(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

A Project Report on

Unmanned Aerial Vehicle For Low Payload Delivery

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CERTIFICATE

It is hereby certified that the work which is being presented in the BTECH Project Report entitled **"Unmanned Aerial Vehicle For Low Payload Delivery "**, in partial fulfillment of the requirements for the award of the Bachelor of Technology in Electronics & Telecommunication Engg.and submitted to the **School of Electrical Engineering** of **MIT Academy of Engineering, Alandi(D), Pune, Affiliated to Savitribai Phule Pune University (SPPU), Pune**, is an authentic record of work carried out during Academic Year **2022–2023**, under the supervision of **Prof. Vinayak Kulkarni**, **School of Electrical Engineering**

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DECLARATION

We the undersigned solemnly declare that the project report is based on our own work carried out during the course of our study under the supervision of **Prof. Vinayak Kulkarni**.

We assert the statements made and conclusions drawn are an outcome of our project work. We further certify that

1. The work contained in the report is original and has been done by us under the general supervision of our supervisor.
2. The work has not been submitted to any other Institution for any other degree/diploma/certificate in this Institute/University or any other Institute/University of India or abroad.
3. We have followed the guidelines provided by the Institute in writing the report.
4. Whenever we have used materials (data, theoretical analysis, and text) from other sources, we have given due credit to them in the text of the report and giving their details in the references.

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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 offers a solution to this issue. For moving necessities of life, the "UAV (Unmanned Aerial Vehicle) for minimal payload delivery" is the ideal option. 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.

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 work. We would also like to extend our gratitude to our project guide for guiding us to relevant resource required for implementing our project. It was not without his constant encouragement, help and doubt solving that we would not be able to design our project and to some basic implementation of it. We also want to express our gratitude towards respected School Dean **Dr. Dipti Sakhare** for her continuous encouragement.

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Chapter 1

Introduction

1.1 Background

Businesses encounter a fundamental limitation in surface road capacity as the demand for commercial deliveries within cities rises. We are all currently part of the generation where men deliver everything to every single door. Therefore, we would like to introduce our project, "Unmanned Aerial Vehicle or Low Payload Delivery " in order to advance technology. In this project, we want to create a UAV that can transport a small payload of goods to the specified location by the customer.

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 labour. 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, utilising machine Learning and deep learning will now make it operate automatically. As per the scheduled delivery, the GPS Drone Delivery System will properly deliver the package to the customer in the allotted time by locating them 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.

Drones 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.

1.2 Project Idea

Our project's goal is to quickly deliver low payload packages from one location to another. We created a UAV, which is essentially a quadcopter, to serve as our aerial delivery vehicle in order to put that concept into practise. Additionally, we employ a rope Pick and Drop system for delivery, which is connected to a transmitter by way of a receiver. Transmitter and receiver are the only two devices used for communication between a UAV and a delivery system. We created a website with a user-friendly layout where users can book their packages by providing all of their contact information. We basically just concentrated on emergency delivery, where we may give out food packets, injections, and medications.

1.3 Motivation

From observation of prior art in UAV, we can say that future is full of unlimited potential and possibilities of UAV. Now a day, UAV are everywhere. It is not only used for civil and commercial but also in scientific research. NASA and space agency are using UAV for many of mission and other uses. And in delivery purpose some companies like zomato , swiggy , flipkart , amazon etc. using delivery system by human . During floods, earthquake and other natural calamities or during emergency situation lots of problem happened for delivery purpose. Due to heavy traffic ambulance cannot be reached their destination at proper time . So UAV can be used for delivering medicine, etc .So we can avoid traffic because our UAV as structure of Drone .It will reach their destination in aerial way.

1.4 Project Challenges

1. The first problem we encountered during this project was selecting electronic and hardware components based on the project requirements and applications.
2. The ability needed to put those chosen components together to construct the real model posed an additional challenge. Components are wired for safety throughout this process, which also involves soldering electronic parts together.
3. After the assembly aspects and connectivity issues of UAV, we encountered with the other challenge which was to configure the UAV with the transmitter using Mission Planner Software along with the GPS system configuration with the UAV.
4. The lateral challenge we encountered at the time we were troubleshooting was during a flight of the UAV. Here, we were unable to maintain the UAV's airborne balance. The UAV crashed to the ground as a result.
5. The other challenge our group faced was the endurance time of our UAV. Because the batteries used in the formation of model are quit heavy and it ran out of power very quickly.

1.5 Proposed Solution

We tackled with all challenges that we faced during the entire project period. We faced those challenges and learned from it throughout the journey. We had the guidance of our project mentor along with subject faculties, which helped us in those crucial situations. The detailed process is further mentioned.

1. The very first challenge that we faced was of selection process of electronic components. This is the most important phase of project life cycle, where a minute change in the component configuration will led to the failure. So here we had the guidance of our mentor and along with that we searched about the information that was required in order to select perfect components according to the project application. We studied several research papers, journals and publications. This process led us to the desired component selection.
2. Further after selection of proper electronic components, major task was to assem-

ble those components with each other with proper and fix connections. This process required the soldering of components with the points available on the UAV frame. Here we used our engineering practical knowledge. This also required proper soldering with good quality metal strip and without any air bubble. Here the assistant faculty of communication lab also guide us in the further process.

3. Further in the process we had other problem with the configuration of UAV with the transmitter of FlySky. Here we were totally new to the topic. So we decided to have a brief about further process and accordingly used internet to learn different aspects of this platform.This helped us in our configuration journey and we were able to make connection with UAV and transmitter.

4. At this stage our UAV was almost ready to have first air-born. At the day of flight test, we came to the conclusion that our UAV was unable to be stable in the middle of flight. This led it to crash down the surface, which caused the damage to propellers and BLDC motors. After the inspection of UAV, we came to know that our UAV was imbalance as the weight of the components present on it were not equally distributed. Later we fixed this issue by arranging all components with well distributed weight on drone frame

Chapter 2

Literature Review

2.1 Survey on Computer Vision for UAVs: Current Developments and Trends.

Unmanned aircraft have attracted a lot of investigation in recent years. UAVs are becoming increasingly used for civilian purposes like surveillance and infrastructure inspection because to their relatively powerful and manoeuvrable mechanical simplicity. The main features that distinguish aerial vehicles from other types of aircraft are their capacities to fly at various speeds, maintain their position, hover over a target and execute manoeuvres close to obstacles, while fixed or hovering over a location of interest, and to conduct flight indoors or outdoors. These characteristics enable their usage in circumstances when human aid would be unsafe, difficult, time-consuming or expensive .

Title	Survey on Computer Vision for UAVs: Current Developments and Trends.
Authors	Christoforos Kanellakis George Nikolakopoulos
Year of publication	Received: 28 April 2016 Accepted: 15 January 2017 Published online: 27 January 2017
Source	Cross Mark
Discussion	**Challenges:** • Although there has been a lot of funding invested in this area of research, there are currently no reliable experimental evaluations. Compared to traditional robots, aerial vehicles can be seen as a difficult testbed for computer vision applications for a variety of reasons. • Although the computer vision community has created complex SLAM algorithms for visual applications, most of them cannot be directly applied to UAVs because to the constraints imposed by their architecture and processing resources. • The state of an aircraft is typically larger than that of a mobile robot, and image processing algorithms must provide visual information robustly in real time while being able to account for challenges like jerky changes in the image sequence and changes in 3D information in visual servoing applications. **Future Trends:** • UAVs have a number of strong traits that may make them the groundbreakers in a number of applications in the near future. • A universe of possibilities may be made possible by traits like the adaptable movement in conjunction with unique elements like the lightweight chassis and the onboard sensors.

