A Project Report

On

Development of Rotary Wing UAV for Drug Delivery in Remote Areas

Submitted in partial fulfillment of the requirement of

University of Mumbai for the Degree of

Bachelor of Engineering

In

Mechatronics Engineering

Submitted By

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Academic Year 2022 – 23

CERTIFICATE

This is to certify that the project entitled **"Development of Rotary Wing UAV for Drug Delivery in Remote Areas"** is a bonafide work of **"Rohit Suryawanshi", "Prathamesh Pawaskar", "Omkar Pandharkar" and "Rugved Bane"** submitted to the University of Mumbai in partial fulfilment of the requirement for the award of the degree of **"BE"** in **"Mechatronics Engineering".**

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Project Report Approval for B.E.

This project report entitled ***"Development of Rotary Wing UAV for Drug Delivery in Remote Areas" by***

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Examiners

1. _ _ _ _ _ _ _ _ _ _ _ _ _ _

2._ _ _ _ _ _ _ _ _ _ _ _ _ _

Date:

Place:

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Acknowledgement

The project has attained completion through the efforts of many people. We would like to thank our internal guide **Dr. Raghvendra Upadhyay** for providing guidelines and giving timely suggestions and inputs to improve the project. He has been a driving force in this project. He has taken immense efforts to guide and explain the concepts behind this project. A special mention should be made about Terna Engineering College and the staff of Mechatronics Engineering department.

We also extend our humble appreciation towards our Project Coordinator, **Prof. D. B. Shinde** our **H.O.D, Prof. Vikram Vyawahare** for helping us with the best of their knowledge and for their unconditional and tireless support.

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ABSTRACT

This report evaluates a possible solution for this application by using a raspberry pi to control a drone and control it with a python script. It also discusses a possible security solution for the delivery package. It concludes with our case for drones to handle the last mile of delivery of most lightweight packages in areas inaccessible by conventional logistics framework. This report represents Quadcopter(QC) as a low weight and low-cost autonomous flight capable Unmanned Aerial Vehicle (UAV) for delivering parcels ordered online by using an android device as its core on-board processing unit. The rapid increase in usage of online ordering has increased the manpower required for deliver by multiple folds. Drone based technology is being used to meet this requirement. A quadcopter can achieve guided flight in a stable manner and be used to monitor or collect data, deliver in a specific region. With advancing drone technologies and increasing commercial usage, we believe the last mile shipping industry is ripe for manpower to be replaced by delivery drones. Drones can significantly accelerate delivery times and reduce the labor and logistics cost associated with the delivery. This QC by following Google maps can locate and navigate destinations. This paper demonstrates the QCs capability of delivering parcels ordered online and coming back to the warehouse ie launch area. The promising result of this method enables future research on using QC for delivering sensitive goods like drugs.

CHAPTER 1

Introduction

1.1 Background

Drones, a common term in this modern technologically advanced & growing world, has been a great invention and has been proven of great use in the last decade. We have seen its implementation in different areas like the military organizations in order to patrol dangerous areas to monitor for any potential threat or illegitimate activities. It is of great use when it comes to provide efficient and convenient surveillance. We have seen drones applications in farming equipment where it is used to spread medicines in the organic fields, carry out easy and safe pesticides disposal over the crops. In the same manner we have developed a drone which is able to deliver essential and vital medicines in the areas where proper transportation is not available for the native people.

This drone is capable of delivering the medicine to the places where it cannot be transported using any mechanical vehicle commonly used by all delivery agencies. In any pandemic situation where human interaction is not advised and social distancing is the key in health management structure, this Unmanned drone medicine delivery system can be used as a strong weapon to fight against the pandemic. In emergency situations where the present transportation structure is shattered due to flood, earthquake etc. this type of automatic drone delivery system can save precious lives with much less and nominal efforts. Not only in the rural areas but also in fully developed cities this project can be of great use.

The GPS system programmed in this device provides accurate locations of the flying drone so one can see and get an idea of where the drone is and can figure out the expected delivery time accordingly. This is much faster than the traditional motor delivery system.

1.2 Motivation

Unmanned Aerial Vehicles are an excellent way to modernize the last mile in medical deliveries and bridge gaps in access. Drones can provide just-in-time resupplies of key medical items, regardless of location. Since some health systems can't afford to keep cold-chain products such as platelets or blood on-site, with further research drones can ensure these supplies are available on demand.

Drones for healthcare logistics have recently seen a range of landmark moments. Last year, a University of Maryland drone delivered a kidney that was successfully transplanted into a patient suffering from a serious neurological condition, the first ever drone delivery of a human organ.

