An Autonomous Unmanned Aerial Vehicle For Inspecting And Supplying Emergency Kits At A Spot Of Casualty In Water Ways

By
Muntasir Ahad
19321012
Lubaina Haque Lamim
19321014
Nafisa Rahman Shamonti
19321016
Shams Fardous Arnab
19321030

A Final Year Design Project (FYDP) submitted to the Department of Electrical and Electronic Engineering in partial fulfillment of the requirements for the degree of Undergraduate

Electrical and Electronic Engineering
Brac University
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Academic Technical Committee (ATC) Panel Member:

Chair- Prof. Abu Hamed M. Abdur Rahim, PhD,

Department of EEE, BRAC University

Tasfin Mahmud

Lecturer, Department of EEE, BRAC University

Md. Mehedi Hasan Shawon

Lecturer, Department of EEE, BRAC University

Electrical and Electronic Engineering
Brac University
August 2023

Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is my/our own original work while completing degree at Brac University.
2. The Final Year Design Project (FYDP) does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

Student's Full Name & Signature:

MUNTASIR AHAD
19321012

LUBAINA HAQUE LAMIM
19321014

SHAMS FARDOUS ARNAB
19321030

NAFISA RAHMAN SHAMONTI
19321016

Approval

The Final Year Design Project (FYDP) titled “An Autonomous Unmanned Aerial Vehicle for Inspecting and Supplying Emergency Kits at a Spot of Casualty in Water Ways” submitted by

1. MUNTASIR AHAD-19321012
2. SHAMS FARDOUS ARNAB-19321030
3. LUBAINA HAQUE LAMIM-19321014
4. NAFISA RAHMAN SHAMONTI-10321016

of Summer, 2023 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Undergraduate on 26-8-2023.

Examining Committee:

Academic Technical
Committee (ATC):
(Chair)

____
Prof. Abu Hamed M. Abdur Rahim, PhD
Professor, Department of Electrical and Electronic Engineering,Brac University

Final Year Design Project
Coordination Committee:
(Chair)

____
Abu S.M. Mohsin, PhD
Associate Professor, Department of Electrical and Electronic Engineering,Brac University

Department Chair:

____
Md. Mosaddequr Rahman, PhD
Professor and Chairperson, Department of Electrical and Electronic Engineering,Brac University

Ethics Statement

Our Final Year Design Project paper had around 8% similarity.

Abstract/ Executive Summary

Nowadays, Unmanned aerial vehicles(UAV) have become popular as a reliable technological invention due to its various usability in the fields of remote observations, surveillance and disaster response. This paper goes through three different UAV designs and analyzes them on the basis of software and hardware examination and analytical point of view of designing and implementing an UAV design, specifically a hexacopter that is put together for coastal area inspection and emergency response scenarios.

The hexacopter model is evaluated on certain criteria such as flying time, stability, and maneuverability using software simulation and actual demonstration. The circuits were built, and the shown designs were simulated in Blender, Solidwork, and ROS.Furthermore, we create the budget and assess all of the data obtained from the simulations and computations.

The Coastal regions are prone to have adverse environmental changes which enables safety concerns for the voyagers and compels frequent monitoring.Additionally, rapid response procedures are pivotal, extenuating emergencies like natural disasters or accidents. In order to rectify these situations, the proposed hexacopter offers an amalgamation of sustainability and malleability consisting six rotors with fixed pitch blade with elevated payload capabilities and endurance, befitting it for frequent surveillance and timely emergency interposition. The hexacopter is given GPS coordinates (latitude and longitude) by the base station via 3DR telemetry and will autonomously follow the waypoint and go to the designated place. The system will have

The choice of a hexacopter came through over the other UAV layouts due to its immutability that ensures steady flight and potent maneuvering capabilities with the support of six rotters that lacks in other establishments. Additionally, its enhanced payload capabilities allows for the carrying of safety kits that can be helpful to nullify any disastrous outburst after accidents in these areas.

Keywords: Unmanned aerial vehicles: Hexacopter, VTOL, Quadcopter, Autonomous, ROS-Gazebo, CFD .

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Chapter 1: Introduction- [CO1, CO2, CO10]

1.1 Introduction

Unmanned Aerial Vehicles have rapidly gained popularity in recent years due to their various applications, including military surveillance, photography, agriculture, delivery services, monitoring and inspecting any event, area, infrastructure, search, and rescue as well as emergency response. With advancements in technology, UAVs have become more efficient, reliable, and affordable, making them a preferred choice for many industries. In 2021, the global market for industrial UAVs was estimated at worth USD 6.52 billion. Whereas It is expected to reach a worth of USD 54.81 billion in 2030[17]. It is forecasted that the military UAV market will be worth USD 30.86 billion within 2029[18]. It depicts that the operations of UAVs for multipurpose will be much increased in the long run. Unmanned aerial vehicles can be controlled both manually and autonomously. In this paper, a comparison has been done among fixed-winged aircraft, hybrid aircraft (VTOL), and hexacopter based on their capabilities and performance such as flight time, maximum speed, mechanical complexity, stability, mobility, and payload capacity with calculations depending on graphs from ROS(Robot operating system) and CFD(Computational fluid dynamics) simulations. The 3D CAD(computer-aided design) designs of three different aircraft are built in SolidWorks for detailed visualization and informative depiction. The designs created in SolidWorks are converted through URDF (Unified Robotics Description Format) to make those befitting to implement in GAZEBO after the motor rotational speed has been fixed. The real-time simulations are created in ROS GAZEBO in a pre-trained environment utilizing PX4 architecture for accurate functionality, communication, visualization, control, and replicating real-world sensory responses. Analyzing the three aerial vehicles it is found that the hexacopter is best for efficient surveillance and inspection missions.\

1.1.1 Problem Statement

Bangladesh is known for its complex river system, it depends on waterways for transportation which is important for the country’s economy. Water transportation is very popular as it is affordable, which causes overcrowding and congestion. Bangladesh Inland Water Transport Authority (BIWTA) recorded 238 motor launch incidents in a survey, which resulted in a terrible toll of 2,309 fatalities, 374 injuries, and 208 people reported missing [1]. These marine accidents are mainly the result of manual rescue operations which have delays because of insufficient resources. Additionally, current protocols are not precise enough to determine the number of possible survivors in need of immediate support.

On the contrary, the fishing sector has a significant impact on the economy of Bangladesh. It provides over 58% of the annual protein consumed overall, contributing 3.74% to the national GDP and 4.04% from exports, still illegal fishing is a serious problem there. The Bangladeshi government enforces fishing restrictions to promote fisheries growth since fish reproduction requires a peaceful environment. 519 Indian fishermen were detained by the Bangladesh Coast Guard in 2019 for entering their Exclusive Economic Zone, according to information provided by Sohini Bose, a junior fellow at the Observer Research Foundation (ORF) in Kolkata. The government has taken action against illicit fishing after a study of 231 fishermen indicated that 46.8% were fishing illegally during the restricted season, endangering this important economic sector [2]. These facts show the ongoing problem of illicit fishing in the nation.

1.1.2 Background Study

The use of unmanned aerial systems is increasing in industries for tasks like- monitoring, providing quick delivery and streaming schedules, cutting costs, and protecting the environment. Wide range of businesses including insurance, mining, transportation, and security can benefit from their use. These unmanned aerial vehicles can clean the interior environment and provide medical supplies during pandemics. Moreover, they can clean and sanitize patient rooms and expedite the delivery of medicines and vaccines, reducing the life risk of frontline staff. Our poll results support the perspective that 83.2% of participants strongly agree that UAVs will have a positive impact on tackling the above-described problems.Surveyresult:

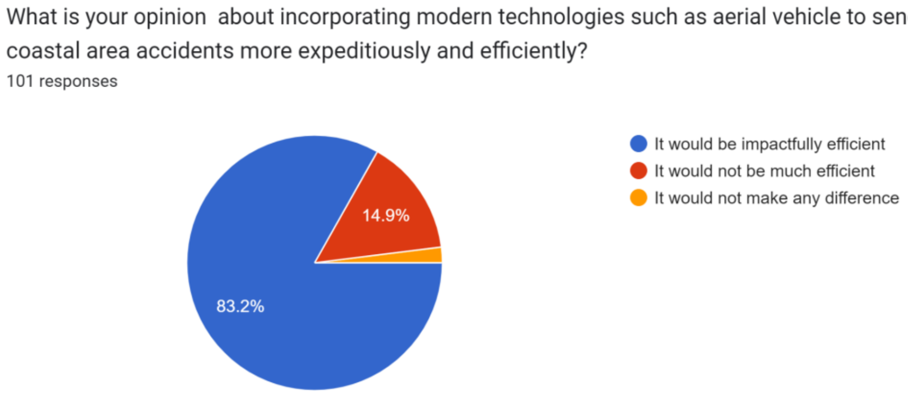


Figure: Our survey result

Drone hardware typically consists of electronic speed controllers (ESC), brushless DC motors (BLDC), flight controllers, power system components such power distribution boards and modules, and electronic speed controllers. The GPS (Global Positioning System) for autonomous navigation and telemetry for remote flight data monitoring from the ground, among other components, provide the basic framework of the drone [8]. Usually, the drone is powered by a lithium-polymer battery [3,4,9].To protect UAVs and prevent accidents involving them, it could be necessary to swiftly deactivate them. A wireless kill switch, which includes of an aerial component coupled to the UAV and a base station housed within a single field-box, is used to reduce this [10].

1.1.3 Literature Gap

Acute case of lacking in comprehensive research and studies, that focuses on comparative analysis of various UAV establishments such as, Hexacopter, hybrid plane and fixed wing plane in context of coastal area inspection and emergency delivery has been observed throughout the community.

Limited studies have been found that details the difference among the performance of hexacopter, hybrid plane and a fixed wing plane. The extensive assessment of stability payload capability, mobility, flight endurance and overall effectiveness among these systems in this scenario was observed.[20] Keeping that in mind, the environmental challenges that come with a coastal area scenario most researches lack clear guidance for investors to consider a specific design that is most suitable to tackle factors like wind conditions, payload requirement, flight range, functionality by the UAV. Cost effectiveness is a major territory that is yet to be covered. As an emerging technology the availability of various components that are used to build such systems has a long way to go before being affordable for several trial and errors. In that case, a detailed component-based analysis will inform the future buyer or builders about the possible budget or worst case scenarios that may be costly later.

Moreover, the deep learning model currently used in object detection in such aerial vehicles lacks research on the network architecture execution that answers the better performance of one than other models. The privacy risks are prominent as UAV's often use the internet and need and occupy security measures.[19]. In the humanitarian and security concerns aspect, there were no extensive researchers among the sea monitoring.

Moreover, a sheer lack of surveys in the area of surveillance by aerial unmanned vehicles have been noticed. In this case both lack of literature to this day and scarcity in the researchers have been found.

1.1.4 Relevance to current and future Industry

Current Industry Relevance:

Disaster management and emergency response: Natural disasters and emergencies are occurring more frequently in the contemporary world environment. Disaster management tactics could be revolutionized by a hexacopter designed for quick reaction and emergency kit distribution. This would allow for swift and focused interventions in coastal areas hit by floods, hurricanes, and other disasters.