2.2 Computer Vision Onboard UAVs for Civilian Tasks

Future research could focus on aerial robots, which could offer tiny and medium-sized unmanned aerial vehicles (UAVs) as a cheap means of doing inspection tasks, potentially altering the economics of this industry. The purpose of this study is to develop the technology required for UAVs to be visually steered using the retrieved visual data. Using the location of features in the image plane, visual techniques are used in this situation to control the position of a UAV. To control the position of the UAV, another option being investigated focuses on the online reconstruction of the trajectory in the 3D space of moving targets (essentially planes).

Title	Computer Vision Onboard UAVs for Civilian Tasks
Authors	Pascual Campoy · Juan F. Correa
Year of publication	Received: 15 March 2008 Accepted: 30 June 2008 Published online: 7 August 2008
Source	Research Gate
Discussion	**Challenges:** • Real-time image processing and tracking techniques must be developed in order to lower measurement uncertainty. The domain of computer vision for UAVs is one that has promise for continued investment in research in order to increase the autonomy and usefulness of this class of aerial platforms. • The algorithms used to process images are crucial, and they are frequently built to identify and follow objects as they move through sequences, whether the algorithms themselves extract key points or are externally determined visual targets. • Successful, widely used algorithms on board a UAV have test bed problems, which serve as an inspiration for continuing innovation and enhancing resilience. • The non-structured and shifting lighting conditions are a few of the test bed difficulties. **Conclusion:** •Computer vision is much more than just a method for a UAV to sense and gather ambient data. • Due to the large amount of information that can be retrieved, the potential uses and applications, and the natural relationship to human-driven tasks, it should be a key component of UAV capability. The development of methods that enable UAVs to navigate through environments utilising visual information as their primary input source is the subject of current research. •This objective entails developing methods that let a UAV navigate toward interesting features whenever a GPS signal is unreliable or insufficient.

2.3 Autonomous Transportation and Deployment with Aerial Robots for Search and Rescue Missions

In a number of search and rescue (SAR) scenarios, systems composed of several airborne robots with autonomous collaboration capabilities can provide aid to responders. In open fields, we use one or more autonomous aerial vehicles to show transportation and precise load deployment testing. The use of aerial robots to assist victims during rescue operations is made possible thanks to this cutting-edge function. Accuracy at the deployment site is a critical problem in SAR circumstances when the injured individual may have limited mobility. A range of cooperative actuation techniques are also made possible by the system, including the joint movement of slung loads and the objects as well as the joint deployment of incredibly small sensors.

Title	Autonomous Transportation and Deployment with Aerial Robots for Search and Rescue Missions
Authors	Konstantin Kondak
Year of publication	Received 26 November 2010; accepted 20 May 2011 Published Year: 12 October 2011
Source	Research Gate
Discussion	**Challenges:** • Various levels of interaction between the UAVs and between the UAVs and the environment, including sensing and actuation, are made possible by the multi-UAV design used in the AWARE project. • The study specifically outlined the findings from the AWARE project, which was the first to demonstrate this challenging application. In this experiment, lifting and moving a slung load by a single helicopter and by three connected helicopters were both demonstrated. **Future trends:** • It is well acknowledged that systems made up of several airborne robots capable of autonomous collaboration can help first responders in a variety of search and rescue (SAR) circumstances. • New possibilities for missions involving many UAVs working together for uses like SAR and interventions in disaster management and public safety. • The movement of cargoes by means of UAVs can also be seen as a precursor to the movement of freight or even the evacuation of persons during SAR operations. • In the majority of the past, they were viewed as platforms for environmental sensing and weren't employed to help victims. • This study presents single/multiple autonomous aerial vehicle transportation and precise load deployment field trials conducted outdoors.

2.4 Generic Slung Load Transportation System Using Small Size Helicopters

There are specific techniques and strategies for a load transportation system based on little unmanned helicopters. The major elements of interest are the control strategy and the movement of the rope connecting the cargo and helicopters. The proposed approach is based on two control loops: an inner loop to manage helicopter orientation and an outer loop to regulate each helicopter's translation in the compound. The incorporation of the force sensor in the rope allowed the development of an accurate orientation controller that is independent of the number of helicopters in the system. Through computer simulation and actual flight tests, the given methods have proven their ability to prevent and correct load oscillation during flights. For the majority of jobs, the resulting control precision is also sufficient.

Title	Generic Slung Load Transportation System Using Small Size Helicopters
Authors	Markus Bernard, Konstantin Kondak
Year of publication	Received: 12 May 2009 Accepted: 17 May 2009 Published online: 6 July 2009
Source	IEEE
Discussion	**Challenges:** • A workable solution for load position detection based on a state observer was offered after the issue of the rope oscillations was examined. • The difficulty in this situation is that both loops must take into account the dynamics of the entire system, including all helicopters and the load. It is demonstrated that a basic model based on connected mass points may be used to construct the outer loop controller in place of a sophisticated model of the helicopters and load. **Conclusion:** • The control approach and the motion of the rope linking the cargo and helicopters are the main points of attention. • One or more connected helicopters can transport a load using the control algorithm. It was demonstrated that, depending on the number of helicopters in the system, only the translation controller should be altered. A reliable orientation controller that is independent of the system's number of helicopters was developed thanks to the use of the force sensor in the rope. • The provided methods have demonstrated their ability to prevent and correct load oscillation during flights through computer modelling and real-world flight testing. • This research focuses on a broad review of methods and strategies applied to a cargo delivery system based on small unmanned helicopters. • The whole dynamics of the entire system are taken into consideration while building the inner loop controller.

2.5 Limitation of State of the Art techniques

The usage of UAVs is subject to several restrictions and worries. A few of the problems are privacy invasion, UAV collisions brought on by a lack of control, hacking, and other security problems.

Before complete active implementation in actual transportation networks becomes a reality, several problems must be resolved. It is essential to have thorough understanding about UAV's current and potential improvements, obstacles they may face, and chances for use in the transportation industry if UAVs are to be successfully integrated into future transportation systems. In fact, the current transportation system as a whole is evolving toward the ITS paradigm. UAVs are one of the key components of the future ITS, necessitating extensive infrastructure upgrades, retrofits, and enhancements in the existing transportation system.

2.6 Discussion and future direction

A UAV qualifies as a "Aerial Robot" since it can operate without a pilot and carry out challenging air flying operations and a variety of load duties. This category of unmanned aircraft, which uses radio remote control technology and self-contained programme control systems, includes fixed-wing aircraft, unmanned helicopters, unmanned airships and , multi-rotor aircraft.

UAVs can divided into three categories depending on various application areas: consumer, civil, and military.

(1) There are stricter standards for sensitivity, intelligence and flight speed for military UAV, which includes decoy,reconnaissance, communication relay, electronic countermeasures, UAV and target aircraft,.

(2) The Civil UAVs often have moderate needs for lift, range and speed but high requirements for operator training and total cost.

Therefore, to deliver parts and support services as cheaply as feasible, it is required to establish a mature industrial chain. Therefore, to deliver parts and support services as cheaply as feasible, it is required to establish a mature industrial chain. Currently, providing government public services like fire fighting, police, energy, meteorology, etc. is the largest market for civil UAVs.