As "rescue robotics" dominated discussions at February's African Drone Forum, last mile drone deliveries in places such as Rwanda and Ghana showed how unmanned aerial vehicles could get much-needed supplies to areas made remote by hills and slow, winding roads.

Today, Zipline drones have flown more than 1 million kilometers in Rwanda for more than 13,000 deliveries, demonstrating their humanitarian potential. Outside of Kigali, drones now carry 35% of blood supplied for transfusion. In Ghana they are beginning to deliver COVID-19 testing materials.

1.3 Problem statement

A majority of the drones operated by delivery service company available in the market, exhibit some common traits that we intend to solve: -

- Heavier frames consuming high% of power.
- Fixed wing frames result in inaccessibility of the small open surface areas.
- Security issue of the delivered package.
- Disrupted medical supply chains in the rural or disaster affected area.
- Due to poor supply of medical goods rural areas face the problem of dealers and medical institutions hoarding and inflating prices of such goods.

1.4 Scope & Goal of project

- Drone delivery will work autonomously using the gps technology which will track the drone and it will also create a fly path for the drone towards the target area where the delivery is to be done.

- Drone will contain a delivery box which will have a security system so that only the authorized person can only access the content in the box. This will ensure the safety of the content in the box.
- Drone will land using a latitude and longitude code in the target area which will help the drone to get a specified area to land which will be marked by the consumer to ensure the safety of the drone and other objects which could be harmed by the drone.

1.5 Objectives

- To Create a Lighter Frame
- To build a security box for the medical supplies which could be accessed only by the authorized personnel
- To keep price of the drone affordable
- To perform end to end delivery task autonomously using gps module

1.6 Organization of the Report

Chapter 1 includes the introduction of the report. It describes basically what a Spy Robot is and how we intent to use it to solve people's problems.

Chapter 2 is all about the Literature survey we have done. It includes brief description of all the research and technical papers we have referred and well as some information about the existing system similar to ours.

Chapter 3 is Methodology. It includes the basic principles and methods that is useful to us to implement our project successfully.

Chapter 4 is Design and Implementation. We have shown the block diagrams of our system, calculations.

Chapter 5 is about Performance evaluation and snapshots of our project.

Chapter 6 is Conclusion and Future scope, where we have achieved the aim of this project and fulfilled objectives mentioned in the project. In future scope, we have listed various ways in which our system could be enhanced so that to achieve more functionality.

CHAPTER 2

Literature Review

2.1 Literature Review Summary

SN	Author of the Paper	Publication	Paper title with investigation	Findings
1.	Aniket Magdum, Vivek Nikam-Patil, Vinaak Mokashi, Prof. Jyotiwaykule Tate	International journal of scientific of research in engineering and management (IJSREM) Volume: 04 issue:03	Title - "Smart Drone Delivery System" Investigation – It represent how the quadcopter UAVs will work with the ground station to pass the data and will navigate with the help of the gps module and using ultrasonic sensor to pre detect the object to avoid the collision	This paper deals with a systematic process of online delivery with an autonomous QC using an interface android device as its core processing unit. QC will deliver the parcel to the customer by following Google map which will reduce both time and manpower using for delivery
2.	Vedant Sakhardande, Cajetan Rodrigues, Atharva Atre,	Alochana Chakra Journal Volume IX, Issue IX, September/2020 ISSN	Title - "Smart Drone Delivery System" Investigation – It represent how the quadcopter UAVs will work with the ground station to pass the data	This paper deals with a systematic process of online delivery with an autonomous QC using an interface android device as its core processing unit. QC

	Prof. Swati Ringe	NO:2231-3990	and will navigate with the help of the gps module and using ultrasonic sensor to pre detect the object to avoid the collision	will deliver the parcel to the customer by following Google map which will reduce both time and manpower using for delivery
3.	Pragati Jain, Ashutosh Rai, Bobby Budhwani, Prof. Sudhir Kadam	International Journal of Engineering Research & Technology (IJERT) ISSN : 2278-0181 Volume.9 Issue 08, August-2020	Title - "Medicine Delivery Drone" Investigation – In this paper the research is done on implementing a medicine drone delivery system using CC3D flight controller which is configured using Open pilot Ground Control Station software using a quadcopter.	This paper deals with the integration of the open source softwares with the quadcopter to store the data of the sensors and other units in the drone and tracking its location.
4	Ardupilot	Ardupilot	Title - "planning a mission with waypoints and events" Investigation– configuration of the fc is done to accomplish a autonomous mision	Assigned a grid of waypoints and configuration details are explained

Table 2.1: literature review

CHAPTER 3

Methodology

3.1System Overview

This system consists of following sub system. All of this system are combined to make this drone.