Infrastructure Inspection: Effective inspection techniques are needed in the upkeep of coastal infrastructure as well as offshore energy and shipping. With regard to evaluating and monitoring crucial infrastructure, lowering downtime, and assuring safety, the hex copter's capabilities provide an affordable alternative.

Environmental Monitoring: The hexacopter is an effective instrument for environmental monitoring due to its capacity to independently fly across coastal areas and its ability to transport cutting-edge sensors. Real-time data gathering and analysis can be advantageous for businesses engaged in environmental preservation, resource management, and conservation.

Future Industry Relevance:

Increased autonomy is envisioned for industries utilizing UAV technology in the future. The autonomous navigation capabilities of the hexacopter fit with the trend toward creating more complicated, independent robotic systems that can handle challenging jobs without constant human involvement.

Logistics and Delivery: The hexacopter's cargo capacity and accuracy in delivering emergency safety kits highlight its potential for future logistics and last-mile delivery services, especially in difficult terrains like coastal regions. This is especially true as companies investigate innovative delivery techniques.

Sensor Integration: The incorporation of cutting-edge sensors, such as environmental sensors, AI-based analytics, and object identification systems, is in line with the needs of sectors looking for data-driven insights. Real-time data collection and transmission capabilities of the hexacopter can support informed decision-making in a variety of industries.

Humanitarian and Disaster Relief: The hexacopter is useful for both humanitarian causes and relief operations in the event of a disaster. Its capacity to transport necessary goods to isolated coastal areas hit by disasters can improve relief efforts and lessen suffering among people.

The hexacopter's surveillance capabilities can be used to monitor vessel traffic, manage fisheries, and spot maritime dangers in the shipping, fishing, and maritime security industries.

The hexacopter created for coastal inspection and emergency response, in conclusion, answers urgent issues encountered by numerous businesses. Its capabilities are in line with the rising importance of independence, data-driven decision-making, and creative approaches to catastrophe management. The hexacopter is relevant in both the present and the future industrial environments by providing prompt interventions, improving infrastructure inspection, and enabling real-time data collection. Its potential to change infrastructure and disaster response.

1.2 Objectives, Requirements, Specification and constant

1.2.1. Objectives

- The ability to locate boats and notify others of their location.
- The ability to lift a weight greater than oneself and move about effectively.
- For easier examination and greater reach, the air setting is recommended.
- Prompt action is necessary to address these issues as quickly as feasible. Consequently, the primary goal of the designated car is to maximize time management in order to provide timely help.
- It also seeks to accomplish certain objectives, such covering 3.6 kilometers, reaching a height of 30 meters, and continuing to fly for at least 40 minutes.

1.2.2 Functional and Nonfunctional Requirements

Functional Requirements	Non-Functional Requirements
Run around 3.6km radius range	Can make decision (autonomous)
Tentative flight time around 40 minutes	Different type of operation modes
At least 30m altitude maintenance	Can move in rain and cold.
Unauthorized boat and human detection	Measure the data of the atmosphere.
Emergency kit delivery system	Image processing on board.
Able to pick up at least 700 gm payload	Having safety protection in the aerial vehicle.

1.2.3 Specifications

- Detecting required objects and sending them to the ground station.
- Autonomous Navigation according to the given geo coordinate.
- Delivery Subsystem for emergency situations.

System Specification

Subsystem	Required components	Description
Autonomous Subsystem	Ardu pilot	For use in unmanned vehicle autopilot systems, such as those in fixed-wing and VTOL aircraft, as well as autonomous multirotor drones, ArduPilot is an editable, open-source software package.
	Gps module	The GPS module is equipped with miniature CPUs and antennas that are intended to directly receive data from satellites by using certain radio frequencies. Time signals and other pertinent data are received by this module from satellites that may be identified.
	Receiver	Receiver of the Radio controller.
	3DR telemetry	The best option for setting up a remote sensing link between the APM and the ground station is the 3DR

Communication Subsystem		Radio Telemetry module. It differs from traditional data transmission modules with its small size, reasonable price, long transmission range, and special characteristics.
	CMOS Sensor for first person view	Improved power efficiency leads to longer battery life for CMOS sensors, which are gradually outperforming CCD sensors in
	Mushroom antenna	Because of the plastic coating, they resemble mushrooms, which is how they got their moniker.
Object detection Subsystem	Real sense camera	Improving the computers' and gadgets' ability to perceive depth is the goal. The innovations of Intel are incorporated into a wide variety of products on the market, including as robotics, AR/VR gadgets, autonomous drones, and smart home appliances.
	Raspberry Pi,	The Raspberry Pi may be used for many different things. Some of its more well-known applications are turning it into a vintage arcade machine, setting it up as a web server, or using it as the brains behind a variety of systems, including robots, security installations, Internet of Things gadgets, or customized Android smartphones.
Supply or Delivery subsystem	Emergency Kill Switch	Putting in place an emergency shutdown procedure is crucial for UAVs to reduce the possibility of losing control or endangering people.
	Mechanical Claw	The task comprises both the retrieval and delivery phases of transferring an object from one place to another.

- **Component Specification**

Component's name	**Specifications**
Mechanical body	Designs are based on a fixed wing airplane, or a hybrid system or a hexacopter.
Propellers	Diameter is - 12 inches in length, Pitch - 4.5 inch
Servo motor	mg786R 15kg payload
BLDC motor	830 KV rating
ESC	Approximate current Rating - 80 amp
Power Distribution Board	250-amp Rating
Flight Controller used	Supply Voltage:5V- 7V. processor: 32-bit Cortex- M4 The controller's bus interface includes UART, I2C, SPI, and CAN. Firmware and code are from Mission Planner. Sensors: Gyro meter, Accelerometer, Barometer, and Magnetometer. Micro SD card for recording flying data and analysis.
Micro controller - nano	Operating Voltage-5V Current for pins-20 mA DC Flash memory -256 KB
Processor: Jetson Nano	220-core GPU Max frequency: 2 GHz. Memory: Dual Channel. Memory type is 4ch x 16. Mechanical Module Size: 69.6 mm x 45 mm; PCB: 8L HDI; Connector : 260 pin SO-DIMM.

Radio Controller	The frequency range is 2.4–2.48 GHz, with 16 channels. Maximum transmission power is 27 dBm. Receiver sensitivity is -105 dBm. 2.4G mode: auto frequency. The Second Generation Digital technique makes use of GFSK digital encoding. Antenna: Dual antenna with extension. The input power is 12 volts DC.
Lipo battery	Capacity: 20000mAH, Voltage: 29.6 V (8 S) Max Continuous Discharge: 45C
Landing gear + Robotics Claw	Custom made Carbon Fiber

1.2.4 Technical and Non-technical consideration and constraint in design process

- Capturing Images in Low-Light Conditions: Taking photos at night or during the evening can be challenging due to limited visibility.
- Obstacle Avoidance and Autonomous Navigation: The drone's ability to autonomously navigate and avoid obstacles may face difficulties.
- Flying in Windy Conditions: Maintaining control of the drone can be challenging when it's exposed to strong winds.
- Limited Battery Life: The commonly used Lipo batteries in Bangladesh can only power the drone for a maximum of 25 to 30 minutes. Using a higher-capacity mAH battery would increase the UAV's weight, which may not be ideal.
- Safety Concerns: Despite the use of a wireless kill switch for security, accidents could still occur if there is a loss of connection with the ground station.
- Privacy Concerns: Equipped with multiple cameras, the drone's use in private areas may raise privacy issues that could be unsettling.
- Social Impact: In certain rural areas, the presence of flying drones might cause alarm and disruption among residents.
- Flight Duration Limitations: Continuous flight times exceeding 30 minutes could pose an issue, as the UAV's maximum flight time is limited to 30 minutes.

1.3 The outline of the system:

In the final year design project, 3 design approaches are proposed to solve the problem statement. In the following semester, we worked on and calculated the power consumption and simulated the designs with ROS(Robot Operating system), Solid works, Proteus, Autodesk Eagle, softwares. As per the results, after finalizing the best approach, the real life implementation is being done in the last semester of the FYDP.

The approximate workflow of our general system is given below.

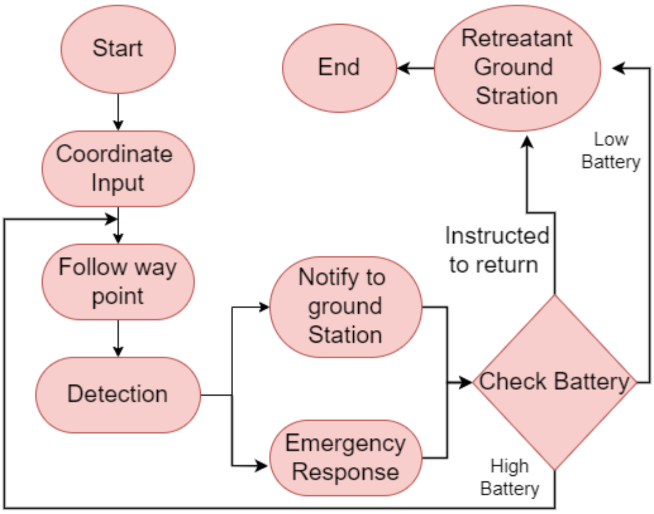


Figure: General technical workflow of the system

GPS coordinate (latitude and longitude) will be given to our system by the user. After inserting the waypoint, will autonomously follow the waypoints and will go to the expected point. Then it will start detecting as per the instruction. If it finds something wrong, it will notify the ground station and will perform the given instruction. However, if something like an emergency occurs, then according to the situation, emergency supplies will be provided. Next, the battery will be checked continuously. If the battery is enough to go, the process will be ongoing but when the battery is less than the demand, the vehicle will come to the ground station. Lastly, if it instructs to return, it will return to the ground station.

Chapter 2: Project Design Approach [CO5, CO6]

2.1 Introduction

2.2 Multiple design approaches of our aerial vehicle system:

This project proposed three alternate design of UAV establishment such as Fixed wing aircraft, Hybrid aircraft and Hexacopter including its 3D cad model, power flow diagrams, circuit diagram and the visual representation of these vehicles that are listed below

2.2.1. Design approach 1

The Fixed wing Aircraft system: CAD MODEL representation

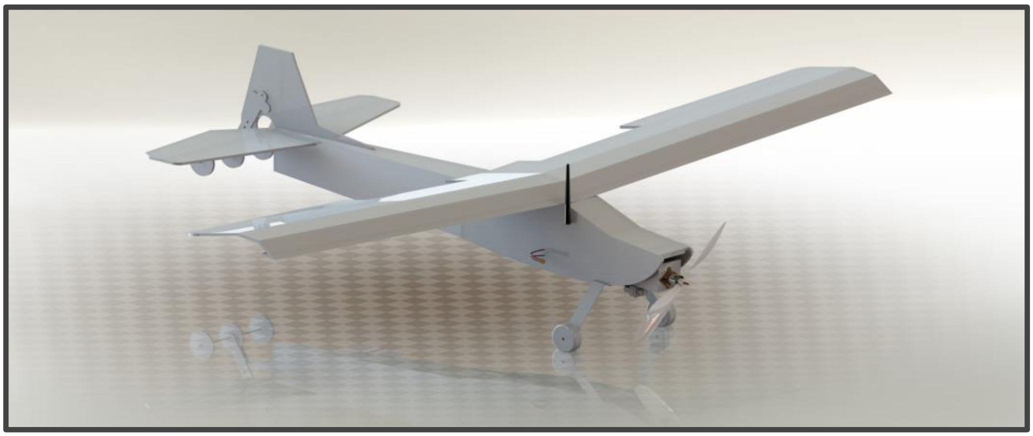


Figure: The 3D rendered model of Fixed winged aircraft system

An intricate and accurate three-dimensional computer model faithfully captures the original artwork. The design was painstakingly created using SolidWorks software, more especially the 2012 edition, which ensured precise adherence to predetermined specifications that had been painstakingly computed previously. The outward forms, proportions, and curves of the airplane are well rendered, including the fuselage, wings, tail, key parts, and control surfaces like ailerons. Furthermore, the three-dimensional model provides an accurate representation of the arrangement of many components, including the engine, gearbox, and avionics.