(3) Consumer UAVs frequently make use of inexpensive multi rotor platforms for aerial photography, video games, and other recreational activities.

A whole new universe of possibilities might be made possible by traits like the adaptable movement in conjunction with unique elements like the lightweight chassis and the onboard sensors.

Unmanned planes are employed all over the world to follow the development of threatened species and track trends in various ecosystems.

Unmanned aircraft will be used in conservation initiatives more and more as drone technology advances.

2.7 Concluding Remarks

Some major obstacles to using UAVs are shown by this discussion. With the rise of UAV applications for transportation, numerous study fields have also emerged in computer vision, with the goal of creating methods for UAVs to navigate around environments utilising visual data as their primary input source. The deployment of aerial robots for SAR and its applications, such as interventions in disaster management and civic security, are covered in this essay together with some other research papers. There are just a few possible research fields found based on the present study areas. Delivering information concerning control strategy and rope movement between the UAV and load is the paper's principal objective. This research focuses on an overview of methods and strategies applied to a cargo transportation system based on small unmanned aerial vehicles (UAVs).

Chapter 3

Problem Definition and Scope

3.1 Problem statement

To design, develop and fabricate an Unmanned Aerial Vehicle (UAV) for the delivery of life essential goods.

3.2 Goals and Objectives

1. To design and fabricate Unmanned Aerial Vehicle(UAV).
2. To integrate controller mechanism for UAV flight.
3. To design and integrate load balancing Mechanism to deliver a low payload.

3.3 Scope and Major Constraints

The Unmanned Aerial Vehicle can deliver the low payload highly essential products. The time required to deliver the essentials will drastically reduced than the conventional method used. The UAV can carry the payload of approx 500 gm. The approx flight time of UAV can be approximately 10 minutes(Considering battery to be full charged before flight). The UAV can deliver the product without landing at the delivery location. The load balancing mechanism will help the UAV to balance itself during the delivery of product from some height above the ground.

The major constraints in the Unmanned Aerial vehicle design is to select the best controller within the low or moderate price. The controller price increases as the functionalities and features of controller increases. So the choice of controller should be done by considering the requirement of project and budget. Also load balancing is very difficult for UAV in some unavoidable situations like strong winds, obstacle collision and much more. In such situations the UAV can be very risky as it can crash and hit someone. Also there can be breakage of parts of UAV can happen, which apparently increases the cost of the project.

3.4 Unmanned Aerial Vehicle as the sustainable development goals

3.4.1 Recent work and economic growth

People will have an opportunity to find employment that matches their qualifications by establishing the UAV industry. 204 million people were unemployed in 2017, according to the International Labor Organization. The lack of employment among recently graduated students, which is also a problem in India, would make them further poorer. As a result, the development of the UAV gave others the inspiration to expand the sector and the manufacturing of UAV for delivery in order to produce an increasing number of them in the future. The influx of workers into this sector will help sustain economic growth, boost productivity, and introduce innovative technologies.

3.4.2 Industry, Innovation, and Infrastructures

UAV delivery investment innovation will accelerate economic growth and development. Additionally, the development of UAV for use in a variety of functions, such as delivery UAV, enhanced working productivity. Delivery drones send packages in quicker than terrestrial vehicles. Drone technology is essential to sustaining issues with the economy and the environment. It, for instance, encourages energy efficiency. Then, by citing scientific studies, it also encourages innovation, investment, and sustainable industries. Those will therefore aid in sustainable development.

3.4.3 Sustainable Cities and Communities

Urban areas must be changed into smart cities in order for sustainable development to be accomplished. As a result, investing in delivery drones in cities will encourage them to become sustainable. This is due to the fact that UAVs in cities have more benefits for both the environment and humans. By deploying UAVs rather than motorised vehicles like automobiles or motorcycles, air pollution surrounding cities will be reduced, and so will the number of illnesses linked to breathing contaminated air. Therefore, since UAVs support a green environment, we should use them.

3.5 Hardware and Software Requirements

3.5.1 Hardware requirement

The UAV is assembled using many accessories and parts, which are

1. Q450 Frame
2. Power Module for APM 2.8
3. Electronic Speed Controller(ESCs)
4. Brush Less DC Motor – BLDC Motor
5. APM 2.8 Flight Controller
6. Flysky Transmitter Receiver
7. External GPS
8. 11.1V 2200 mAh Li-Po Battery Charger
9. Servo motor

10. Landing Gear

11. 1045 Propeller Pair

Q450 frame

Figure 3.1: UAV Frame

The UAVs frame and components that are aligned near its centre of mass are main factor for its stability. So, we have bought the Q450 Quadcopter frame for our project.

Power Module for APM 2.8

Figure 3.2: Power Module

Power module transfer power from the battery to the ESCs. However, as a result of recent advancements in technology, Power Module can now provide power to other accessories including FPV video transmitters, FPV cameras, and the quadcopter flight controller itself.

Electronic Speed Controllers (ESCs)

Figure 3.3: ESCs

Flight controllers can control and modify the speed of the aircraft's electric motors using electronic speed controllers (ESC). The ESC adjusts the voltage to the motor in response to an instruction from the flight controller, adjusting the propeller speed as necessary.

Brush Less DC Motor – BLDC Motor

Figure 3.4: BLDC Motor

An electronically commuted DC motor without brushes is referred to as a brushless DC motor(BLDC motor). The synchronous motor's speed and torque are controlled by the controller by sending short bursts of current to the motor windings.

APM 2.8 Flight Controller

Figure 3.5: APM Flight Controller

1. A small circuit board of various complexity is known as a flight controller (FC). Its job is to control each motor's RPM in response to input. The flight controller receives a directive from the pilot to move the multi-rotor forward and decides how to manage the motors accordingly.

2. Most flight controllers use sensors as well to support their computations. These might be as basic as gyroscopes for orientation or as sophisticated as barometers that maintain altitude automatically. Additionally, GPS can be utilised as a fail-safe or autopilot system.

3. APM is based on the Arduino Mega platform, Ardu Pilot Mega (APM) is a high-quality IMU autopilot. Fixed-wing aircraft, multirotor helicopters, and conventional helicopters can all be controlled with this autopilot.

FlySky Transmitter Receiver

Figure 3.6: Transmitter and Receiver

1. For Transmitting the command from human pilot to the drone, the Radio Transmission technique is used.

2. An electronic device called a radio transmitter transmits commands wirelessly over a predetermined radio frequency to a radio receiver, which is attached to the aircraft or multirotor that is being remotely controlled.

3. In other words, it's the device that translates pilot's commands into movement of the Drone.

4. Channels are used by a radio transmitter to send commands. An separate action is communicated to the aircraft via each channel.

5. The quadcopter may be controlled via four main inputs: throttle, yaw, pitch, and roll. Since they each use one channel, a minimum of four channels is needed. Each knob, slider, or switch on the transmitter uses a single channel to send command to the receiver.

External GPS

Figure 3.7: GPS

UAVs have a GPS module that allows them to navigate their surroundings. By connecting to signals from these GPS satellites, the drone may do activities including position hold, autonomous flight, return to base, and path navigation.

Servo motors

1. A servomotor is a closed-loop servomechanism that uses position feedback to control its motion and end position. The input to its control is a signal (either analogue or digital) that represents the command position of the output shaft.