1. Drone: -

    a. Frame

    b. Propulsion System (Motors)

    c. Motor Speed Controllers (ESCs)

    d. Flight Controller (Omnibus f4 pro)

    e. Power Supply scheme

    f. GPS module

2. Main Controller: -

    a. Raspberry pi

    b. Ardu-pilot (mission planner)

3. Delivery box

    a. Arduino UNO

    b. Servomotor

    c. 4*4 membrane keypad

The Drone part is our drone assemble which is the basic frame of the drone here we are using quadcopter design in which 4 motors will be used.

In the main Controller part, we are using Raspberry pi as a controller where the main communication between the operator and drone will take place remotely using internet connections through mobile hotspot and WIFI. To write the path coordinate through which it will travel.

Here ardupilot is a opensource mission planner software where the mission or path of the drone will be compiled to the file and then feed into the drone flight controller through which it will navigate itself further while flying.

The delivery box contains the Arduino through the servo motor is connected and is controlled using the membrane keypad when the security code is entered the servomotor will rotate and will unlock and lock the box which ever required.

3.2 Block diagram of the system

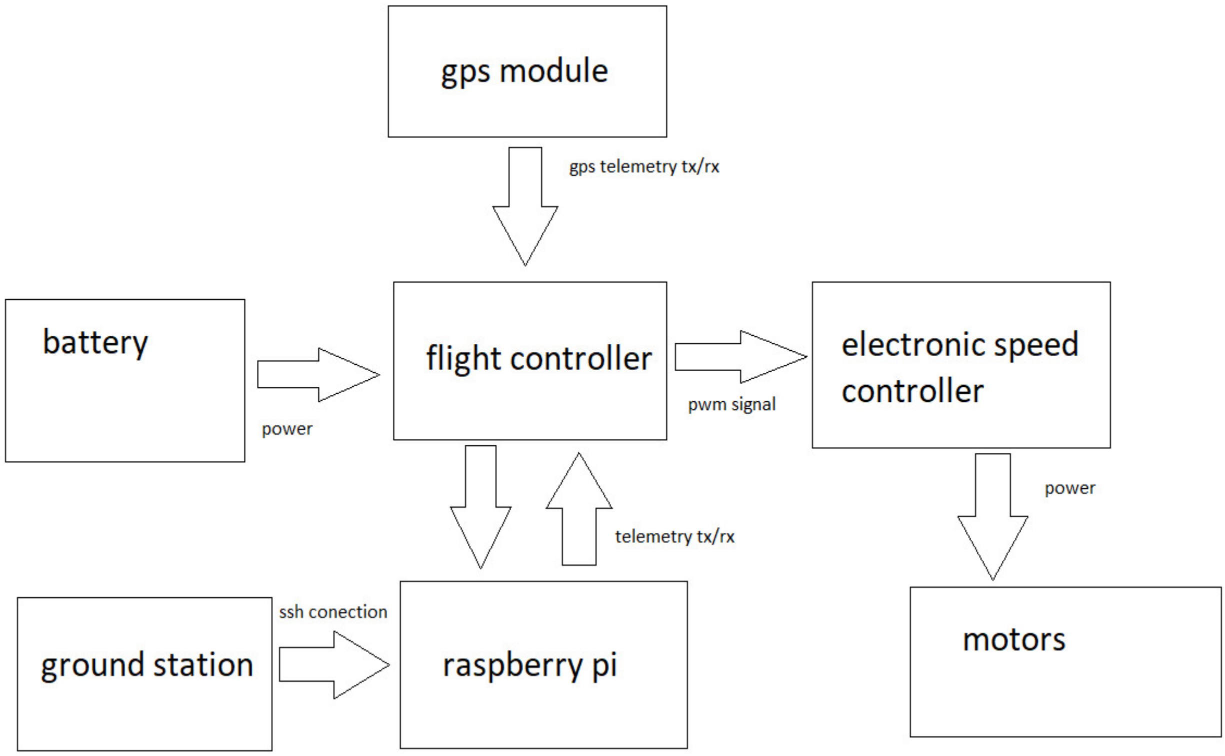

Figure 3.2.1 Block diagram of drone

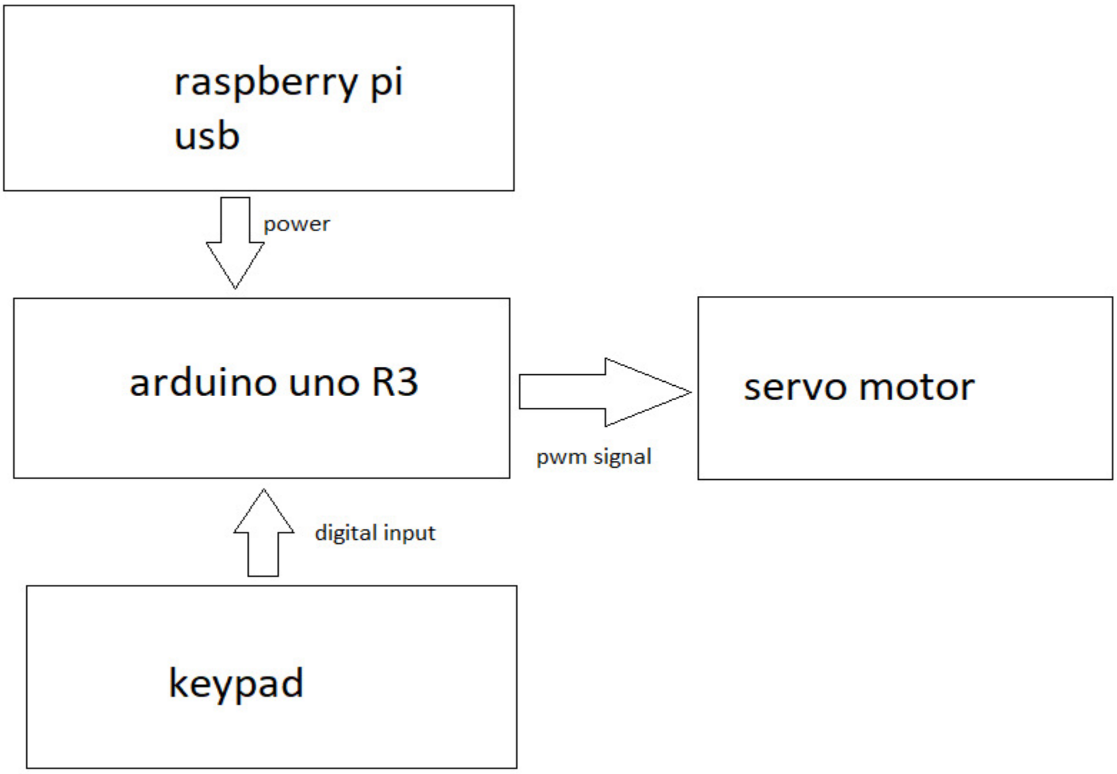

Figure 3.2.2 Block diagram of security box

3.3 Flow chart of the system

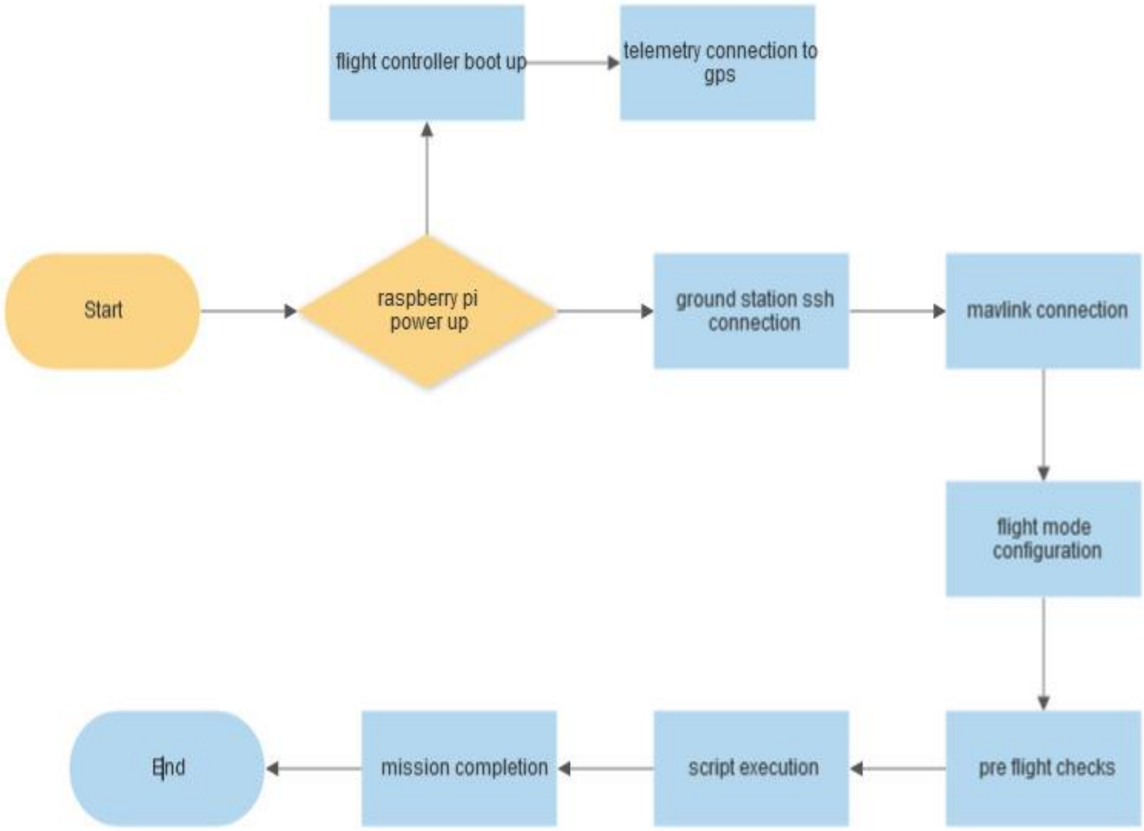

Figure 3.3.1 Flow chart of the system

3.4 Hardware Components

1. **Frame(f450)**

Figure 3.4.1 f450 frame

- Wheelbase : 450mm

