Unmanned Aerial Vehicle for Low Payload Delivery

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***Abstract*-- There are various problems faced by people live in remote places. In the situation like flood, emergency situation or due to bad construction or unavailability of roads there is unnecessary delay in transportation of life essential products at remote places. This report gives an idea to solve this problem. The "UAV (Unmanned Aerial Vehicle) for low payload delivery' is the best for transportation of life essentials. This helps in reduction of unnecessary delay in transportation of life essentials such as medicines, small food packets, etc. Efficient and economical drone healthcare delivery to potentially save lives. This project will contain the body, electronic design, and component designs for a UAV. This prototype aims to demonstrate how the delivery drone will benefit our logistical network, particularly in times of medical emergency. UAVs claim to be quick, economical, and environmentally friendly for everyone. These represent a more advanced technology that may one day lessen the strain on people. To demonstrate that the delivery drone can be used safely and effectively and, perhaps, can aid in daily human work, more study and testing will be required.**

***Index Terms*- UAV, Delivery, Payload, Drone, RC aircraft.**

I. INTRODUCTION

The future lies in robotics. By creating services like Prime Air, a fully autonomous delivery system intended to securely and promptly deliver products to clients utilizing robotic unmanned aerial vehicles, popularly known as drones, businesses like Amazon are presently capitalizing on this opportunity [1]. As the demand for commercial deliveries increases within cities, companies face a Fundamental limitation in surface road capacity. At present we all were in the Generation where each and every door delivery is given by a Man. So to make a step ahead for Future towards the Technology, We would like to introduce our Project through this paper "Unmanned Aerial Vehicle or Low Payload Delivery Make a Step ahead for Future". In this project, we would like to make UAV which work to deliver the product (low payload) at customer prescribed address.

This is the latest innovation being used in the delivery procedure. Both precision and efficiency are aided by it. They aid in lowering the cost of labor. UAV technology eliminates the need to spend millions of dollars on the supply chain process in order to achieve quick and effective outcomes. Drones are operated remotely or by software with the aid of embedded systems that incorporate GPS and other sensors. However, utilizing machine Learning and deep learning will now make it operate automatically. As per the scheduled delivery, the GPS UAV Delivery System will properly deliver the package to the customer in the allotted time by locating those using GPS of the tracking device and determining their live location. It will make sure that the customer receives the package and does not have to worry with picking it up. And after proper verification, deliver the product.

UAV are being used in many locations throughout the world for deliveries that need to be made quickly, such medical supplies, and that are challenging to do with conventional vehicles. By taking over many of the deliveries now done by conventional delivery vehicles, delivery drones have the potential to transform the economics of last-mile delivery for smaller and lighter products.

II. LITERATURE REVIEW

Numerous drone delivery issues have been addressed in the most recent and pertinent articles on drone-based parcel delivery systems, demonstrating the significance of drones in overcoming many logistical issues, notably in the last mile, and revolutionizing the future of package delivery. A method for calculating the traffic demand for a drone-based delivery system in a typical crowded European city was put out by Doole et al. [2]. The Paris metropolitan area served as the subject of a case study. By 2035, the urban airspace of Paris, which covers an area of 12,012 km2, would have an average of 63,596 hourly traffic density delivery drones of small express parcels as well as fast-food meals.

Gonçalves et. al.[3], 2017, proposed a safety model based on Petri nets to provide proof of drone safety and dependability, which is necessary for the airworthiness certification procedure, they brought attention to the safety issue.

Recent studies predict that 400,000 drones will be flying at Very Low Levels (VLL), meaning between 0 and 500 feet, by the year 2050. This reflects a significant number of autonomous drone missions [4]. As a result, safe air navigation, decision-making tools, and obstacle data analysis methodologies are required in order to successfully operate this system, taking into account that flying closer to the ground also means being closer to natural and man-made impediments[4].