Signal and Powerflow Diagram for the first design approach fixed wing aircraft:

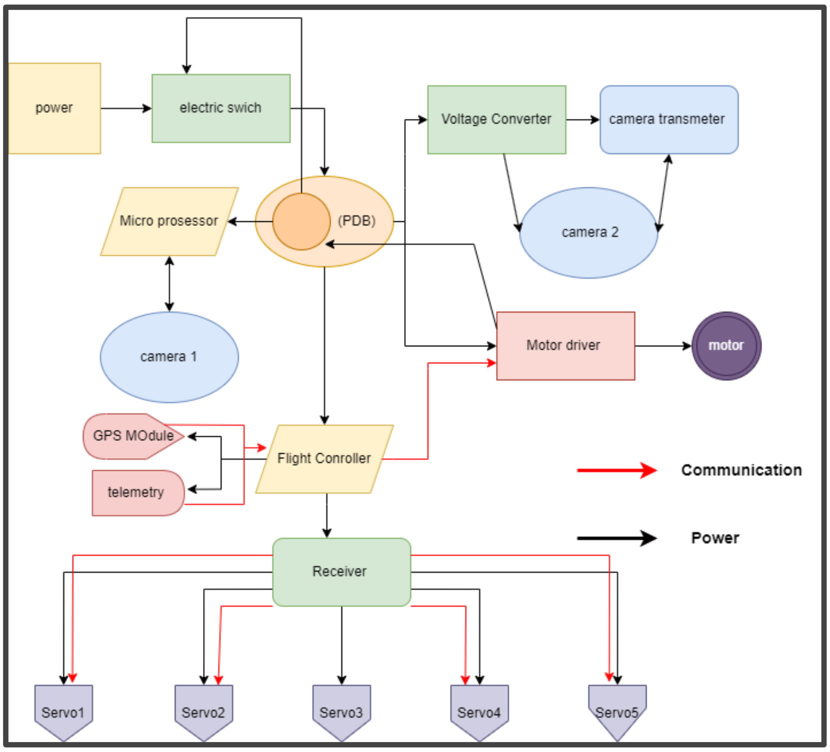


Figure: Signal and power flow diagram of Fixed wing Aircraft

The unmanned aerial vehicle (UAV) in question will be a fixed-wing aircraft that relies on its wings to generate lift through the forward wind speed. Additionally, a front-mounted motor will assist in propelling the aircraft forward. This UAV will be equipped with a servo-controlled double-door chamber for storing emergency items intended for delivery purposes. A navigation camera will be positioned underneath the aircraft.A lot of crucial parts and supplies are needed to construct this system effectively. These include a motor, motor driver, propeller, battery, microcontroller, receiver, ebonite sheet, camera, and claw. The only area the vehicle can maneuver and take off in is a big open space. Once in the air, it will fly to a certain place, do its assigned duty, and then follow pre-planned waypoints to return to the ground station. To ensure a safe landing, enough clearance is needed.Servos play a pivotal role in the operation of most UAVs, as they enable the adjustment of wing and elevator positions, contributing to the control and stability of the aircraft.

Circuit Design of the Fixed wing Aircraft system:

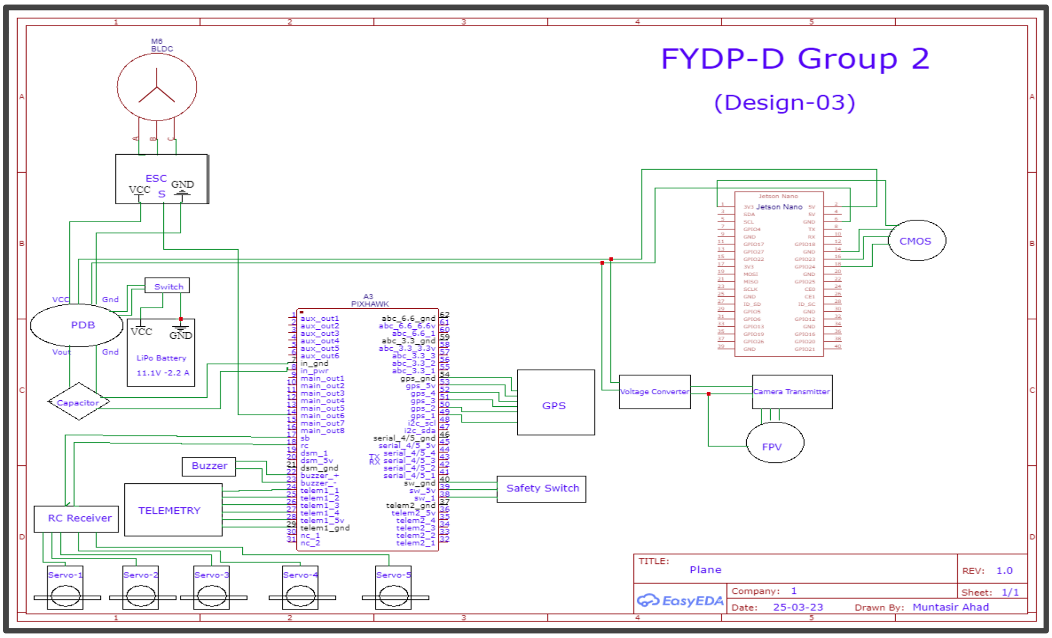


Figure: Circuit Diagram of Fixed wing Aircraft

Blender simulated model:

Figure : Visual representation along with pick and drop feature of fixed winged aircraft

2.2.2 Design approach 2

HybridAircraft-CAD MODEL

Figure: The 3D animated model of Hybrid Aircraft system

The 3D model of the hybrid aircraft reveals its intricate design, capable of supporting both conventional plane-like flight and vertical takeoff and landing (VTOL) capabilities. This model was also created using SolidWorks. While its primary structure resembles that of a traditional airplane, the addition of four propellers integrated into the body allows it to achieve vertical lift, similar to a quadcopter.

Signal and Power flow diagram for the first design approach fixed wing aircraft:

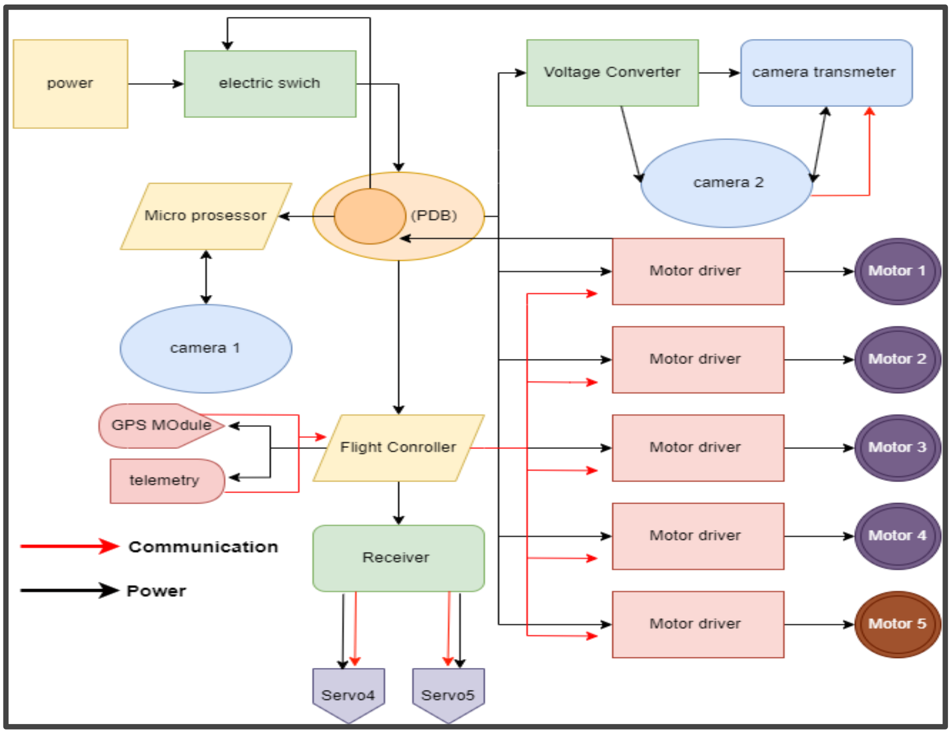


Figure: Power and signal diagram of the Hybrid Aircraft system

This unmanned aerial vehicle (UAV) was created by combining elements of contemporary drone technology with components from conventional fixed-wing aircraft. It's a great example of the merging of design innovation. Its propulsion system consists of a primary engine up front that drives it forward, and four motors attached to its wings that assist in pushing upward. The airplane lifts off with vertical thrust during takeoff and smoothly switches to horizontal motion. It also has a servo-controlled release mechanism that makes it possible to supply supplies in an emergency. An inbuilt pan-tilt camera enables autonomous navigation, and a second camera records ground-based activity. The mechanical structure and electronic circuit design significantly differ from the initial design approach.In the provided diagram, the black lines symbolize the flow of power, while the red lines indicate signal or communication flow within the UAV's system.