- Material: Glass Fiber+Polyamide -Nylon
- Motor Mounting Hole Diameter
- Arm Size: 220 x 40 (LXW)mm

2. Motor (1400kv)

Figure 3.4.2 Motor 1400kv

- Motor KV: 1400
- Current Capacity: 12A/60S
- LiPO Batteries:2S-3S
- Shaft Diameter: 3.17 mm

3. **ESC**

Figure 3.4.3 ESC

- Constant Current:30A (Max 40A<10 sec)
- BEC: 5V 2A
- Suitable Batteries:2-3S LiPo

4. Battery

Figure 3.4.4 Battery

- Weight : 175g
- Voltage : 11.1V
- Dimensions :25 X 34 x 105 mm
- Max Continuous Discharge : 40C(88.0A)
- Balance Plug : JST-XH
- Max Burst Discharge : 80C(176.0A)

5. XT 60 Connector

Figure 3.4.5 XT 60

- Connector Type : XT60 Female
- Material of Connector : High-Temp Nylon
- Length : 10 cm

6. Flight Controller 64

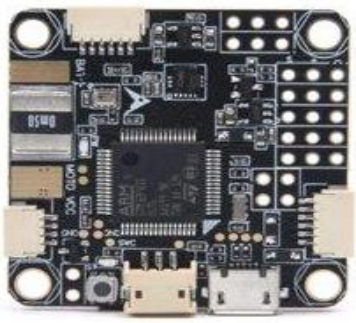

Figure 3.4.6 Flight Controller

- Micro-SC Back-Box
- Built-in Current Sensor
- F4 Processor (F405)
- On-Board Video Filter (only can supply 5V to VTX & Camera)
- SPI Gyro IC268G
- On-Board OSD (controlled by Betaflight, FC over SPI bus)

7. GPS

Figure 3.4.7 GPS

- Ready to Connect to all APM FC with 5-pin Connector Attached
- Receiver type 72- channel M8 engine
- Galileo-ready E1B/C (NEO-M8N)
- Nav. update rate1 Single GNSS: up to 18 HZ
- Position accuracy 22.0m CEP
- Acquisition Cold starts: 26s
- Weight: 33 gm
- Sensitivity Tracking & Navigation: -167 dBm

8. Microcontroller (Arduino UNO)

Figure 3.4.8 Arduino UNO

- Microcontroller : ATmega328P
- Operating Voltage : 5V

- Digital I/O pins : 14
- PWM Channels : 6
- Analog Input Channels : 6
- DC Current per I/O pin : 40 mA
- DC Current for 3.3V pin : 50 mA
- Flash Memory : 32 kb
- SRAM : 2 kb
- EEPROM : 1kb
- Clock Speed : 16 MHz