Gang Xiang et. al. [5], 2016, conducted research on the rescues made by lifeguards at the beach in United States. They stated that over 40% of the US population visits the beach every year. Among the 10-year period between 2003 to 2012, lifeguards have made 67,700 rescues per year. A system was created to deliver a flotation device to the victim in order to prolong the victim's time of survival during the rip current rescue procedure. A victim will be able to survive long enough for lifeguard rescue once they have the flotation device. An unmanned aerial drone will deliver the flotation device. They demonstrated the Life-ring Delivery Drone System, which can reach victims faster than a lifeguard by delivering life rings. Once they have a life ring, victims can make it until the lifeguard gets to them by decreasing the mean time to reach a victim by 39% (and the standard deviation by 66%), the Life-ring Delivery Drone System raises the likelihood of a successful rescue from 92.3% to 99.4%. The LDDS octo-copter reduces the mean time to reach by 39%, the standard deviation by 66%, and the probability of a failed rescue by a factor of 13. These results are based on lifeguard-only rescue [5].

Jaihyun Lee et. al.[6], 2017, conducted a study and research on drone delivery solutions and rapid delivery of parcel system. It is stated that due to their inherent battery and payload restrictions, drones present a significant operational and management challenge for a successful delivery system. Adopting modularity in drone design can have a positive operational impact on fleet readiness and size reduction. They conversed about the advantages of a drone delivery system's modular design. For the operation management of a fleet of modular delivery drones, they suggest an optimization method. They presented the results of a simulation that contrasted the suggested method with current operation management techniques. The findings demonstrated how a straightforward operation management strategy could cause instability in a drone delivery system by raising the need for particular types of fleet modules. The results of comparing the operations of modular and non-modular drones also demonstrated that the proposed operation management method using modular drones can reduce delivery time and energy consumption during a delivery operation compared to non-modular drones. When comparing non-modular drone operations, the operation with nine types delivers packages more quickly than the operation with one type, indicating that drone delivery operations with nine non-modular drones can be managed effectively to speed up delivery. Package can be delivered 4.4% faster with modular drone operation, 14.5% faster with non-modular drone operation, and 23.5% faster with non-modular drone operation with one variance [6].

Markus Bernard et. al.[7], 2017, presented the ideas and approaches used for a load delivery system based on small, unmanned helicopters. The approach to control the motion of the rope linking the load and the helicopters are the main points of emphasis. The problem of oscillations in the flexible ropes due to external disturbances (e.g. wind gusts) is discussed and a solution based on load state observer is presented. Typically, the Quadcopter uses two sets of identical fixed-pitch propellers, clockwise (CW) and counterclockwise (CCW) (CCW). By changing the speed of each rotor direction, the position may be controlled. Additionally, altering each rotor's speed can yield desired total thrusts that are located in the thrust center both laterally and longitudinally. Every motor produces torque in the vicinity of the rotational center in addition to thrust. These thrust creates a drag force oppositely to make the drone to fly [7].

Jalu A. Prakosa et. al.[8], 2019, discussed about the importance controlling the speed of BLDC motor for ground test of drone rotor. The increase of PWM duty cycle produces the increase of motor speed. The important BLDC motor calculations are discussed with the example as the calculations are very important in case of Motors. The motor directions required for Aerial Vehicle to fly is the two opposite motors should rotate in same direction as anticlockwise or clockwise And the other two should be rotating in opposite direction with respect to the And the main conclusion of the paper is that the speed control can be made by regulating characteristics of motor and by taking duty cycle and motor speed in linear proportionality [8].

Christopher Burke et. al.[9], 2019, conducted a study on reliably delivering packages using a drone. The researcher's conclusion shows that while delivering the package battery positioning is crucial for a balanced take-off. They use a lipo battery situated underneath the carbon-fiber frame. That’s why the size of the battery, this forces the drone to balance on the battery. This is not optimal for drone take-off as the propellers may force the drone to tip over. But using that design it is very easy to drop the package to the target place. But the performance of the drone is affected by every design parameter. Although the strong racing motors may make up for extra off-center mass, it was believed that having the payload so far away from the center of mass would have a negative impact on the responsiveness of the control inputs. They also provide a solar cell into the frame for alternative energy sources, which allow the drone to stay in the air longer [9].