Figure 3.8: Servo Motor

2. The motor is connected to a position encoder to provide feedback on position and speed. Simple location measurement is used in the simplest case. The measured output position is contrasted with the controller's external input, the command position. If the output position differs from the desired one, an error signal is sent, and the motor will then rotate in either direction as needed to shift the output shaft to the proper point. As the places move closer together, the error signal goes down to zero and the motor stops.

Propellers

Figure 3.9: Propellers

The motor's propeller is a component that produces upward thrust by translating rotary motion. When the propellers rotate, they create an air flow that results in a change in pressure between the top and bottom surfaces, as such they produce thrust. Shorter propellers uses less energy to accelerate to a certain speed due to their lower inertia, however long and broad propellers produced significantly more force and lift due to their bigger surface area. However, due of their inertia and slightly increased weight, longer propellers required much more motor power. a longer and small pitch propeller is suitable for delivery purpose UAV because it provides stability to the UAV.

Landing gear

Figure 3.10: Landing Gear

Landing gears are very important component for take-off and landing. This part is crucial because it supports the UAV during takeoff and helps it land safely. The area of landing gear is large at bottom which reduces the imapct of shock during landing and provides extra support while take-off. In delivery purpose UAV it can be used support delivery container.

3.5.2 Software requirement

1. Mission Planner(1.66.3) Mission planner is used to Setup, configure, and tune any Aerial vehicle for optimum performance. It can plan the navigation of UAV. Mission Planner is a full-featured ground station application for the ArduPilot and it is open source.

3.6 Expected Outcomes

The complete working implemented UAV which can carry the payload of approximately 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 (full charge). The UAV should deliver the product without colliding with obstacles and with reducing the effect of air resistance by using the load balancing technique. The delivery of product should be done without landing.

Chapter 4

System Requirement Specification

4.1 Overall Description

4.1.1 Product Perspective

The UAV is used to deliver the life essential products. It has quadrotor frame. It will have capacity to carry 500 gm of essential products and can fly about 10 minutes. The UAV can deliver the essential products from some height above the ground without landing. The location to deliver the product is decided using GPS. The UAV is very useful in emergency situations and can be life-changer for many remote areas.

4.1.2 Product Function

The UAV is started by connecting the battery with power module. Then turn on the transmitter and position the throttles at initial position. And the left throttle should be at the downward direction. The BLDC motors will start rotating if you push the left throttle in right side for some seconds. Take the left throttle in upward direction and as soon as you push the throttle upward for more than 50 percentage, the UAV will start flying in the sky. To change the direction of UAV the right throttle have to move in the required direction.

As the UAV reaches the delivery location the UAV will start to slowly drop the product using rope and pulley delivery mechanism. The servo motor will start rotating and drop the product.

The UAV will carry the essential products like vaccines and other medical instruments from the pickup location. Then the delivery location is decided by using the GPS co-ordinates. As the UAV reaches remote delivery location it will deliver to the remote delivery location.While delivering the product the UAV will be balanced using the load balancing mechanism specifically designed to get rid of this problem.

4.1.3 User Characteristics

The UAV delivery is very useful for the people in remote places, who cannot get the emergency treatment during need. The UAV will be life-saver for such people. The people in remote places also get such basic essential products. The UAV can also reduce the cost of delivery and bypass other difficulties faced due to government inefficiencies.

UAV can also be used in natural disaster affected places to supply the essential needs. In situations like flood, cyclone the UAV can easily and very fast deliver the essentials.

Introduce drone delivery for online retailers. The UAV reduces the distance travelled for deliveries and reduce the price that comes with it. It is believed that as the market for delivery drone services grows over time, E-commerce companies will increasingly outsource their delivery needs to other companies who own and manage a fleet of UAVs. Restaurant delivery UAVs should be introduced. For restaurant owners, the logistics of delivering food to clients' homes have long been a major challenge. It is challenging to establish staffing levels in advance because of the high costs and fluctuating workloads.

4.2 Specific Requirements

4.2.1 User Requirements

The user has access to UAV location and there will be OTP(One Time Password) provided to the User. The UAV location will help the user to track the UAV and OTP(One Time Password) is required to prove his identity. There are other fields which cannot be accessed by User such as UAV control while transportation, overall customer dashboard, product landing control.

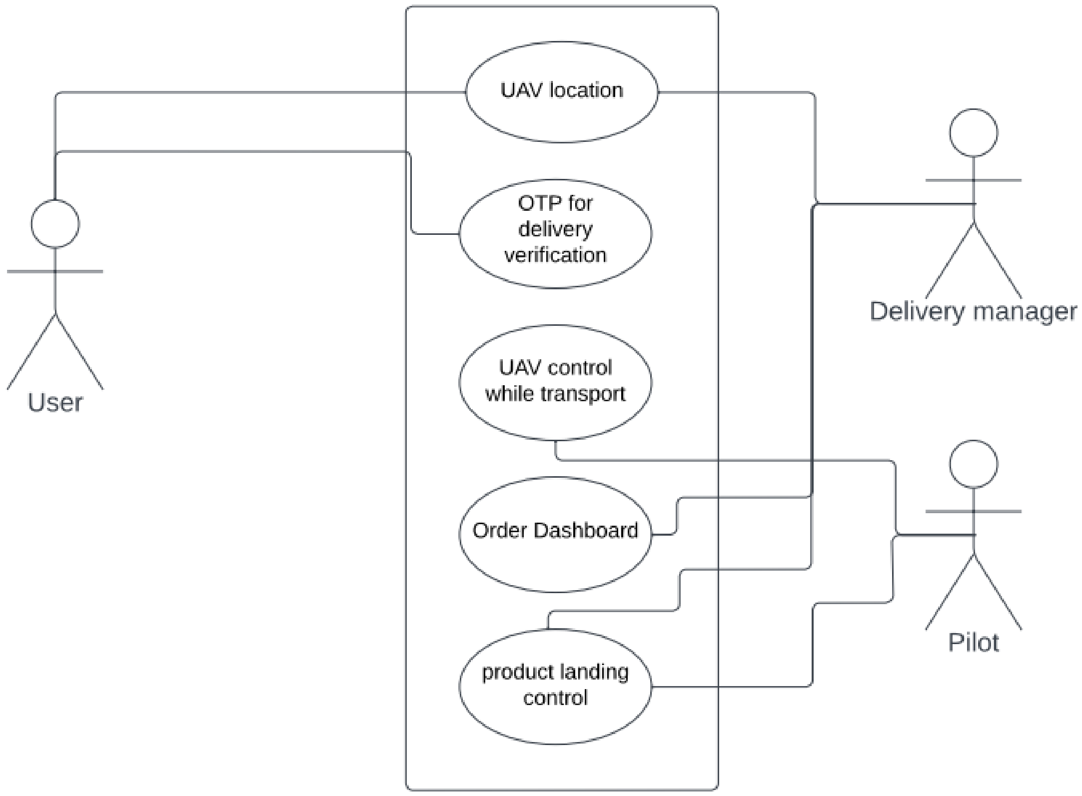

Figure 4.1: User Requirements

The UAV location, Overall customer order dashboard, and product landing control is with delivery manager. As delivery manager needs to track the UAV location is very useful. The customer dashboard will helpful in managing and planning the orders of the day. The product landing control gives the manager overall the control of order.