9. Membrane keypad 4*4

Figure 3.4.9 membrane keypad

- Each row is connected to an input pin, and each column is connected to an output pin.
- Input pins are pulled HIGH by enabling internal pull-up resistors.
- The microcontroller then sequentially sets the pin for each column LOW and then checks to see if any of the row pins are LOW. Because pull-up resistors are used, the rows will be high unless a button is pressed.
- If a row pin is LOW, it indicates that the button for that row and column is pressed.

- The microcontroller then waits for the switch to be released. It then searches the keymap array for the character that corresponds to that button.

10. Servo Motor

Figure 3.4.10 Servo Motor

- Operating voltage : 408V ~ 6.0V
- Operating Speed : 0.12sec/60 degree
- Output torque : 1.6kg/cm 4.8V
- Dimension : 21.5 x 11.8 x 22.7 mm
- Weight : 9g

11. Buck converter

Figure 3.4.11 Buck Converter

A buck converter or step-down converter is a DC-to-DC converter which steps down voltage (while stepping up current) from its input (supply) to its output (load). It is a class of switched-mode power supply. Switching converters (such as buck converters) provide much greater power efficiency as DC-to-DC converters than linear regulators, which are simpler circuits that lower voltages by dissipating power as heat, but do not step up output current.[1] The efficiency of buck converters can be very high, often over 90%, making them useful for tasks such as converting a computer's main supply voltage, which is usually 12 V, down to lower voltages needed by USB, DRAM and the CPU, which are usually 5, 3.3 or 1.8 V.