Troudi Asma et. al. [10], 2017, conducted a study on delivery drones developing a new service during this last decade. But they suggest in their paper that because drone delivery is unique as a commercialized system, the drone operator must modify the Logistics Support system in accordance with the rate of exploitation and the activity restriction. They suggest using a post-production study to determine the suitable maintenance scope and discover potential system evolution, driving the exploitation required in function of the activity. Their goal is to monitor activity that could be affected by system modifications and to continuously assess the need for logistical support [10].

Amirhossein Moadab et. al.[11], 2022, this paper conducts a detailed study of drone usage in last-mile delivery. Informed us of a technologically enabled, economically and environmentally sound solution. This article combined drone delivery operations with the public transportation network as a mobile charging station to address the drone combat range constraint. Utilizing a real-world scenario based on the actual input parameters of nodes in Bremen, Germany, the constructed model is evaluated and put into action. First they developed an algorithm model to efficiently solve the model for complicated issues. In order to support drones for last-mile delivery, especially in light of customer order density and distribution in relation to bus station locations, the complex public transportation routing in large cities can be taken into consideration. This is especially true for the development of an intelligent transport network in the context of smart cities [11].

Maryam Torabbeigi et. al.[12], 2020, this paper conducts to comprehend the effects of drone battery usage on the development of a drone-based delivery system for packages. The amount of payload carried and the flight time were two factors examined in this paper as factors affecting drone battery consumption. There work can be expanded by incorporating more BCR-influencing variables, such as flight speed and ambient circumstances. They suggest their idea overall about the drone battery consumption. Because this plays a crucial impact in how far the drone can be flown [12].

III. METHODOLOGY

A UAV can essentially hover and fly like a multicolor while flying like a fixed-wing aircraft. In flight dynamics, where the coordinate system is fixed in relation to the aircraft, a body-fixed coordinate system is typically used. It is appropriate to categories the three rotation axes that can change the attitude of a multicolor aircraft as 1) Roll, rotation of the x-axis, 2) Pitch, rotation of the y-axis, and 3) Yaw, rotation of the z-axis. These rotational axes are depicted in Figure Fig. 1.given below.

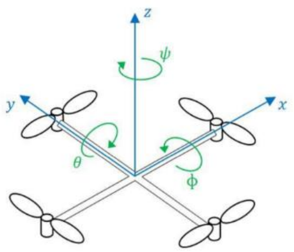

Fig. 1. The multirotor UAV's coordinate system

A. Flowchart

As shown in Fig.2. Is which was created at the beginning of the project, displays the flow chart for the overall research design? This flowchart will act as the general direction for moving this project forward. The flowchart is broken up into two sections, the first of which focuses on design and the second of which focuses on fabrication and flight tests. The goal of this research is to examine how well the UAV performs when delivering the package using the suggested mechanism.

Assemble UAV components: To create an unmanned aerial vehicle, it is essential to select components with the best possible balance of quality, price, functionality, and performance (Quadcopter). We look for information on components there on YouTube, blogs, and other websites. So, in order to get the best out of them, we buy specific components from other websites. The UAV's frame can be bought at an electronics store.
We began putting together all the parts in the advanced communication lab with the aid of devices. To create a power supply, we joined an ESC and a power module.

Configuration of UAV with transmitter: It is extremely difficult to link and fly UAVs without communication, which is the project's key component. Here, the use of a transmitter and receiver for communication is intentional. We chose a six-channel receiver so that we could test six functions simultaneously. We utilize mission planner software to connect the transmitter and receiver. In mission planner, we prepared up and down and right and left knob.

Configure pick and drop mechanism with UAV: We needed parts such a servo motor, pulley, box, transmitter, and receiver for the pick-and-drop system. Since our receiver only has six channels, we must configure the receiver in a different channel for the transmission between the transmitter and servo motor. We Can drop our low payload cargo using a pick-and-drop method that is operated by a pulley thanks to the transmitter.