Circuit Diagram of Hybrid Aircraft

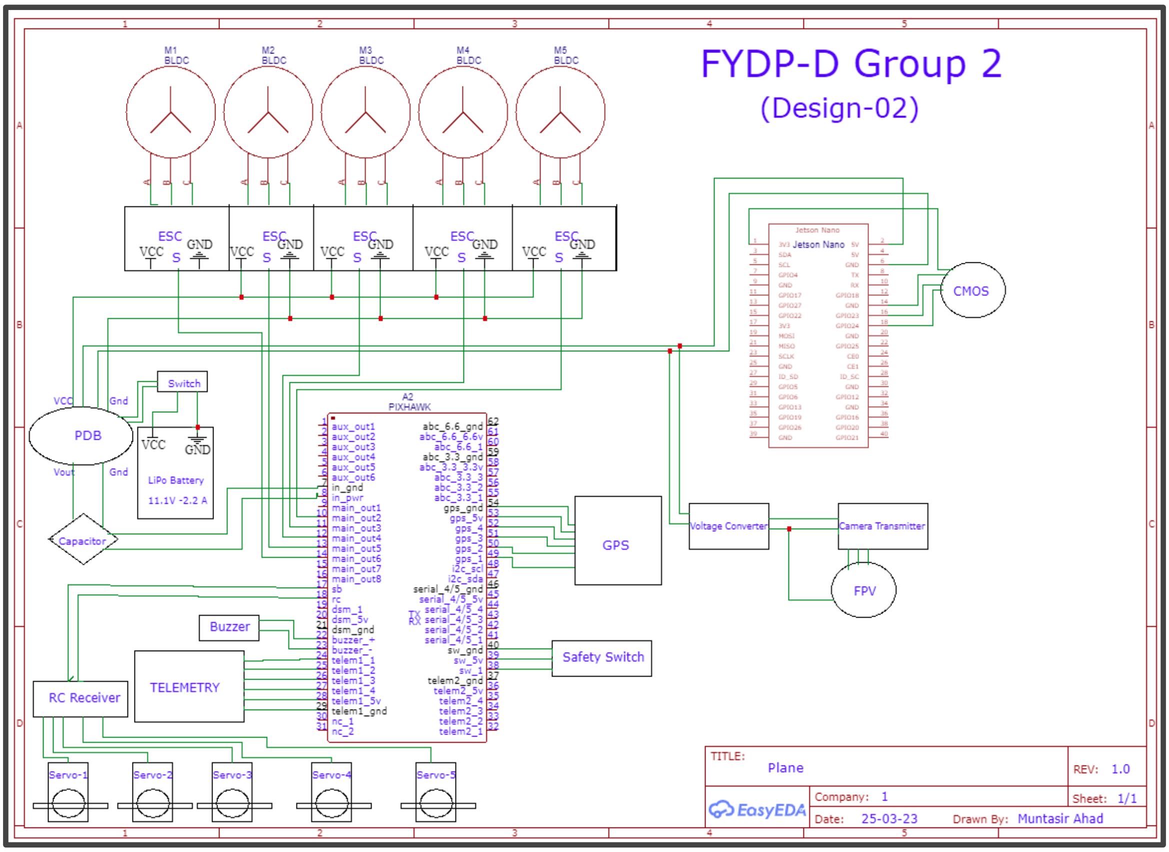


Figure: Circuit Diagram of Hybrid Aircraft

Blender:

Fig : Visual simulation of emergency kit dropping work of hybrid aircraft

2.2.3 Design approach 3

Hexacopter CAD MODEL

Figure: 3D model of Hexacopter

Powerflow and Communication Diagram:

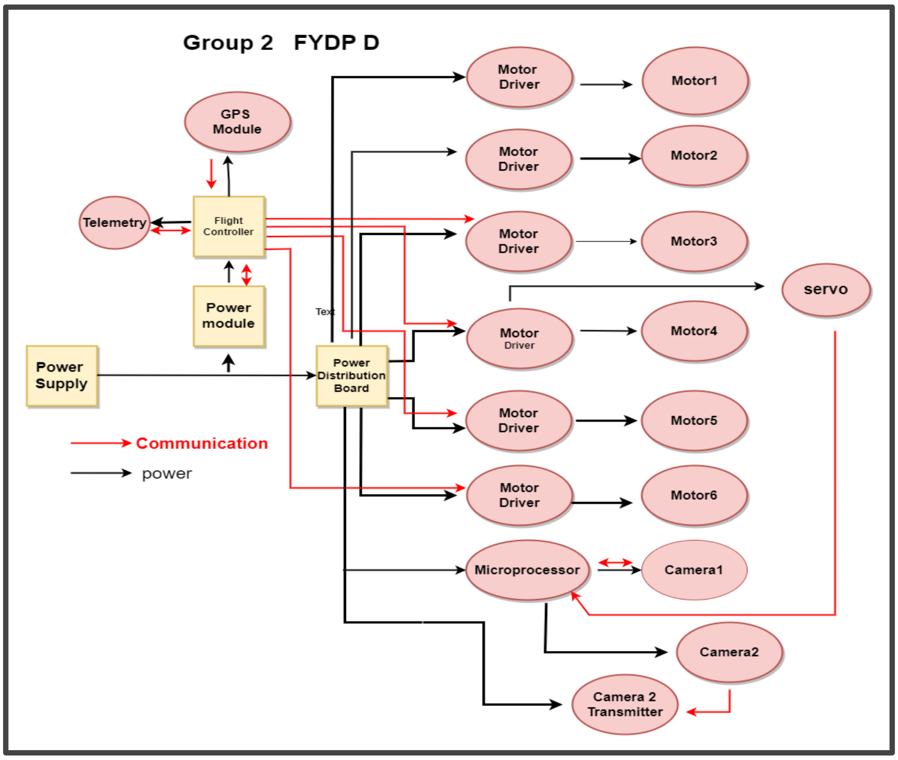


Figure: Power flow diagram of Design approach 3 (Hexa-copter)

The unmanned aerial vehicle (UAV) in question is designed with six arms, making it akin to a hexacopter. This versatile UAV has the capacity to take off and land from any location at any time. Furthermore, it possesses the capability to reach higher altitudes and carry heavier payloads compared to conventional aircraft. To enable the transportation and delivery of items, it will be equipped with a mechanical end-effector.The construction of this UAV will necessitate several key materials and components, including a battery, motor, motor driver, carbon fiber components, propellers, a receiver, a claw mechanism, cameras, a flight controller, a microcontroller, and the aforementioned mechanical end-effector.In the provided diagram, the black lines represent the flow of power within the system, while the red lines indicate the flow of signals or communication pathways.

Circuit Diagram of Hexacopter

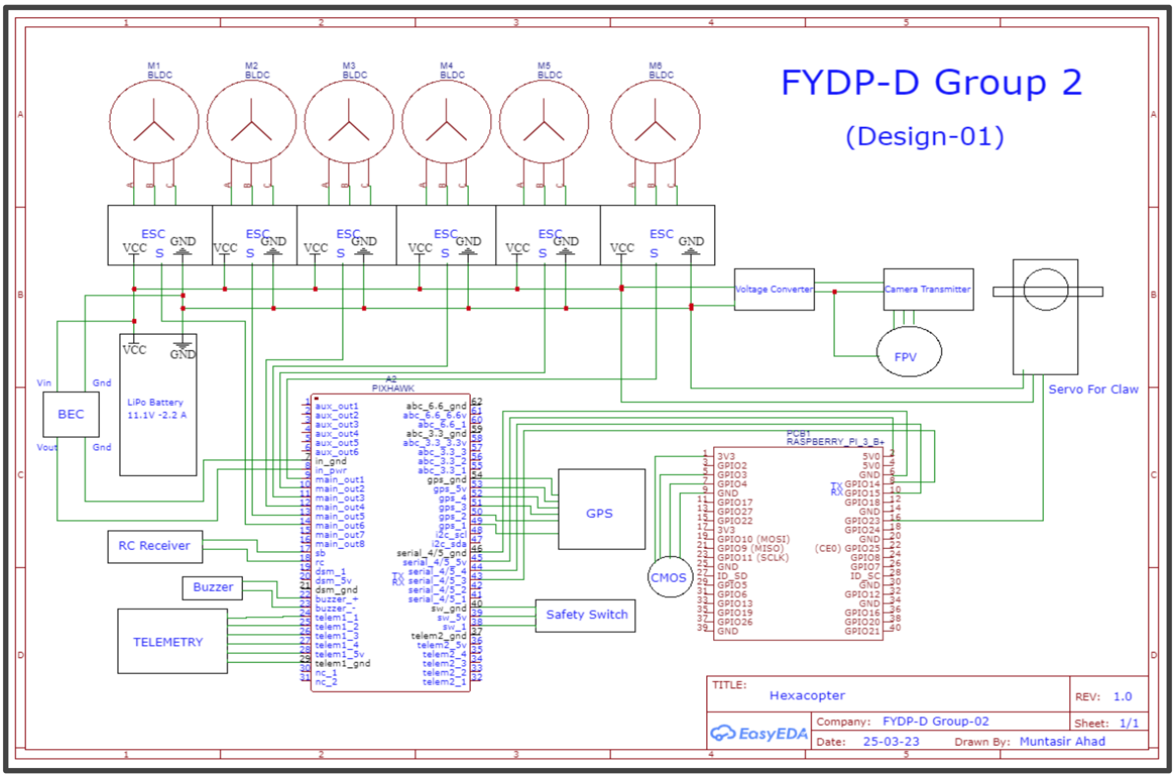


Figure: Circuit Diagram Diagram of Hexacopter

Blender

Fig : Virtual simulation of emergency kit dropping of Hexacoper

2.3 Analysis of multiple design approach

We are working with three different kinds of build and here is a brief design analysis of the three types of aerial vehicles you mentioned: hexacopter, fixed-wing RC plane, and hybride VTOL (Vertical Takeoff and Landing) plane.

1. Hexacopter:

Design: Hexacopters are multirotor UAVs with six rotors arranged in a hexagonal configuration. They are known for their stability, maneuverability, and ability to hover in place.

- Pros: Excellent hovering capabilities, agile maneuvering, can take off and land vertically, suitable for close-quarters operations, such as photography and surveillance.
- Cons: Shorter flight times compared to fixed-wing aircraft, less efficient for covering large distances, limited payload capacity.

2. Fixed-Wing RC Plane:

Design: Fixed-wing RC planes have traditional aircraft-like designs with wings. They require forward movement to generate lift, meaning they cannot hover.

- Pros: Longer flight times due to aerodynamic efficiency, efficient for covering larger areas, can carry heavier payloads, better suited for mapping and surveying missions.
- Cons: Requires a runway or catapult for takeoff and landing, less maneuverable than multirotors, can't hover in place.

3. VTOL Plane:

Design: VTOL planes combine features of both fixed-wing aircraft and multirotors. They can take off and land vertically like a multirotor and transition to horizontal flight like a fixed-wing aircraft.

- Pros: Best of both worlds with vertical takeoff/landing and efficient forward flight, suitable for missions requiring versatility and flexibility in both urban and remote areas.
- Cons: Typically more complex and mechanically intricate, which can lead to higher maintenance requirements and potential points of failure.

In summary, the choice between these designs depends on the specific requirements of your mission. If you need stable hovering and agility for close-range operations, a hexacopter might be the best option. For longer flight times and larger coverage areas, a fixed-wing RC plane could be more suitable. If you require the ability to take off and land vertically while also efficiently covering distances, a VTOL plane might be the ideal choice. Each design has its strengths and weaknesses, so consider your mission needs carefully before making a decision.

2.4 Conclusion

In conclusion, the choice between these designs depends on the specific requirements of your mission. If you need stable hovering and agility for close-range operations, a hexacopter might be the best option. For longer flight times and larger coverage areas, a fixed-wing RC plane could be more suitable. If you require the ability to take off and land vertically while also efficiently covering distances, a VTOL plane might be the ideal choice. Each design has its strengths and weaknesses, so consider your mission needs carefully before making a decision.