12. Raspberry Pi 4 Model B

Figure 3.4.12 Raspberry pi

- RAM :- 2GB
- CPU:- cortex A7
- CPU speed:- 1.5 GHz
- Bluetooth:- 5.0, BLE, gigabit ethernet and has 802.11ac wireless at 2.4GHz and 5GHz

13. 1045 propeller

Figure 3.4.13 1045 props

1. Length: 10″.
2. Pitch: 4.5″.
3. Weight: 14 gm.
4. Shaft Diameter: 6 mm.
5. Total length: 10 inch / 254 mm.

3.5 Software Requirements

Figure 3.5 Ardupilot software interface

The Mission Planner, created by Michael Oborne, does a lot more than its name. Here are some of the features:

- Point-and-click waypoint/fence/rally point entry, using Google Maps/Bing/Open street maps/Custom WMS.
- Select mission commands from drop-down menus
- Download mission log files and analyze them
- Configure autopilot settings for your vehicle
- Interface with a PC flight simulator to create a full software-in-the-loop (SITL) UAV simulator.
- Run its own SITL simulation of many frames types for all the ArduPilot vehicles.

It is a open source software which is used to plan, control, Build the drones and other UAV system and has many features which is convinent and easy to understand and troubleshoot the system errors and other hardware bugs.

CHAPTER 4

Design and Implementation

4.1 Overview of Implementation

Initially we calculated the loads according to our implementation then we calculate parameters for components selections. These calculations further help in calculating the load on components as well as electrical load calculations, we select the components according to our calculations and compatible interfacing options. We then start connecting and interfacing components as per our block diagram. We design the delivery box suitable for the drone frame with the help of Autodesk fusion and simulate stress on the model to check it's safety factor. We install the firmware necessary for mission planning on our flight controller. We then continue with interfacing the flight controller with the raspberry pi using mavlink protocol and telemetry to GPIO pins to establish a connection between both. We tested the connection and then moved to a open location for better reception of GPS signal. Thus, we have successfully completed configuration and are ready for flight.