Testing UAV delivery mechanism in real environment: After putting everything together and joining the pick-and-drop mechanism, the UAV must be tested in a real-world setting. When a customer orders a low payload package, our UAV will notify the customer of the delivery location's coordinates, arrive, and drop the package.

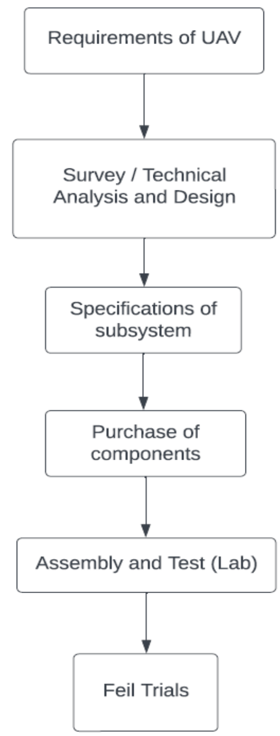

Fig. 2. UAV Design Terminology

B. Structural Design Parameters

It is crucial to keep some size parameters within a practical range when designing a small-scale UAV delivery in order to make other dimension-related parameters fabrication-friendly. To ensure that the UAV can execute stable and safe flights across all of its flight modes, the design parameters chosen must also adhere to well-known theoretical concepts and equations.
The general methods for figuring out fundamental structural design parameters are as follows:

1. Calculate the aircraft's total weight.
2. Design of the Delivery Mechanism: Calculate the size of the mechanism's enclosing box.
3. Managing and combining both phases.

The prototype's size will be estimated using these standard methods. The actual dimensions will be adjusted after construction and flight tests.

C. Weight Estimation

Prior to fabricating the prototype, some easily accessible components were weighed, and the weight of the remaining components was estimated. It would be planned for the total All-

Up-Weight (AUW) to be a little bit higher than the total estimated weights. This is so that the actual prototype weight, which typically exceeds the initial weight calculations. Estimating the additional weight also widens the window for the additional payload. Since the subsequence design calculations are solely based on this parameter, it is crucial to select the appropriate AUW for the prototype (see Table below).

Items	Mass(g)	Quantity	Total Mass(g)
APM 2.8 Flight Controller	82	1	82
Quadcopter Frame	330	1	330
Electronics Speed Controller	24	4	92
Receiver	15	1	15
Brushless DC Motors	54	4	256
Power Module	24	1	24
Battery	250	1	250
Propeller	7	4	28
Servo Motor	7	1	7
Pulley	3	1	3
Total All-Up-Weight			1063

Hence, AUW would be estimated a bit higher than the calculated value to be 1.06 kg

D. Material Selection

The material chosen is one of the most important and crucial design factors for such a UAV. Weight is an important consideration when choosing any component, from the smallest part, like a screw, to the largest, like a frame. The best material to choose is one that is lightweight and resilient to mechanical (drop, shock), environmental (waterproof, salt spray compliant, altitude/low pressure, oil/chemical contamination/corrosion), and mechanical (drop, shock) stresses. Such a UAV that is typically used in harsh environments must adhere to some international standards of compliance to ensure the product is reliable and suitable for any application or circumstance. High design/fabrication and qualification test costs should be expected.

The final material selection and method of manufacture/fabrication, however, also depend on how much will be produced and how affordable the cost will be. The material selection for this study, which is a prototype or PoF (Proof of Concept) model, is in no way in compliance with the aforementioned Mil Standard. The fact that the UAV is demonstrably functional and effective is what matters most in this study. The material for the frame should be sufficiently lightweight and accessible. The carbon fibre composite used in this study for the UAV frame is very light, durable, and reasonably priced. This frame support would be made up of both hollow and structured landing gears and a ready-made F450 frame to house the electronics components.

E. Electronics Design

In this study, no particular electronic design was implemented. The majority of electronic components, including the battery/charger, radio frequency modules, control module, and motor, are COTFs (commercial off the shelf) items. The integration of parts and systems is the focus of most electronic activities. The following are the UAV's main and most important electronic components:

1. Radio remote control
2. Motor Brushless
3. Battery voltage and capacity
4. Servo motors

F. Electronics Layout and Operation

The UAV model with delivery mechanism's electrical wiring diagram is shown in the figure below. The system's brain or primary drive is a control processor unit calling the APM 2.8 Flight Control Unit. During take-off, landing, or any horizontal movement of the UAV, it controls the RPM or rotation of the motor.