The delivery location, UAV control while transport and product landing control is given pilot for controlling purpose of UAV.

4.3 Project Planning

Semester	Month/Year	Task	Progress
V	August	Literature Review and concept fomulation	Well defined problem statement is ready
	Septeber	Concept modification and defination of problem statement	Project concept is well understand and documented
	October	Design of broad system for UAV	The system design is done with consideration of different stages of overall system
	November	Design of refined system with design of actual UAV	The system is modified and actual design process begins
	December	Design of actual UAV structure and finalise the project report for design	The semester project report is made with structural design of UAV
VI	January	Search for components in market with required specifications	The required electronic components searched in market(i.e online e-commerce sites)
	February	To check feasibility of previous design and modification of design	The design is modified and finalise
	March	Finalise the components for structural design	The components are ordered and taken for structural design
	April	Implement the structure of UAV	UAV is implemented and all structure is ready with some errors in UAV flight
	May	Finalise the project report for UAV considering the project progress	The project report is ready for semester work presentation
VII	August	To work on literarture review of delivery mechanism	The implented UAV is ready with all components functioning properly
	Septeber	To design and finalise the delivery mechanism	Implented UAV and delivery mechanism is ready
	October	Implement delivery mechanism	Delivery mechanism is implemented
	November	To search for research paper publication options and finalise the research paper and conclude the project	The search is going on for research paper publication and finalising the paper

Figure 4.2: Project Plan

The overall plan is made in consideration of three semesters and detail three semester plan is made accordingly.

Chapter 5

Methodology

5.0.1 Working Module

The signal for the dispatch of the package is collected by the base or warehouse. The signal is then sent from the base to the designated drone. In order to avoid obstructions and disruptions, it takes off while flying to a greater height.
The UAV is directed toward its destination along a path that has been set to the delivery site. The drone is given the customer's precise location as it reaches a greater height, and it is continuously updated so that it can follow the location as it travels to its destination. The UAV will read the distribution point's GPS position in accordance with the architecture diagram. It will continuously track the current location after reading the precise position, then depart from the base.By requesting the OTP supplied to the confirmed device, it will fly to the delivery location and verify that the package is for the right consumer. Following confirmation, it will deliver the package and return it to the base from the delivery location. The drone won't lower itself and return to the base if the OTP is invalid, meaning it doesn't verify. Until the package is delivered to its recipient, the process will be repeated.

5.0.2 Performance Of UAV Base

Now we only created one base from where UAV will take off .In future we will create many UAV base in particular are that will operate in a specific zone . As we thought if the delivery location is out of its boundary it will try to communicate with nearest bases, than it first deliver ti that nearest base than if possible as per battery requirement UAV will deliver load to destination zone .Other wise it will deliver the package to the nearest base or warehouse. In this project we are only trying to deliver low payload so it will only use for emergency requirement like injections, medicines, food packets, etc.

5.0.3 System-User Interaction

The user-system interaction Long-distance vehicles need to have more energy and batteries per unit of travel since they may carry heavier payloads. Larger multi-stop vehicles drag more as a result of carrying more battery and payload.That's why our prototype only able to deliver low payload for emergency purpose. To be able to travel the complete delivery route and return to the fulfilment centre with all of the products, vehicles are prudently sized. With each extra package and compound, the load of irreversible packages grows.

The customer receives the information on the day of delivery on his phone, and he updates the system with either his current location. If payment is made at the time of delivery, the drone deposits the funds in a safe-box that is housed in the main controlling head. When the drone got close to the users, it didn't lower itself,the OTP is confirmed.To guarantee that the customer will receive a code during the production of the package on its defined route, the drone must be equipped with a special feature that prevents interchange with some other customers' products. The code will be requested and compared to the number provided in the drone as soon as the package is delivered to the customer. This will guarantee that the right package will be delivered.

5.1 System Architecture

In UAV we connect several components to create a architecture like drone frame, Electronic Speed Controller, BDLC motor, flight controller, external GPS, transmitter and receiver, servo motor, pulley. By using all these we made a architecture of our prototype UAV with low pay load.

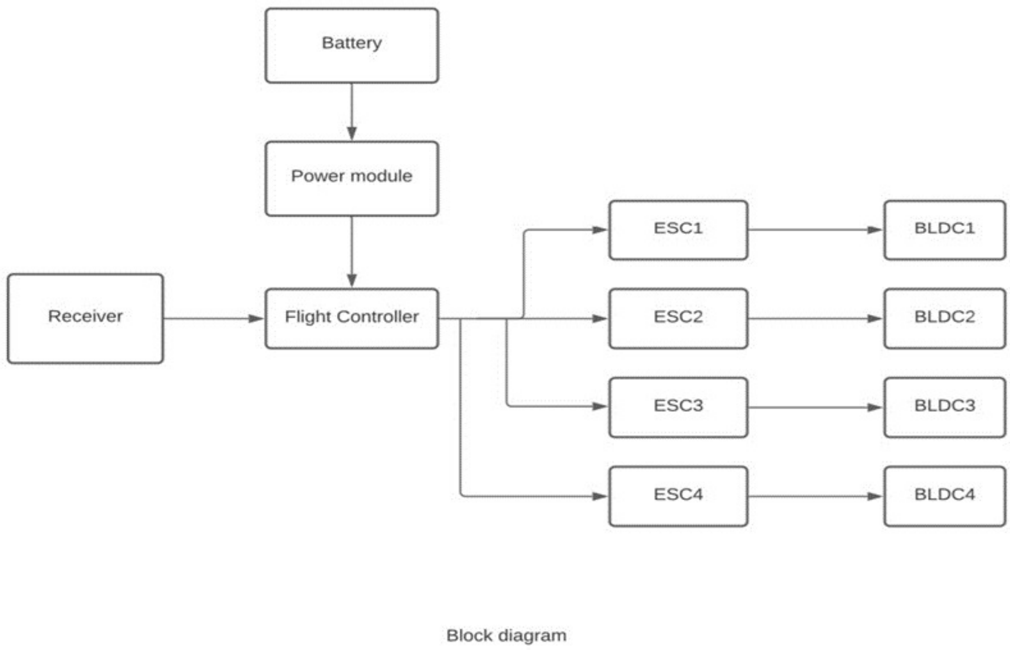

Figure 5.1: Block Diagram of UAV Architecture

1. We have to install the motors in alternate fashion.
2. The ESC's used are connected to three wires of motors via soldering.
3. The ESC's connected to motors are further connected to main board on the Quad copter frame.

4. The power module is connected to main PCB board of frame and other end to flight controller.
5. The remaining third wire of each ESC is connected to controller.
6. The receiver is connected to flight controller.
7. The power module is further connected to LiPo batter

Pick and drop mechanism

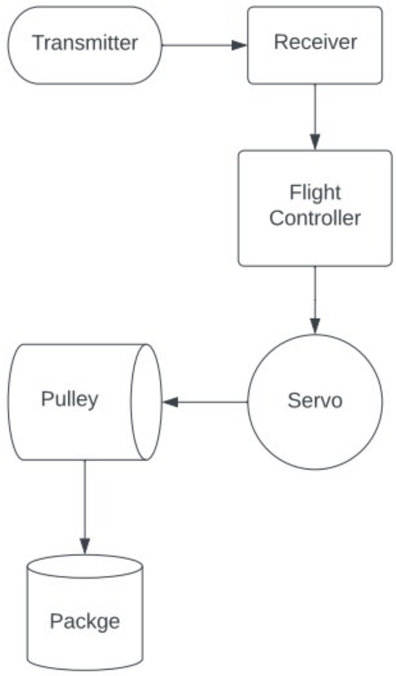

Figure 5.2: Block Diagram of Pick and Drop Mechanism

1. Here, the pick-and-drop functionality is entirely dependent upon the servo motor. To connect the user with the pick and drop mechanism architecture, we first needed a transmitter and a receiver.
2. The transmitter is connect with receiver through their digitally functioning in transmitter.
3. Receiver is connected with flight controller which is the brain of this mechanism .A command from the user or pilot for the multi-rotor to move forward is fed into flight controller.
4. Hence flight controller is connects with servo motor which can rotate 360 degree.
5. Servo motor is linked or connects with pulley which can use to lift load up and down to deliver our low payload object.