4.2 CAD Model

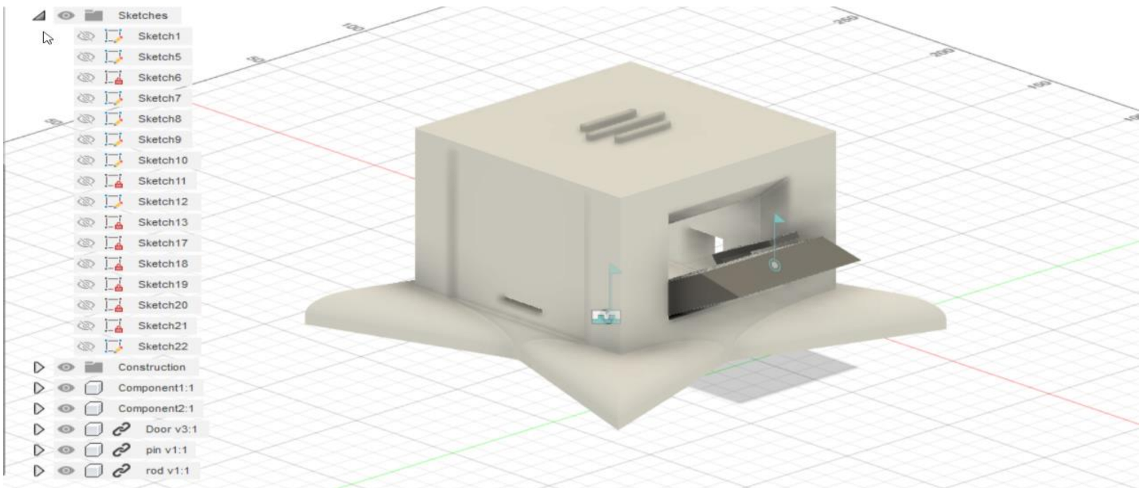

Figure 4.2.1 CAD model of security box

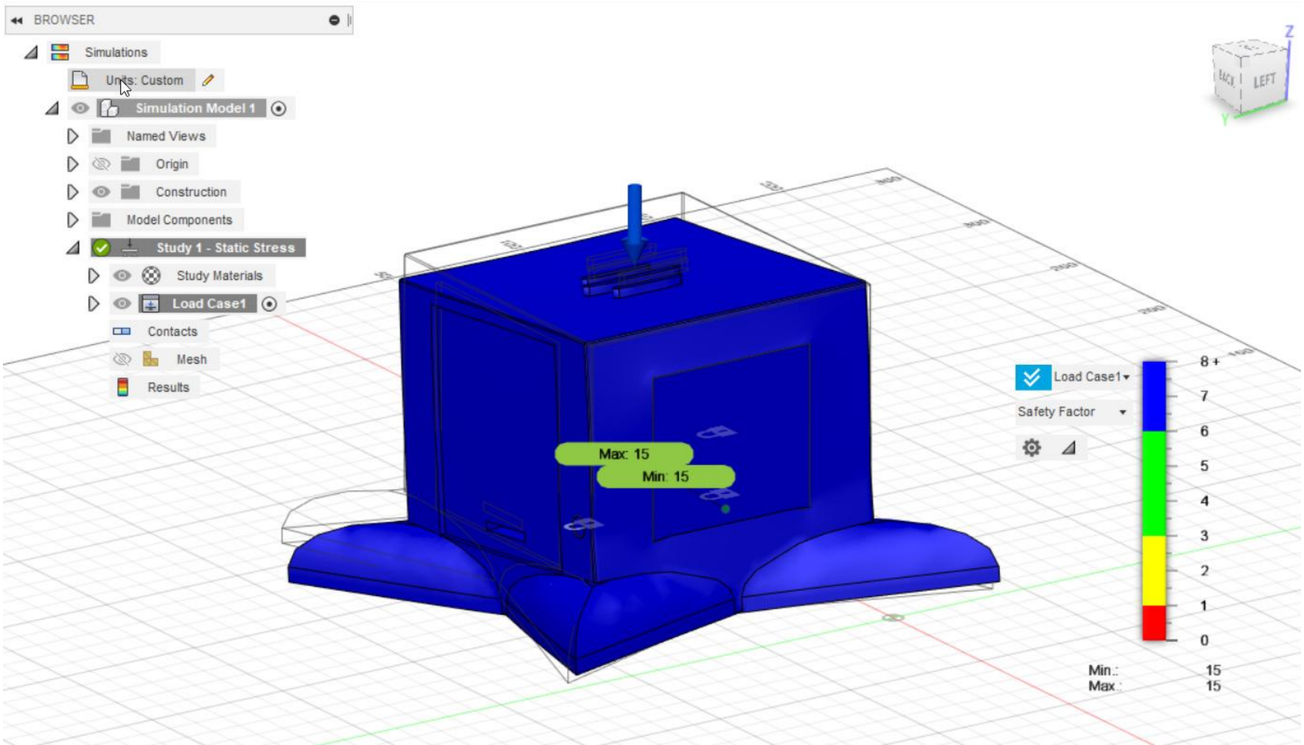

Figure 4.2.2 Stress test

4.3 Mathematical Calculations

- Frame: 275gm
- Motor: 230gm
- ESC: 110gm
- Battery: 175 gm
- XT-60 connector: 10gm
- Flight controller: 40gm
- GPS: 35gm
- PI-Camera: 20gm
- Propeller: 10gm
- Delivery box(empty) approx.: 200gm
- Delivery box(load) approx.: 300gm

TOTAL WEIGHT: 1100gm(ideal) / 1500gm(with load)

$$Power = Prop\ Const * rpm^{Power\ factor}$$

$$T = \left[\frac{\pi}{2} D^2 \rho P^2 \right]^{1/3}$$

T=thrust [N]
D=propeller diameter [m]
v =velocity of air at the propeller [m/s]
Δv=velocity of air accelerated by propeller [m/s]
ρ = density of air [1.225 kg/m³]

$$Flight\ time = Battery\ capacity/amps$$

	Mechanical					Electrical		
		Power (watt)	Prop. Constant	Rpm	Power factor	Voltage (V)	Current (A)	
	min	56.6573	0.144	6.47	3.2	11.1	5.10426	
	ideal	90.8989	0.144	7.5	3.2	11.1	8.18909	
	max	332.982	0.144	11.253	3.2	11.1	29.9984	
Thrust Calculations						Flight time		
	Thrust (kg)	Thrust (N)	Diameter of prop (m)	Density of medium (kg/m^3)	Power (watt)	Flight time (min)	Battery Capacity (Mah)	Current (mA)
min	0.7502705	7.35764	0.254	1.225	56.6573412	25.8607264	2200	5104.265
ideal	1.0282201	10.0834	0.254	1.225	90.89888059	16.1190104	2200	8189.0883
max	2.4433994	23.9616	0.254	1.225	332.9822722	4.40023425	2200	29998.403