Chapter 3: Use of Modern Engineering and IT Tool. [CO9]

3.1. Robot Operating System for Control Architecture

As a coordinating framework, the Robot Operating System (ROS) makes it easier for the unmanned aerial vehicle (UAV) and the central station to communicate and synchronize. ROS is specifically designed to facilitate complex robot behavior control across a wide range of robotic platforms using a set of tools, libraries, and standard devices. It operates on a publisher and subscriber model, where ROS Nodes communicate with each other through ROS topics. ROS employs the TCP protocol for connections, which minimizes data loss and enhances reliability, especially over the same local network.

1. It is able to effortlessly connect many devices, including the NVIDIA Jetson Nano, the Pixhawk autopilot, and an Arduino Uno-based claw, by using the ROS communication framework. Smooth data flow between these devices and the central station is made possible by ROS and its accompanying libraries. The main reasons for using Ubuntu 18.04 Bionic Beaver for both the central station and the UAV (NVIDIA Jetson Nano) were the team's expertise with it and ROS Melodic Morenia's compatibility.

    - Within this ROS framework, communication and data sharing occur through ROS Nodes and ROS Topics. Several ROS Nodes are employed by both the UAV and the base station:

    - Independent Teams of Unmanned Aerial Vehicles (UAVs):
    - Supervisor of Autonomous Teams: The central body responsible for managing the operations of autonomous mode teams. It oversees many independent activities and converts ROS data into Mavlink data for Ardupilot using MAVROS.
    - ArduPilot Automation Unit: This unit sets ArduPilot's automated mode, directs the UAV, and deactivates it as necessary. Coordinates are also sent to it via MAVROS.
    - Object Detection and Route Guidance Unit: This unit is responsible for using PX4 and PID algorithms to continuously improve navigation, determine the optimal routes, and attain a 30-meter altitude.

    - Toggle Claw Node: Responsible for toggling the claw open or closed.
    - Descending Node: Manages the descent of the UAV to a 30-meter altitude above ground.

    - The Claw Camera Live Stream Node displays video feeds using the image_view ROS library, records video using the Video4Linux2 API layer, and transmits data to the base station via the claw camera feed.

2. Photogrammetry System Nodes
    - Photo Capture Node: This node manages UAV motions for boat and person detection, gets a live feed from the FPV system, and transmits images through the FPV system.
    - Nodes of UAV Flight Systems:
    - UAV Manual Flight System Node: Oversees data transmission via the manual flight system topic, publishes manual flight acknowledgment data, and receives orders for manual flight mode, mission start and finish, and UAV flight control data from the base station.
    - Diagnostic Node: Provides important information on data connectivity, internal temperature, battery voltage, overall current usage, and flight duration.

- Both autonomous and human instructions are sent through the Base Station's Flight Control Node. Its responsibilities include sending and receiving confirmation data for manual flying in order to control UAV operations, as well as transforming ROS data into Ardupilot-specific Mavlink data. Furthermore, it makes information exchange easier about landing gear control, battery voltage, data connection status, internal temperature, overall power consumption, total flight time, claw status recovery, and mission command initiation and termination.
- ROS enables seamless communication and coordination between these nodes, allowing the UAV to execute a variety of tasks, from autonomous flight to data acquisition and control.

3.2. ArduPilot

Robust open-source firmware known as ArduPilot was developed especially for unmanned aerial vehicles (UAVs) and drones. It manages the self-driving capabilities of aircraft and helicopters with remarkable efficiency. We have decided to use the Pixhawk 2.1 hardware, which was originally known as the Cube Flight Controller. It is a stand-alone project that provides top-notch autopilot hardware to manufacturers of commercial equipment. This controller is ready for use and provides all-inclusive support. We have chosen QGroundControl for interfacing as it is a flexible solution suitable for both DIY enthusiasts and mainstream applications. In terms of connection, ArduPilot communicates with the Jetson Nano via Telemetry Port 2.

The Telemetry Ports are used as Serial Ports for communication while using ArduPilot. The TELEM 2 port, which is in use right now, is particularly important for allowing MAVLINK connection, which is necessary for controlling flow in ROS-based systems. Important characteristics include:

1. The Return to Launch (RTL) feature enables the Unmanned Aerial Vehicle (UAV) to return autonomously and at a predefined height to its base station.

2. When in Auto Mode, the UAV adheres to a mission plan that has been predetermined and include navigational guidance. Based on user-supplied coordinates, ArduPilot employs an integrated PID (Proportional-Integral-Derivative) controller to navigate adeptly toward predetermined waypoints.

3. Stabilization: In this mode, the copter can independently level the roll and pitch axes, ensuring stable flight.

4. Altitude Hold: Alt Hold mode enables the UAV to automatically maintain altitude when leveling roll and pitch axes.

These features represent just a few of the capabilities of ArduPilot. With ArduPilot, users have access to a wide array of features and functionalities that can be harnessed to achieve various tasks and flight behaviors for unmanned vehicles.

Chapter 4: Optimization of Multiple Design and Finding the Optimal Solution. [CO7]

4.1 Introduction

The project was about selecting the better design for an unmanned aerial vehicle among three designs that performs better in inspecting and surveilling disastrous places.

4.2 Optimization of multiple design approach

4.2.1. Hand Calculation:

Design approach 1: Fixed-wing Plane Calculation:

- Battery: 29.6 Volts (8S), 20000mAh, 45C discharge rate

- ESC: 80A

- Motors: Four motors with a total weight of 490g

- Total Weight: 4703g

- The thrust at 100% throttle is calculated as 5500g. This value is derived from the motor's datasheet, indicating that at 100% throttle, each motor produces 5500g of thrust.

- The weight lift ratio is calculated as the total weight of the aircraft (4703g) divided by the total thrust produced by the four motors at 100% throttle (5500g per motor * 4 motors), resulting in a weight lift ratio of approximately 0.85. This ratio suggests that the aircraft's thrust can lift approximately 85% of its total weight.

- The estimated flight time is calculated based on the battery's capacity and the current usage. The battery has a capacity of 20000mAh (20Ah). For safety, it should not be discharged below 85% capacity, so 20000mAh * 0.85 = 17000mAh (17Ah) is available for use. With an estimated current usage of 9.7A, the flight time is estimated as 17000mAh / 9.7A ≈ 1752 hours. Converting this to minutes gives an estimated flight time of approximately 92.5 minutes.

Design approach 2: Hybrid Aircraft Calculation:

- Battery: 33.6 Volts (8S), 20000mAh, 45C discharge rate

- ESC: 80A (320A total for 4 motors)

- Motors: Four motors with a total weight of 500g

- Total Weight: 5680g

- The thrust at 100% throttle is calculated as 5500g per motor. Like in Design Approach 1, this value represents the thrust produced by each motor at full throttle.

- The weight lift ratio is calculated as the total weight of the aircraft (5680g) divided by the total thrust produced by the four motors at 100% throttle (5500g per motor * 4 motors), resulting in a weight lift ratio of approximately 0.25818. This ratio indicates that the aircraft's thrust can lift approximately 25.8% of its total weight.

- The estimated flight time is not explicitly calculated in the provided information. To estimate the flight time, you would need to consider the battery capacity and the total current usage. If you provide more information on the current usage or intended flight conditions, I can help with the calculation.

Design approach 2: Hexacopter Calculation:

- Total Weight: 3000g (3 kg)

- Battery: 33.6 Volts (8S), 20000mAh, 45C discharge rate

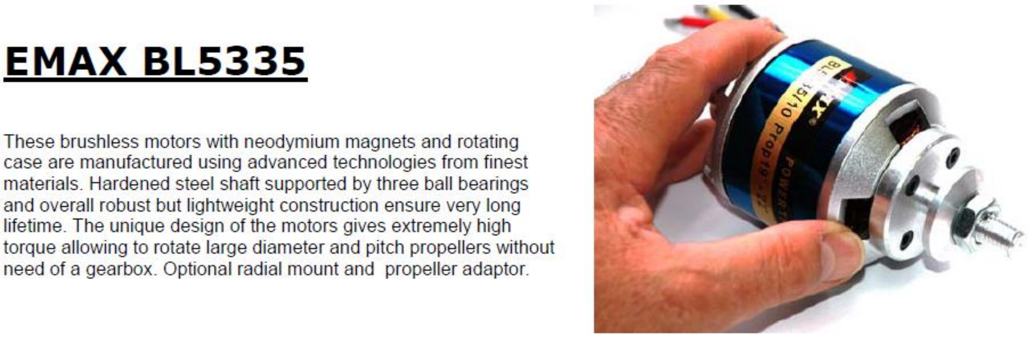
- ESC: 80A (480A total for 6 motors)

- Motors: Six motors with a weight of 500g each

- the thrust at 100% throttle is calculated as 5500g per motor, as previously mentioned.

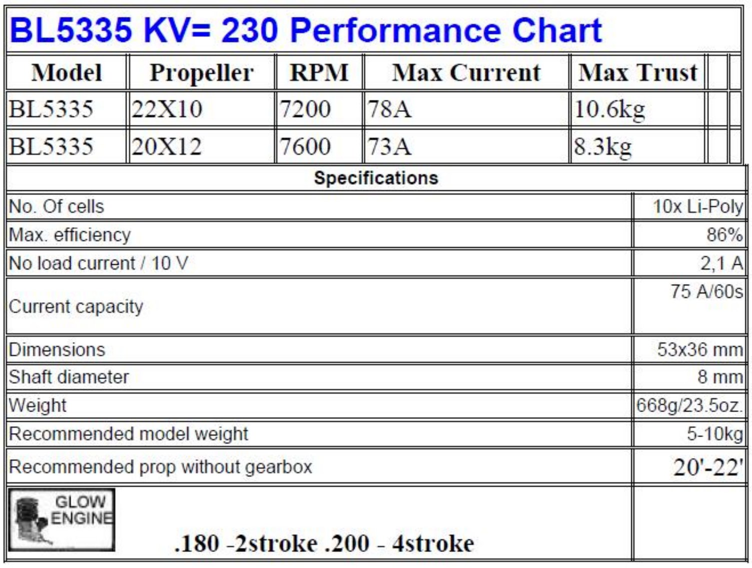
- To calculate the weight lift ratio, we'll use the total thrust produced by the six motors at 100% throttle. Total thrust = 6 motors * 5500g per motor = 33000g. Weight lift ratio = Total Weight / Total Thrust = 3000g / 33000g ≈ 0.0909. This ratio indicates that the hexacopter's thrust can lift approximately 9.09% of its total weight.

- To estimate the flight time, we can use a similar approach to Design Approach 1. The battery capacity is 20000mAh (20Ah), and we'll consider a discharge not less than 85% for safety. So, the available capacity for flight is 20000mAh * 0.85 = 17000mAh (17Ah).



EMAX BL5335

These brushless motors with neodymium magnets and rotating case are manufactured using advanced technologies from finest materials. Hardened steel shaft supported by three ball bearings and overall robust but lightweight construction ensure very long lifetime. The unique design of the motors gives extremely high torque allowing to rotate large diameter and pitch propellers without need of a gearbox. Optional radial mount and propeller adaptor.