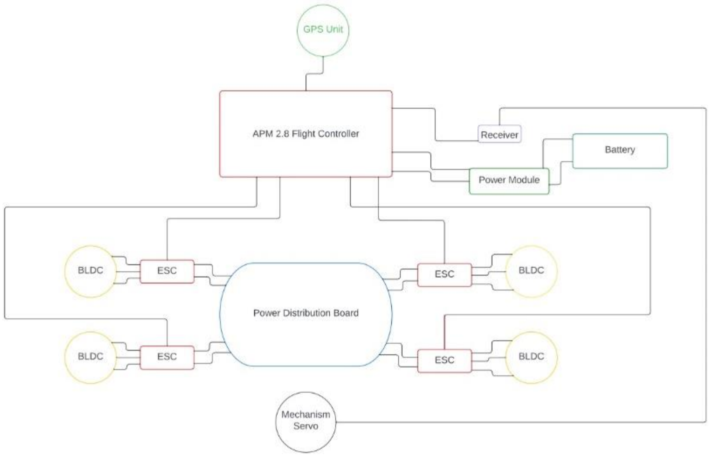

Fig. 3 Diagram for On-board Wiring

The operator at the ground controls the motor's RPM by adjusting the speed. Data was sent using a 2.4 GHz microwave signal from the ground-based transmitter RC to the unmanned aerial vehicle (ISM unlicensed band for commercial application). The controlling and navigational information for the aircraft is another type of data transmitted from the ground. The range (distance the UAV can travel from the pilot) is established by the RC's ground-based transmission power and the RC receiver's on-board UAV receiver sensitivity. Any obstruction, including rain, clouds, and trees, will reduce the remote control's usable range, so it must be a line-of-sight link. The risk that the UAV will fall or drop to the ground is inevitable when it is outside the reach of the RC or because of obstruction.

The UAV has a GPS unit on board. The UAV's position, speed, and altitude were all read by a GPS device. These GPS data, along with data from other sensors and battery status information, could be transmitted back to the ground centre. The battery's capacity determines how long the flight will last. The UAV can fly for a longer period of time with larger batteries.

G. System Implementation

The successful project is the one which contains mainly four stages i.e. initiation, planning, execution, testing. Here these all four stages plays an important role in the successful completion of the project. The very first step of our project implementation or execution is of selection process of electronic components. The failure of the project can be caused by even the smallest change in the component configuration during this crucial stage of the project life cycle. Our mentor provided us with guidance in this situation, and we also searched for the information that was necessary to choose the best components in accordance with the project's application. We studied several research papers, journals and publications. We were able to choose the desired component through this process.

Assembly of the electronic components using secure connections was the next crucial step after choosing the right electronic components. Components had to be soldered to the available UAV frame points during this process. Here, we applied our practical engineering knowledge. Additionally, this is considered for proper soldering using metal strips of high quality and without any air bubbles. Here, the assistant professors from the communication lab also instruct us towards the next step. Later on in the process, we have to enable connection of this assembled model with each part of the UAV and this can be achieved with the configuration of the UAV with the Fly Sky transmitter. Therefore, we made the decision to get a quick overview of the next steps and used the internet to research various aspects of this platform. This aided us in the configuration process and allowed us to connect the transmitter and UAV. This will enable the power supply to each part of UAV and we are able to transmit the signals to UAV.

The delivery mechanism consists of a pulley, a servo motor that rotates 360 degrees, and a package delivery compartment that is attached using thread. The hard box body further encloses the entire set of components. For the thread coming directly from the pulley connected with the servo, this box has an elliptical opening on the bottom. While transporting the package through the air, this structure will lessen the thread moment. Our UAV is currently on the verge of its first airborne launch. We need to perform some inspection work before the UAV takes off on its actual flight.

