linear thrust by acting upon a working fluid such as water or air.

Flight Controller and Arduino Uno

A flight controller (FC) is a small circuit board of varying complexity. Its function is to direct the RPM of each motor in response to input. A command from the pilot for the multi-rotor to move forward is fed into the flight controller, which determines how to manipulate the motors accordingly.

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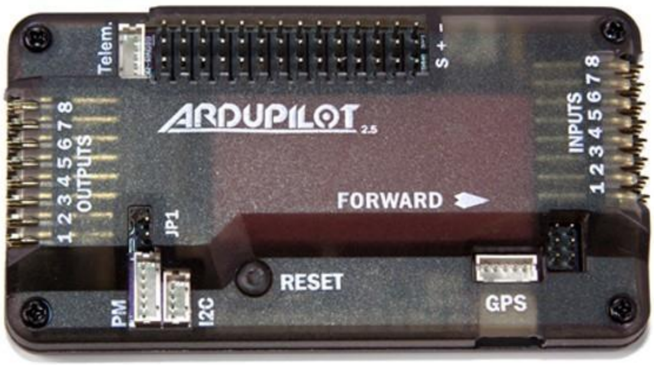
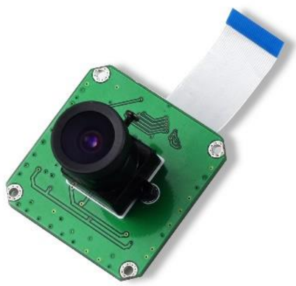


Camera Module

Camera module is used to scan QR code displays by receiver to authenticate the user. If QR code matches then drone will release the package otherwise it returns to launch location.



Drone Frame

Remote controller and transmitter

FlySky FS-CT6B 2.4ghz 6CH Transmitter and Receiver

Transmitter and receiver TX RX with

- Channels: 6 Channels
- Model Type: Heli, Airplane, Glid
- RF Power: Less than 20db
- Modulation: GFSK
- Code Type: 2.4Ghz No Interference

8. Snapshots

9. Advantages of The MARK8 Drone

The MARK8 Drone Droneis an intelligent flying machine where it's main advantages are

- Specially created for Medical supplies
- Quick and rapid Take Off and Landing
- Can carry Upto 2.5 Kg of Medicines
- Ranges Upto 4 Km
- Self balancing and responds to Air pressures and Air speed
- Speeds Upto 60 to 80 Km/Hr
- All weather delivery
- Can hold Altitude and hover at any point of interaction
- Maintain hight upto 1500 mtrs
- Authenticate user using QR Code

10. Limitations

The MARK8 Drone Dronehas few weakness

- The MARK8 Drone DroneUse Barometer to hold height due to Magnetic interference it can miss calculate its hight or hover. This interference can be caused by Radar, High frequency mobile towers or any electromagnetic fields generated by coils
- No night flight modes
- Currently Obstacle detection is not mounted
- It Self-weighing up to 3 kg and with battery 3.5 kg so payload lifting is restricted to 2.5 kg only. In total weight of the drone with package cannot exceed 6 kg
- It has 30 min flight time with full battery.

II. Future work

The MARK8 Drone Droneit self a good and reliable delivery system but we wanted to add some more features in it. In future will improve its battery life and flight duration.

We proposed to put high sensitivity radar and obstacle detection and avoidance for better performance and less accidents or crash during flight.

Currently it has no night flight modes we are improving The MARK8 Drone Droneto fly in night sky as well.

III.CONCLUSION

The MARK8 Drone Droneis a intelligent and rapid transportation medium specifically design to deliver essential and urgent medical supplies to user. The MARK8 Drone Dronehas all the ability to hover in mid air and safely take off and land on any surface suitable for the operation.

It has latest and advanced flight controller and navigation aids to make it reliable and smooth in operations.

Our on-board camera module scans the QR code displayed on user mobile to authenticate the user to avoid mishandling of the parcel and accurate delivery if the cade is not matched drone won't release package and return to location from where it has begun the journey. Rapid and consistence tracking is done in each flight and it can provide up to 2 km range in a fully charged battery.

We tried to over come various problems stated in the problem statement and created a sustainable and fast yet efficient delivery drone for the medical supplies

This project describes a drone whose operation is completely based on effectively programmed flight controller. Drone provides accurate delivery with the help of GPS/ Barometer using drone. This project reduces time of delivery and gives precise performance. With the help of ESC we can control the behaviour of drone and hence provide better operation to fulfil the requirements. Using transmitter, we can adjust the direction and speed of drone.

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