BL5335 KV= 230 Performance Chart

Model	Propeller	RPM	Max Current	Max Trust		
BL5335	22X10	7200	78A	10.6kg		
BL5335	20X12	7600	73A	8.3kg		

Specifications	
No. Of cells	10x Li-Poly
Max. efficiency	86%
No load current / 10 V	2,1 A
Current capacity	75 A/60s
Dimensions	53x36 mm
Shaft diameter	8 mm
Weight	668g/23.5oz.
Recommended model weight	5-10kg
Recommended prop without gearbox	20'-22'
GLOW ENGINE .180 -2stroke .200 - 4stroke	

There are two interpretations for the number 1260. It represents the initial length, precisely measuring 12 inches. Enhanced lift capacity can be achieved with larger propellers; however, this comes with the trade-off of increased motor strain due to higher power consumption. The second digit, six, signifies the propeller's pitch, defined as the "distance traveled by a propeller in one full rotation." For instance, a propeller with a pitch of six would ascend six inches in a single rotation if gravity were ignored. In other words, a higher pitch value enables the quadcopter to fly faster.

To enable a quadcopter to fly, a weight-to-thrust ratio of 1:2, or 0.5, is necessary. The power equation is expressed as Power(watts) = Kp * D^4 * P * RPM^3, where D is the diameter, P is the pitch, and Kp for mid-sized propellers is approximately 1.2.

The total weight of the hexacopter is calculated as follows:

- Frame: ~1200 grams

- Receiver: ~15 grams

- Flight controller: 40 grams

- Battery: 835 grams each (4s, other brand) x 2

- Power distribution: 68 grams
- ESCs: 6 x 74 = 444 grams
- Propellers: 6 x 10 = 60 grams
- Motors: 6 x 490 = 2960 grams
- Rpi: 46 grams
- GPS: 16 grams
- CMOS camera: 400 grams
- Mechanical Claw: 100 grams
- Others: 500 grams

Total Weight = 7476 grams

The weight lift ratio is calculated as 7476 / 33000 = 0.226545.

According to motor specifications, the motors require 9.33 Amperes (at 50% throttle) of continuous current. Using a linear ratio, the assumed usage per motor is 9.33 * 0.226545 = 2.113665 Amperes. Therefore, the total required amperes during normal flight is 12.68199 A.The example battery has a rating of 20000 mAh. However, to ensure safety, it should not be discharged beyond 85% of its capacity, which translates to 20000 * 0.85 = 17000 mAh or 8.5 A for this battery. Dividing this number by the power used gives the estimated flight time in hours: 17 / 12.68199 = 80.4290 minutes, which means an estimated flight time of approximately 80.4290 minutes.

4.2.2. Computational Dynamic Simulation of the Designs:

Design Approach 1(Fixed winged plane)

CFD Model:

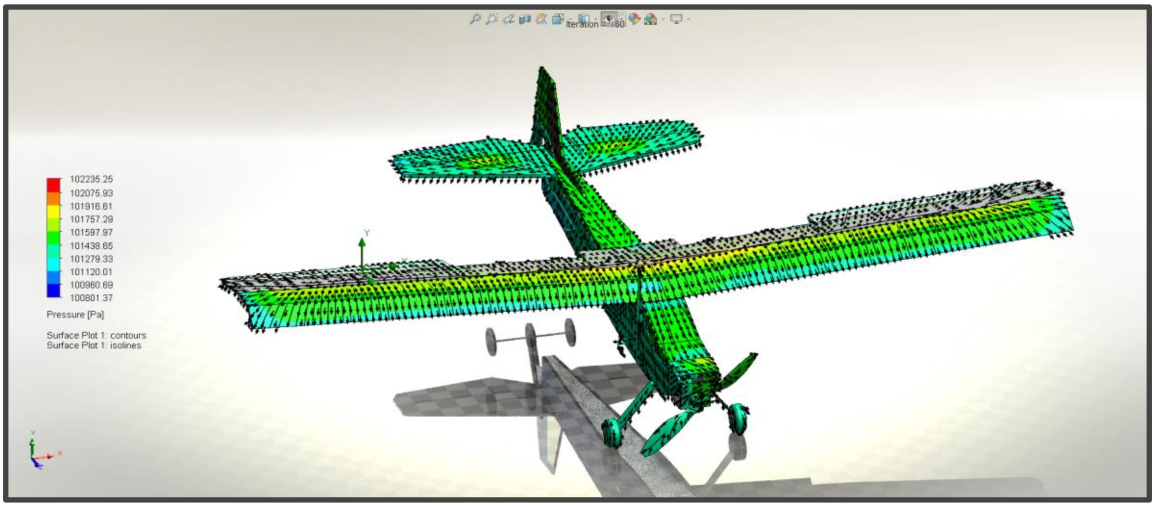
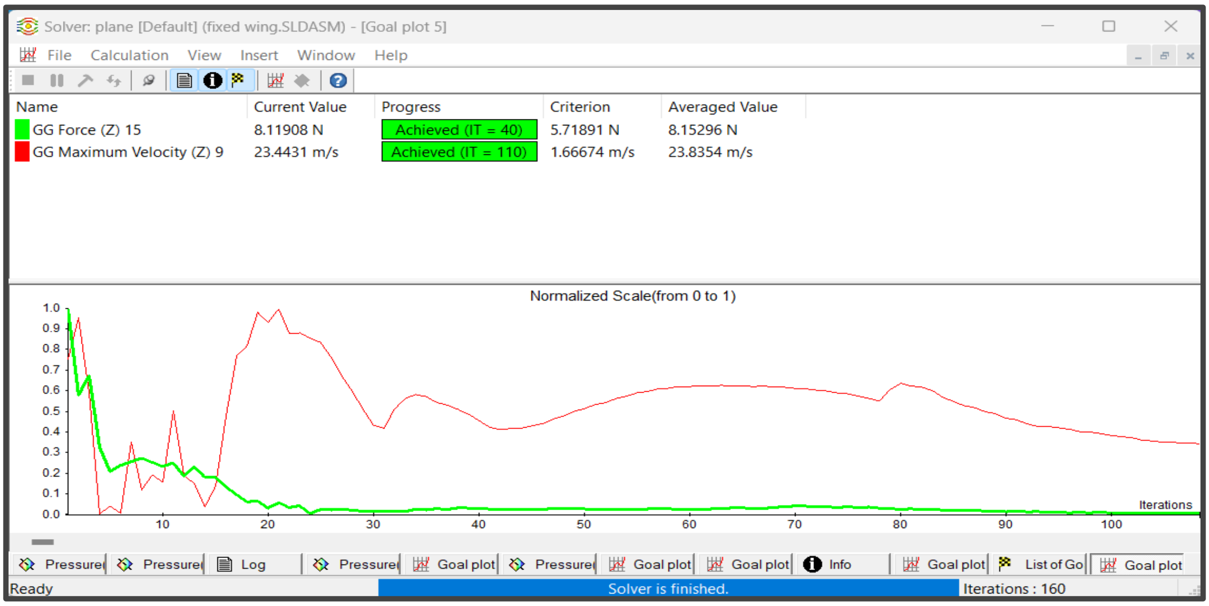


Figure: Air pressure CFD simulation of the fixed wing aircraft

A thorough flow simulation analysis was completed once the SolidWorks CAD model was created. This evaluation looked at the fluid dynamics around the aircraft and gave valuable information about how aerodynamically sound it is. This method included observing airflow patterns, analyzing lift and drag forces, and ultimately improving the design to enhance the UAV's efficiency.

CFD Result (Fixed winged plane):



Name	Current Value	Progress	Criterion	Averaged Value
🟩 GG Force (Z) 15	8.11908 N	Achieved (IT = 40)	5.71891 N	8.15296 N
🟥 GG Maximum Velocity (Z) 9	23.4431 m/s	Achieved (IT = 110)	1.66674 m/s	23.8354 m/s

Ready
Solver is finished.
Iterations : 160

Figure: The force vs velocity curve of the fixed wing aircraft

This diagram illustrates the force and speed that the fixed-wing aircraft is applying while it hovers over the chosen area, searching for or identifying distressed boats. The figures indicate that the force in the z-direction might be as high as 8.15N and that the maximum speed could be close to 23.83 meters per second. Eventually, simulation-based tests using ROS verified these results.

The Design Approach 2 (Hybrid Plane):

CFD Model:

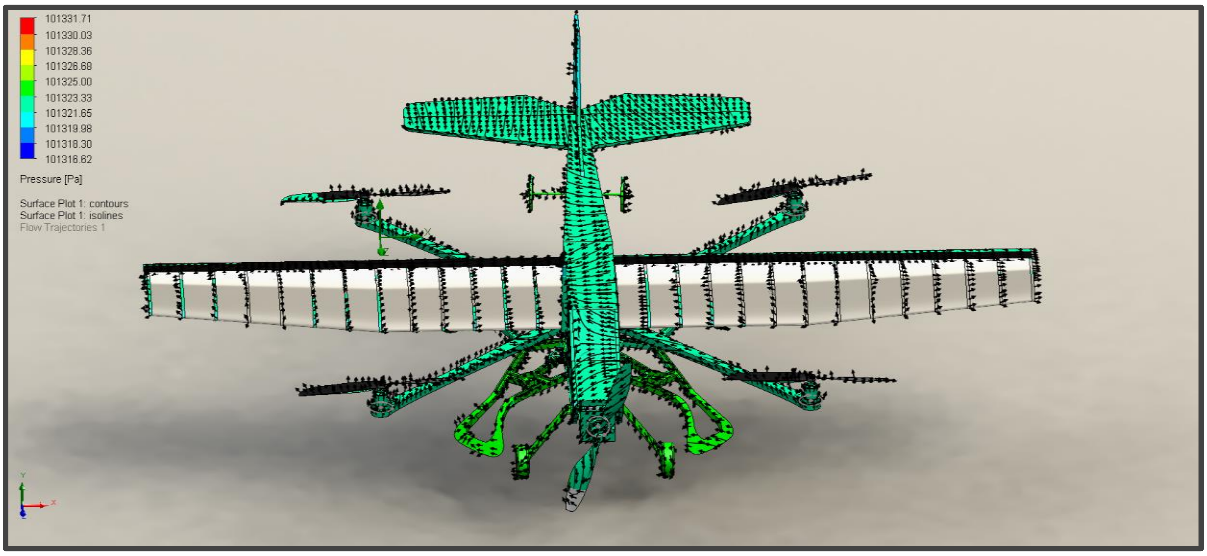
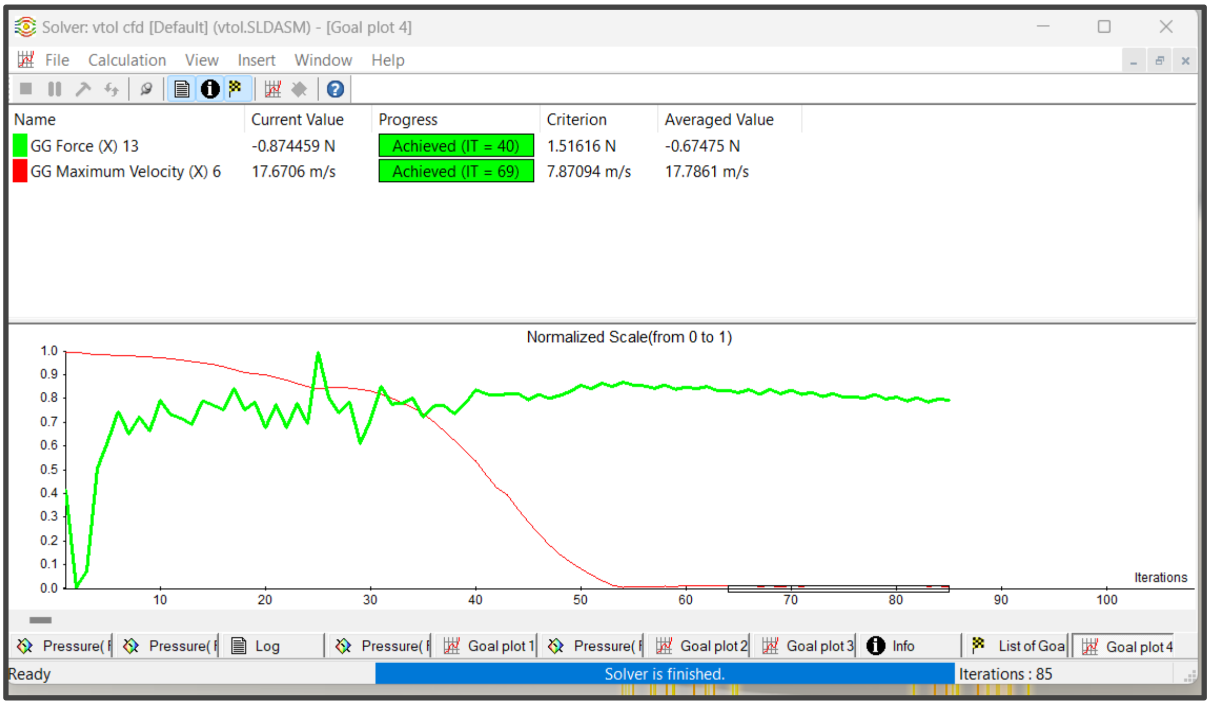