5.2 Mathematical Modeling

The major aspect of a project are directly proportional to the mathematical and theoretical background of the concepts used. This leads to the mathematical calculations and terminologies that are associated with the UAV hardware implementation and building phase.

The major components used in the making of UAV consists of APM 2.8 Flight Controller which is a small circuit board of various complexity. Its job is to control each motor's RPM in response to input. The flight controller receives a directive from the pilot to move the multi-rotor forward and decides how to manage the motors accordingly,Flysky Transmitter Receiver is used for transmitting the command from human pilot to the drone, here the Radio Transmission technique is used, Servo motor which is a closed-loop servomechanism that regulates its motion and final position using position feedback. A signal (either analogue or digital) representing the output shaft's command position is the input to its control, Brush Less DC Motor, External GPS and 1045 Propeller Pair.

The weight of the final UAV model is around 1053 grams. The overall payload capacity of the UAV according to the thrust generation of four brush less DC motor is around 3200 grams. It is concluded that it can carry a payload of 500 grams easily with this much amount of thrust. This much payload capacity is enough for delivering medical supplements and consumables.
The Overall estimated weight of the UAV includes the weight of main body model and payload.

i.e. 1053+ 500 (with payload) = 1553 gm

Thrust by single A2212 1000 KV BLDC Motor is approximately 800 gm.

Total Thrust produced by 4 motors = 4*800 = 3200 gm

Thrust to weight ratio:
Most of Drones have T/W ratio of 2:1 as ideal case. While calculating this ratio we came to know following:

Thrust/Weight = 3200/1553 = 2.06/1

i.e. T/W = 2.06: 1

Flight Time: The flight time of the UAV depends upon the power input used i.e. the battery used to provide the power to overall model. The different components used for the fabrication of UAV consumes variable amount of power. This affects the battery capacity requirements for the endurance time of the UAV.

Table 5.1: Component Current Consumption

Components	Current Requirements
Motor	20 Amp
Receiver	0.1 Amp
Flight controller	0.1 Amp
ESC (4)	0.4 Amp
Total	20.6 Amp

As seen from above table different components are consuming variable amount of current. Here we can calculate the estimated flight time of UAV as we have the total current output from the battery i.e. 3300mAh. We have the total current consumption of components i.e. 20.6A.

We can now easily calculate the endurance time using following equation:

$$BatteryEndurance = \frac{\text{Current Output from Battery}}{\text{Total Current Consumption}}$$

$$BatteryEndurance = \frac{3300 * 10^{-3} * 60}{20.6}$$

$$BatteryEndurance = 9.6 \text{ Minutes}$$

This leads to the conclusion that the approximate flight tie of UAV will be around 10 minutes.

5.3 Objective Function

5.3.1 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.

5.3.2 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 utilise mission planning software to connect the transmitter and receiver. In mission planner, we repaired the up and down, right and left knobs.

5.3.3 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.

5.3.4 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.

5.4 Approach/Algorithms

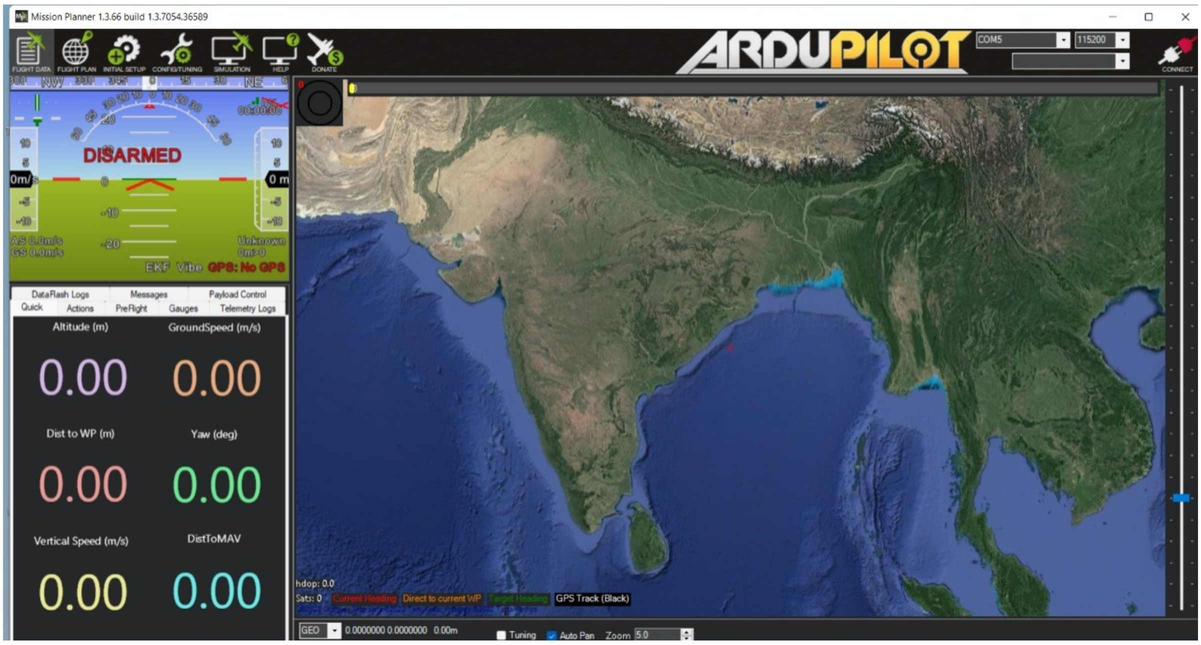

Figure 5.3: Algorithm based software for UAV

1. We just employ an algorithm for the UAV mechanism to connect the transmitter and receiver.

2. Software called Mission Planner is used to link the transmitter and receiver in order to run all devices connected to the flight controller, such as servo motors and BLDC motors.

3. All algorithm already run at background of mission planner software which help to do any functioning or work to UAV.

4. Pick and drop mechanisms in particular need precise destination coordinates in order to transfer low payload objects from our UAV.

Chapter 6

Implementation

6.1 System Implementation

The project that includes the first four stages-initiation, planning, execution, and testing—is the one that succeeds. Here, each of these four phases is crucial to the project's effective conclusion.

During the project initiation phase, we must define it. We had to decide on the project's goals, parameters, resources available, and team member responsibilities. If the expectations of the stakeholders, as well as the precise project goals and their explanations, are made apparent at this time, the project and team will have a clear direction. This stage is crucial to the project's success. Without a clear understanding of what has to be done and why, the project runs the risk of falling short of both the expectations of its stakeholders and its intended outcomes.