Table 4.3 Calculations

4.4 Assembled model

Figure 4.4.1 Drone assembly

Figure 4.4.2 Drone assembly with Box

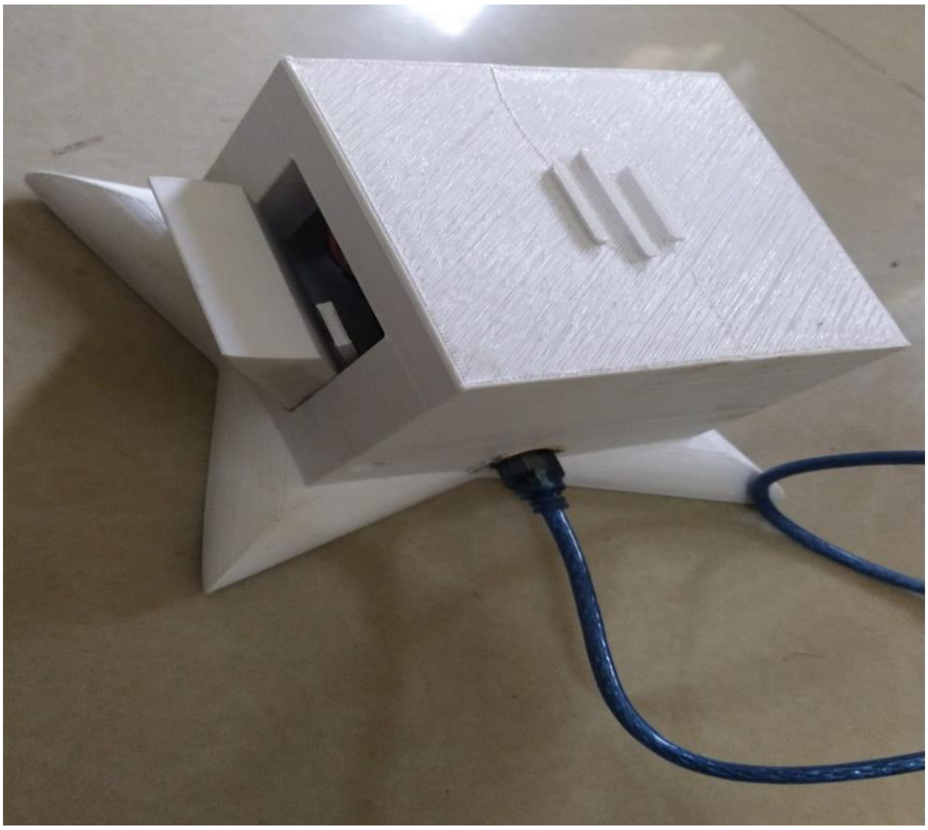

Figure 4.4.3 3D printed security box

CHAPTER 5

Results

5.1 Performance Evaluation

The Development of rotary wing UAV for Drug delivery in remote areas Robot project was successful in achieving its objectives. As per our objectives and expected outcome from the project, it worked flawlessly just as we planned. The drone was able to move in all directions and the Raspberry pi was able to connect to the ground station and we were able to control the drone remotely, which could be viewed remotely with an interface remote utilities windors app for remote connection for raspberry pi. The remote control of raspberry pi capability of the drone made it ideal for controlling drone without any interference.

The drone was able to communicate with the ground-station and was able to fly towards it's defined direction and land the drone and the security box which was designed also worked accordingly which was defined and worked smoothly delivering the desired load successfully.

CHAPTER 6

Conclusion

6.1 Summery

In this project we have studied how the drone system works and also learned about the robot delivery system. In this we have tried to implement many objectives like the drone should be lightweight it should have high endurance time less charging time and a dedicated landing zone and a delivery box.

In this project we have worked on the problem statements which we have discussed earlier in the problem statement here we are making a delivery box which will be detachable from the drone whenever needed due to the dedicated landing zone it is possible for the drone to land easily in any area which is predefined in the system which will also help in securely deliver of the object whoever needed for required it.

6.2 Future Scope

- The drone can be deployed to deliver other resources other than the medical supplies, this can be used to deliver e-commerce items or personal items to a person door steps.
- This can help in centralization of the medical supplies so that every part of the region receive the supplies at the same time.
- We can replace the supply box with the camera equipment, and use the same drone for the surveillance purpose by the military personals or for personal purpose
- This can also help to map a area using technologies like lidar mounted at the place of the supply box.
- QR landing using pi can can be done to get the confirmation of the landing area so that the drone need not to rely soly on the onboard sensors for the accurate positioning and if any error is caused the secondary sensor can verify the landing easily.

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