Figure: Air pressure CFD simulation of the Hybrid Aircraft VTOL

The aerodynamic performance of the ship may be assessed using computational fluid dynamics (CFD) simulations, with a focus on the airflow—that is, the air around it. The stability of our hybrid aircraft is guaranteed by the analysis of key forces, such as drag and lift, made feasible by CFD. This study indicates that the air distribution around the wings is linear, producing an effect near the propellers that resembles a turbine. The flow patterns surrounding the vessel are also displayed by the simulation. Once in the air, lift is produced Our technique helps keep the airplane at altitude by making use of the radial airflow produced by the wing-mounted propellers. It is important to note how this model represents the pressure distribution, emphasizing areas of high pressure. The airplane is notable for having green arrows prominently displayed on it, which represent the proper pressure distribution for flight.

CFD Result (Hybrid Plane):



Solver: vtol cfd [Default] (vtol.SLDASM) - [Goal plot 4]

Name	Current Value	Progress	Criterion	Averaged Value
🟩 GG Force (X) 13	-0.874459 N	Achieved (IT = 40)	1.51616 N	-0.67475 N
🟥 GG Maximum Velocity (X) 6	17.6706 m/s	Achieved (IT = 69)	7.87094 m/s	17.7861 m/s

Ready

Solver is finished.

Iterations : 85

Figure: The force vs velocity curve for VTOL

Either for observational purposes or to identify troubled boats, the hybrid aircraft is suspended over the designated area. This image shows the dynamic interaction between force and velocity throughout this operation. A maximum speed of 17.6 meters per second and a force measurement of -0.67475 on the x-axis are noteworthy data points. ROS simulation techniques were then used to confirm the correctness of these results.

Design Approach 3(Hexacpter):

CFD Simulation:

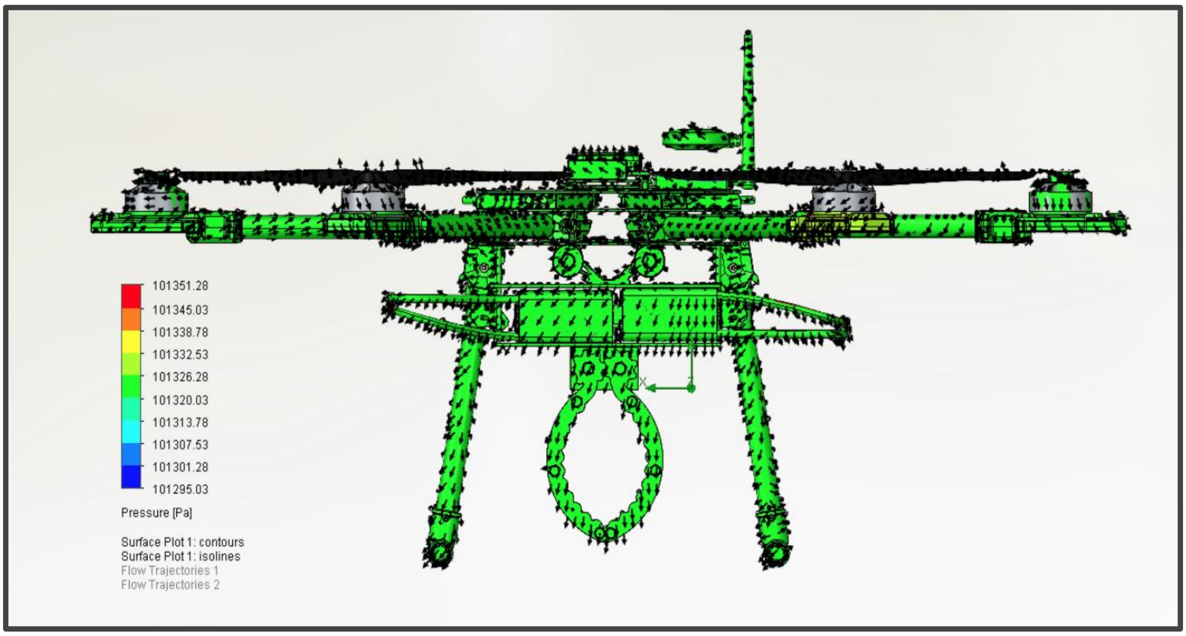
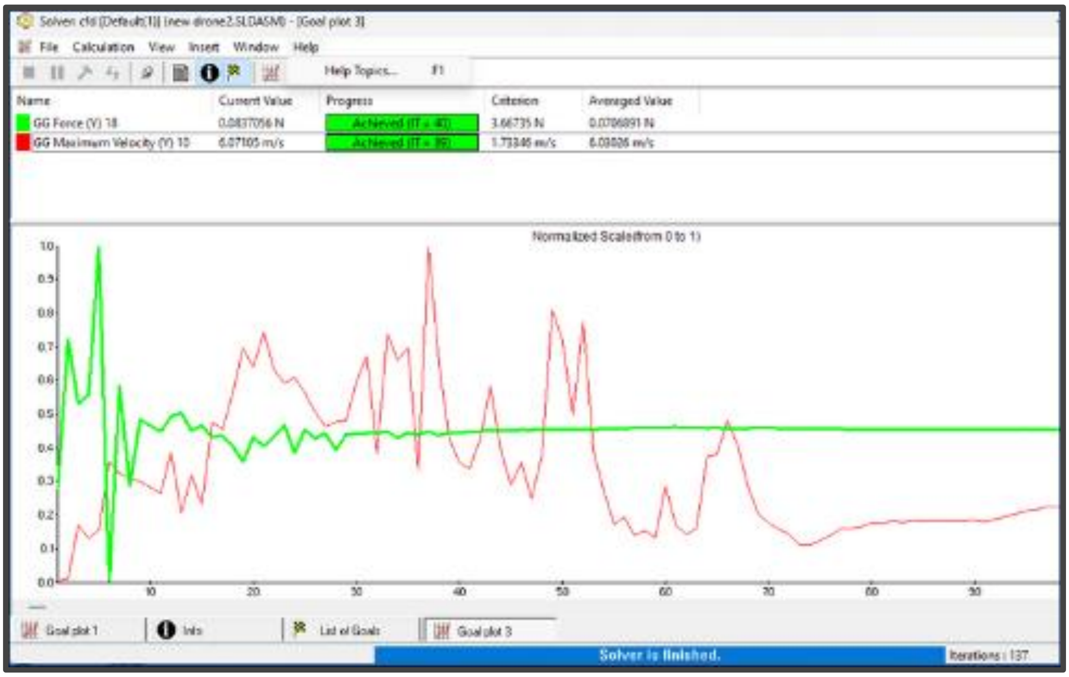


Figure: Air pressure distribution in CFD simulation for hexacopter

We use computational fluid dynamics (CFD) models to study the airflow dynamics surrounding the aircraft, offering valuable insights into its aerodynamic features. Through these simulations, we are able to accurately evaluate the forces operating on our hybrid aircraft, such as lift and drag, which are critical to preserving its stability. Furthermore, the models show intricate airflow dynamics that show a structure like a turbine encircling the propellers and providing push for the hexacopter's ascension. Additionally, the simulation shows the distribution of pressure by highlighting high-pressure regions, which are mostly shown by green arrows. This demonstrates the perfect alignment of pressure required for flawless flight operations.

<u>CFD Simulation result for the Hexacopter:</u>



Name	Current Value	Progress	Criterion	Averaged Value
🟩 GG Force (Y) 18	0.0837056 N	Achieved (IT = 40)	3.66735 N	0.0706891 N
🟥 GG Maximum Velocity (Y) 10	6.07105 m/s	Achieved (IT = 39)	1.73346 m/s	6.03026 m/s

Solver is finished.

Iterations : 137

Figure: The force vs velocity curve during CFD simulation

In order to track or identify affected vessels, this graph displays the hexacopter's movements and speed while it hovers over the designated region. The figures indicate that the highest speed might reach 6 meters per second, with a corresponding force of up to 0.0837 Newtons on the y-axis. These findings were subsequently verified using the ROS simulation.