The "how" of project completion—the processes to actually attaining the project goals—are decided upon during the planning phase. Along with the sources and necessary documents, budgets, timeframes, and milestones are established. This phase also entails forecasting and calculating future risk. Choosing what to do with one's forces is the planning phase, if assembling one's troops is the initiation phase. We must make decisions and take action in accordance with the discussed plan. The next stage of execution is now.

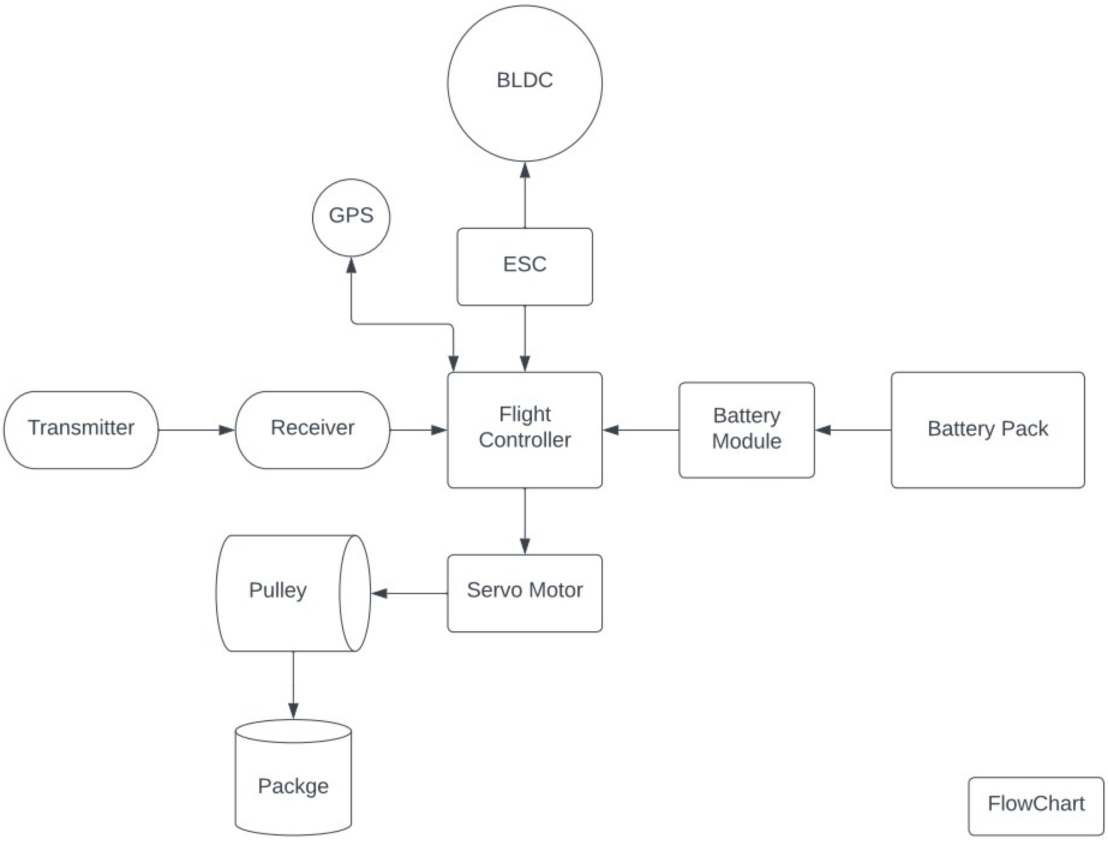

Figure 6.1: UAV's primary Block Diagram

A project's execution implies carrying out the plan and directing the team. For the most part, this entails monitoring and measuring progress, reducing risk of failure, managing the budget, and using data to guide your decisions.
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 FlySky 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.

We have yet to work on the design and implementation stage of the delivery mechanism after the overall UAV model is finished. 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. To prevent parts from wobbling and shaking during flight, the components on the UAV frame should be properly arranged and fastened to the frame with strips. This will ensure smooth operation and stop the UAV from becoming unbalanced. Additionally, the UAV parts should have the appropriate current supply to function as expected. The GPS configuration is also rechecked to ensure the better navigation through mission points.

6.2 Experiment/Implementation Parameters

The success of project depends upon the parameters designed and the expected parameter outcomes achieved during the actual testing of project.This parameters are discussed as follow:

1. The very first parameter stated was of the BLDC motor rotations in the preferred direction i.e. opposite fashion of rotation.
2. Next we have to check if the GPS attached with the APM 2.8 flight controller works well and gives proper positioning.
3. The use of APM 2.8 flight controller further extends in the use of working of the servo motor, here it is desired to rotate the servo motor in both clockwise and anti-clockwise fashion.
4. The usage of APM 2. flight controller majorly depends upon the signals it's been receiving. This leads to the proper connection between receiver and transmitter.

6.3 User Interface

For greater efficiency and ease of use, customers primarily choose apps as user interfaces. App can be used at any time and from any location. However, as a first step in our project, we use a website. In the future, we'll create an app that allows users to securely order any package in order to receive it as fast as necessary in an emergency.