H. Software Setup

Mission planer is used to configure the UAV. The Mission planner wizard helps us to configure the motors, accelerometer, Radio calibration, Battery performance check, fail safe, etc.

The Pixhawk flight controller unit is set up with the use of mission planner software. This software installs the appropriate firmware to Pixhawk that corresponds to the Quadcopter UAV prototype type of the UAV. In order to get the best stability, this programme is also used to adjust the PID control gains. This can be done either during actual flight tests, during which the pilot will adjust the gains appropriately, or it can be done beforehand and the best result will be obtained using the trial-and-error method. A screenshot of the home tab in Mission Planner is shown in Figure 4.

The precise setting of the flight controller with transmitter and receiver is done using the mission planning software. The Quadcopter frame was selected according on the application, and subsequent acceleration calibration was carried out using a wizard. Furthermore, we used both the internal and external GPS for the calibration component. Through transmitter we rotate servo motor clockwise and anticlockwise.

Fig. 4. Mission planner software

IV. RESULT AND DISCUSSION

The transmitter, APM, and servo motor are all properly connected and in communication with one another. The pick and drop system works well and the configuration between the transmitter and servo motor is done correctly. The fabrication process went smoothly, and the finished prototype passed a functional test. Fig. 5 shows the prototype's construction. Physical inspection, subsystem tests, and full system tests were carried out after the manufacture and assembly were finished. The UAV implemented can lift the payload of 500 gm and the overall weight of the UAV is 1553 gm. The Thrust to Weight ratio for UAV is 2.06/1. The flight time for UAV is approximately 10 minutes (considering the battery will be full charge). The payload capacity of UAV can be increased.

Fig. 5 Final Prototype Following Full Fabrication and Assembly

V. CONCLUSION

The manual delivery will not be able to satisfy the demands of human race in the future. UAV will become indispensable and be incredibly helpful in delivering packages and couriers to the appropriate customers. People in the future will be so preoccupied with their own work that they won't have time to collect packages and boxes separately. Thus, wherever they are, these UAV will guarantee the proper delivery of their requests in their existing situations. Autonomous unmanned aerial vehicles with tiny payloads are the focus of our project. Only low payload objects will be loaded by UAV. So, balancing our UAV should be simple. By following Google Maps, a UAV will transport the package to the consumer, saving time and labor costs.

From this discussion, some key challenges of using UAVs are identified. With the advancements in UAV applications in transportation, various research areas have also emerged towards the Computer vision technique in which the development of techniques that allow UAVs to maneuver in spaces using visual information as their main input source. Some research paper like Deployment with Aerial robots for SAR and its applications like interventions in disaster management and civil security are also discussed in this paper. Based on the current research areas, few potential research areas are identified. The main goal of paper is to deliver the information about control approach and on the movement of the rope connecting UAV and load.

In this paper we focus an overview of techniques and approaches used for a load transportation system based on small size unmanned UAVs.

VI. FUTURE SCOPE

Ranchers and farmers may use unmanned drones in the future to methodically monitor and spray their harvests. Drones used in agriculture are getting more typical by the day. Real estate listings are about to undergo a revolution as a result of high definition video shot by drones flying across featured homes' interior spaces and surrounding areas. In addition, unmanned aircraft will undoubtedly begin to supplement police presence at significant public events. They would in a few years significantly improve public safety.

UAVs are ideal for challenging search and rescue operations because they can go places that humans cannot. Additionally, these drone vehicles will be helpful in getting supplies to remote areas and disaster areas. Around the world, unmanned aircraft are being used to monitor trends in various ecosystems and track the progress of threatened species. As drone technology develops, unmanned aircraft will become more and more important in conservation projects. UAVs are becoming more and more common in both the commercial and nonprofit sectors. In the upcoming years, their use will increase much further.

VII. ACKNOWLEDGMENT

We want to express our gratitude towards our respected project guide Prof. Vinayak Kulkarni for his constant encouragement and valuable guidance during the completion of this project and research work

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