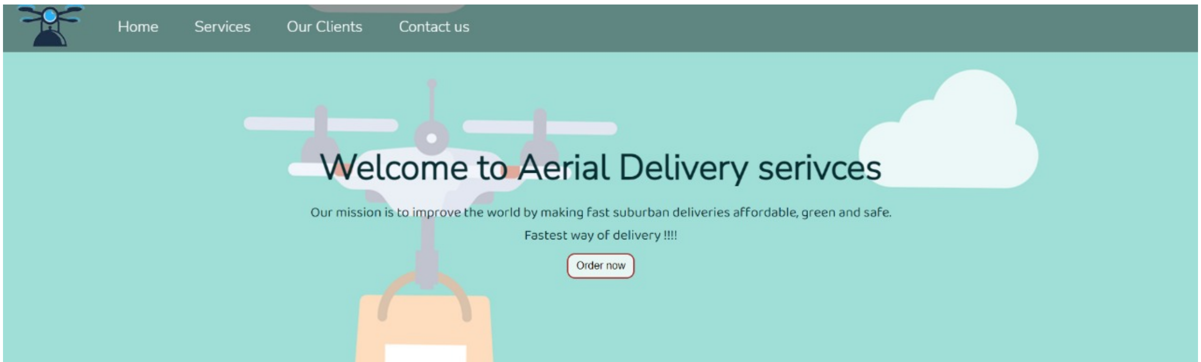

Figure 6.2: Aerial Delivery Website

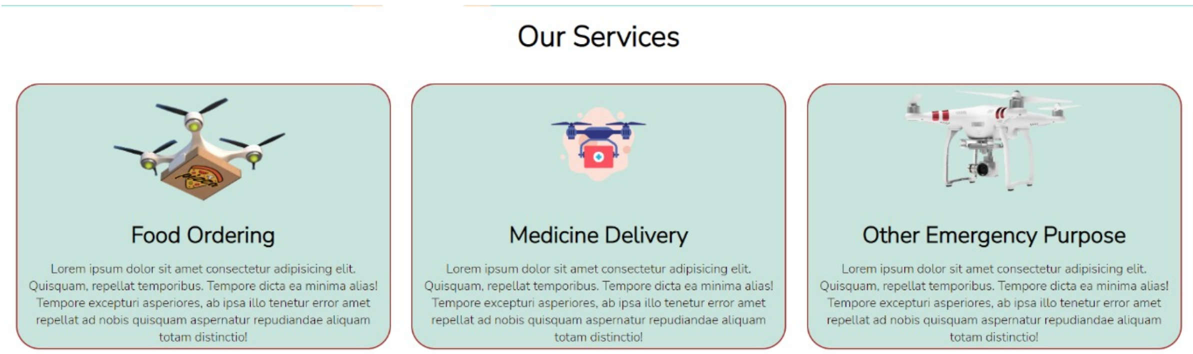

Figure 6.3: Services for Aerial Delivery

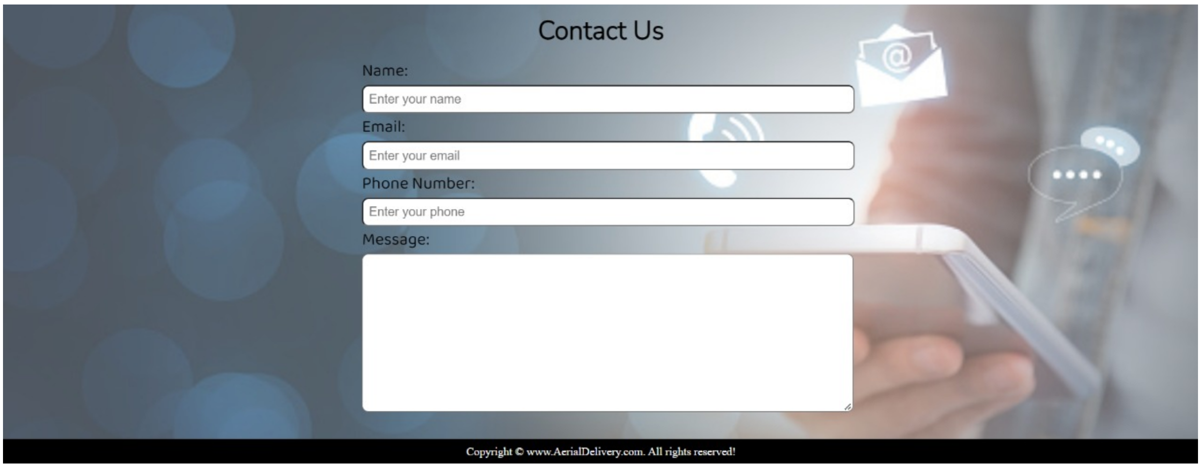

Figure 6.4: Contact Page for Aerial Delivery

1. To allow customers to order packages from anywhere they like, we designed this aerial delivery service. We consider food services, medical services, and any other emergency services when discussing this.

2. As shown in Figure 6.2, we can choose from a variety of options when creating the main page of our website, including "home," "services," "our clients," and "contacts."

3. As seen in Figure 6.3, there is a service page from which we can select any number of services. Additionally, we can add more services based on our preferences and convenience.

4. Figure 6.4 shows the contact screen where you may enter all of your contact information to place a package order. You only need to provide your contact information and order the bundle at first. After that, if you want to place an order, all you have to do is log in and place your order without repeatedly entering your contact information.

6.4 Output

Having followed the actual flight test of the UAV and successful project model implementation, the project's overall results and conclusion come next. Here, we're talking about the results we got after providing the proper inputs.
Here, after the hardware implementation stage and the electronic component assembly, we obtained the desired UAV with each component functioning correctly. It also includes the Brush-Less DC motors attached in the opposite direction rotating properly. The receiver also picked up the right signals in accordance with the inputs provided by the FlySky transmitter. Additionally, the APM 2.8 flight controller is also sending the appropriate signal to the servo motor. It is turning the attached pulley in the necessary directions.

Additionally, the UAV's flight test outcomes with its attached delivery mechanism facing downward were as expected. The UAV's flight time was anticipated to be around 10 minutes, and in this case, the actual value we attained was very close to that estimate. The 500 gram package is smoothly raised by the UAV. In accordance with the operation viewpoints, the package was then delivered to the specified location.

Chapter 7

Result Analysis/Performance Evaluation

The UAV implemented in this project 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.

7.1 Result Analysis of Objective 1

In order to create a UAV, our first goal for this project is to select components and a frame that perform best as per our requirements. Therefore, we chose the following components: 1. Quadcopter frame = Q450

2. BLDC Motor = 1000 KV

3. LiPo battery = 3000 mAH

4. Flight controller = APM 2.8 (ARM based)

7.2 Result Analysis of Objective 2

The UAV used in this project has an overall weight of 1553 gm and can lift a payload of 500 gm. For UAVs, the thrust to weight ratio is 2.06/1. The average UAV flying time is 10 minutes (considering the battery will be full charge). As the BLDC motor power ratings and UAV frame are modified, the payload capacity of the UAV can be enhanced. On our initial attempt, we were able to lift the UAV up to a height of 4 m. We can also extend our flying time by boosting battery power.

7.3 Result Analysis of Objective 3

Last but not least, we need to integrate our UAV's pick-and-drop mechanism. We have selected a motor that can rotate in a 360-degree circle for that purpose. Thus, we select a servo motor (360 degree). We want the servo motor-connected pulley to release the package. In order for the transmitter to control rotation according to the user, we link the servo motor to the receiver.

Chapter 8

Conclusion

8.1 Conclusion

The needs of the human race will not be met in the future through manual delivery. When it comes to getting shipments and messengers to the right clients, UAV will become vital and tremendously beneficial.People in the future won't have time to collect packages and boxes separately since they will be so busy with their own tasks. Therefore, these UAV will ensure that their demands are properly delivered to them in their current circumstances no matter where they are. Our study focuses on autonomous unmanned aerial vehicles with small payloads. The UAV will only load objects with a small payload. Therefore, balancing our UAV ought to be easy. A UAV will deliver the delivery to the customer by following Google Maps, saving time and money on labour.

Some major obstacles to using UAVs are shown by this discussion. With the rise of UAV applications for transportation, numerous study fields have also emerged in computer vision, with the goal of creating methods for UAVs to navigate around environments utilising visual data as their primary input source. The deployment of aerial robots for SAR and its applications, such as interventions in disaster management and civic security, are covered in this essay together with some other research papers. There are just a few possible research fields found based on the present study areas. Delivering information concerning control strategy and rope movement between the UAV and load is the paper's principal objective.This research focuses on an overview of methods and strategies applied to a cargo transportation system based on small unmanned aerial vehicles (UAVs).

8.2 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.

"UAV is the way of the future!"

begin

Appendices

Appendix A

Plagiarism Report

10-Modified - Btech-09-VBK EVMS-Uav

ORIGINALITY REPORT

17%	10%	8%	11%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to MIT Academy of Engineering Student Paper	3%
2	cyberleninka.org Internet Source	2%
3	M. Bernard, K. Kondak. "Generic slung load transportation system using small size helicopters", 2009 IEEE International Conference on Robotics and Automation, 2009 Publication	1%
4	Markus Bernard, Konstantin Kondak, Ivan Maza, Anibal Ollero. "Autonomous transportation and deployment with aerial robots for search and rescue missions", Journal of Field Robotics, 2011 Publication	1%
5	Submitted to King's Own Institute Student Paper	1%
6	Submitted to CSU, San Jose State University Student Paper	1%

Figure A.1: Plagiarism Report

References

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