4.2.3. ROS Simutations of our three design approaches:

The first design approach for the fixed wing aircraft:

<u>ROS simulation:</u>

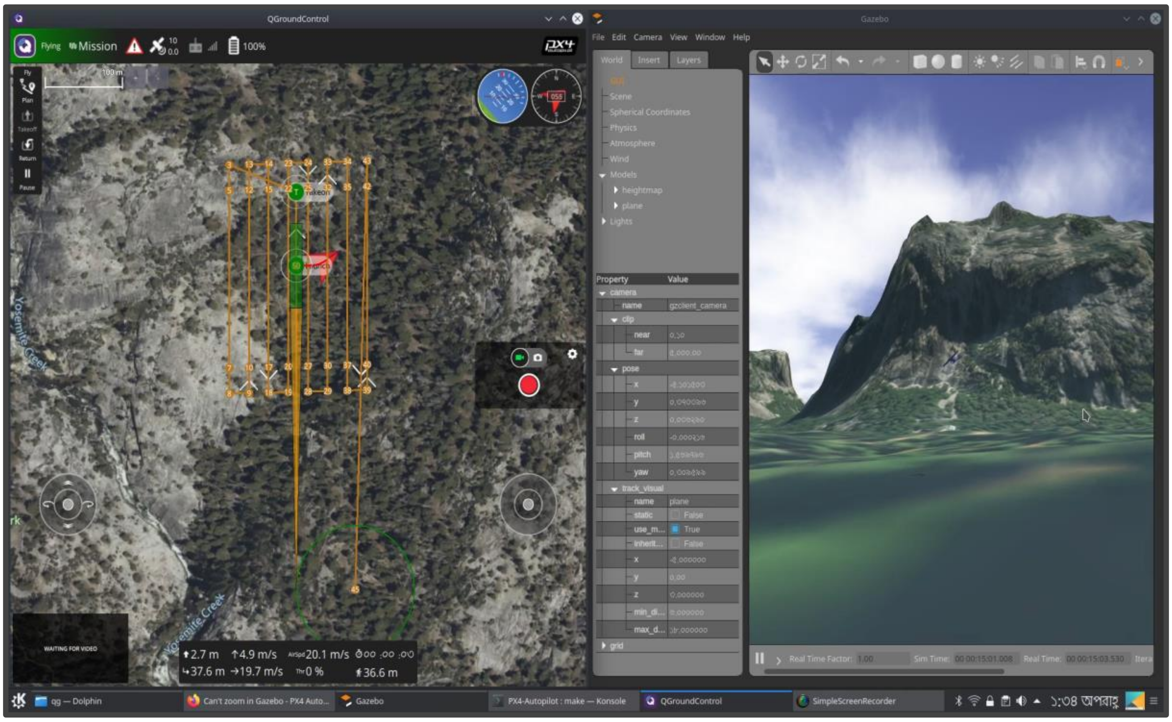
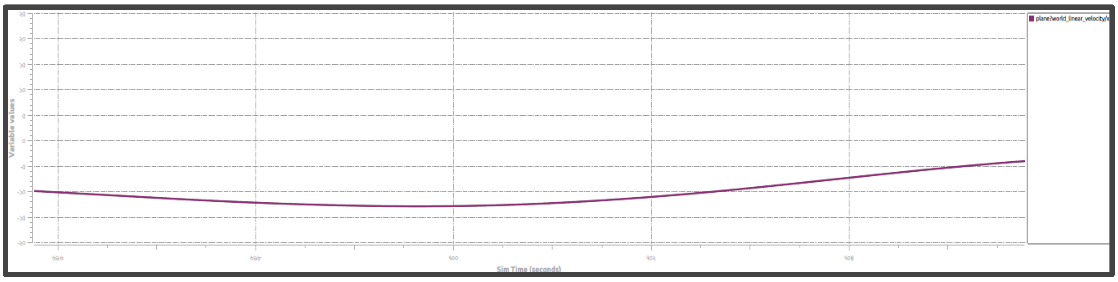


Figure: Flight simulation of Fixed Wing Aircraft in ROS

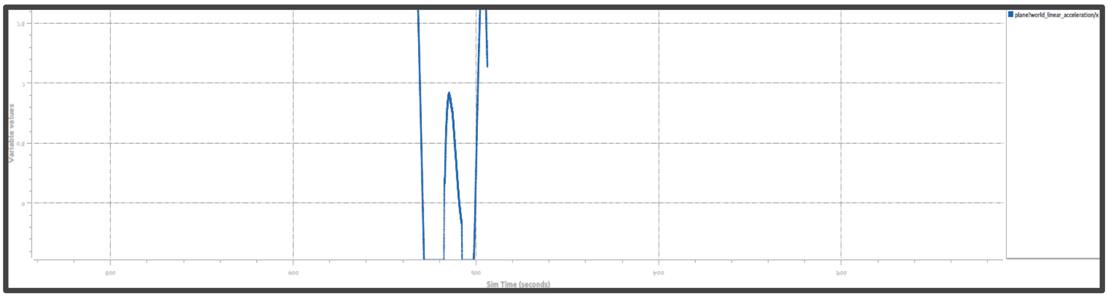
- Built a virtual environment in Blender and incorporated it into the platform.
- In order to facilitate a smooth interface with ROS, the SolidWorks-created STL files were converted into the URDF format.
- The PX4 framework was integrated to give autonomous control features.
- Planned and carried out flying tactics using the QGround Control program.
- Rather of starting at zero, set the initial air speed parameter to fifty meters per second.
- We made graphical depictions and performed data analysis in ROS to determine movement, acceleration, and position changes.

The velocity changes in the x axis :



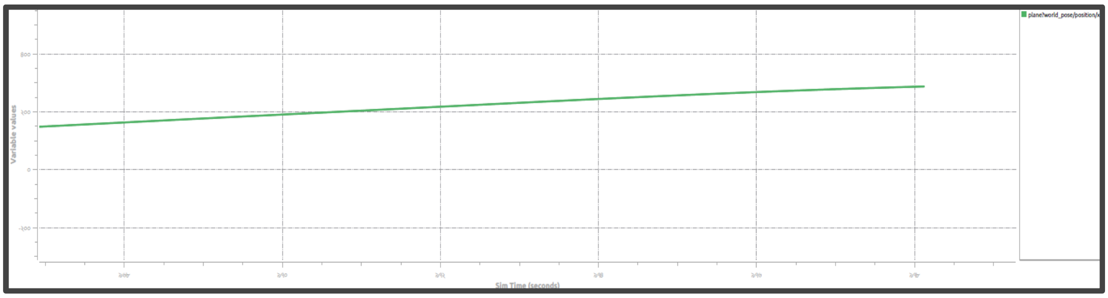
After some time, the aircraft's horizontal velocity abruptly changes to maintain a steady fifty meters per second. Due to this adjustment, the aircraft attempts to maintain a steady location in the environment, which significantly reduces its speed.

The Acceleration changes in the x axis :



This illustrates how acceleration along the x-axis must vary regularly over time in order to maintain the flying velocity. It also implies that the uneven acceleration is the cause of the higher power consumption.

The position changes in the x axis :



This shows that the aircraft is flying in time with the simulation and maintaining its height without any problems.

The second design approach for Hybrid system:

ROS simulation:

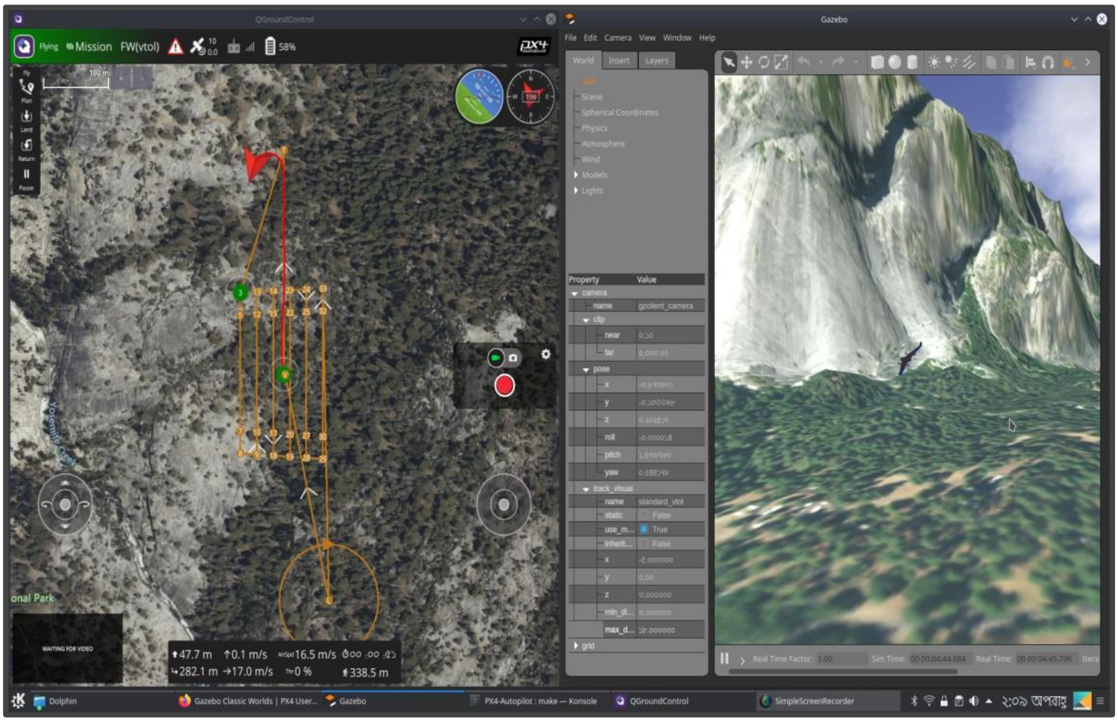
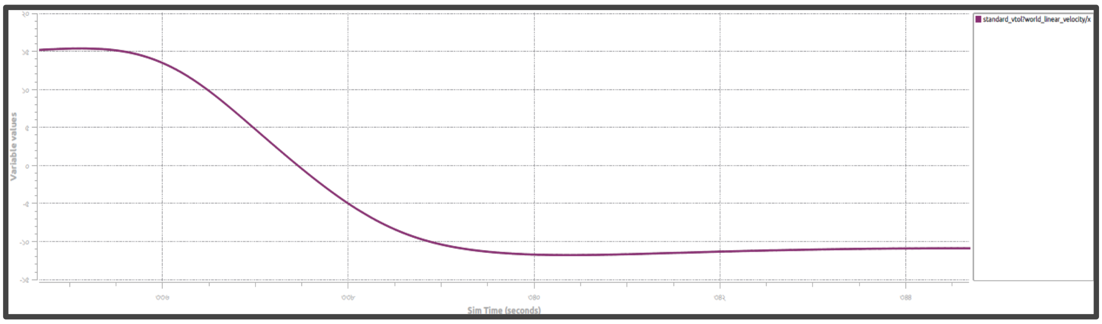


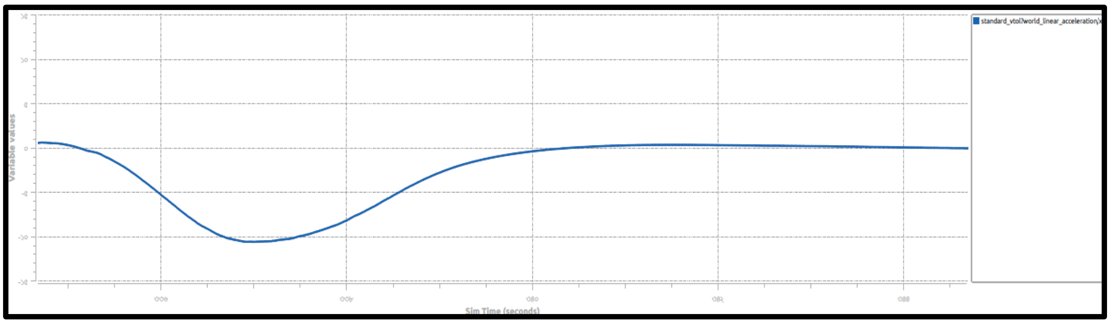
Figure: The flight simulation in robot operating system (gazibo)

Velocity changes in the X axis



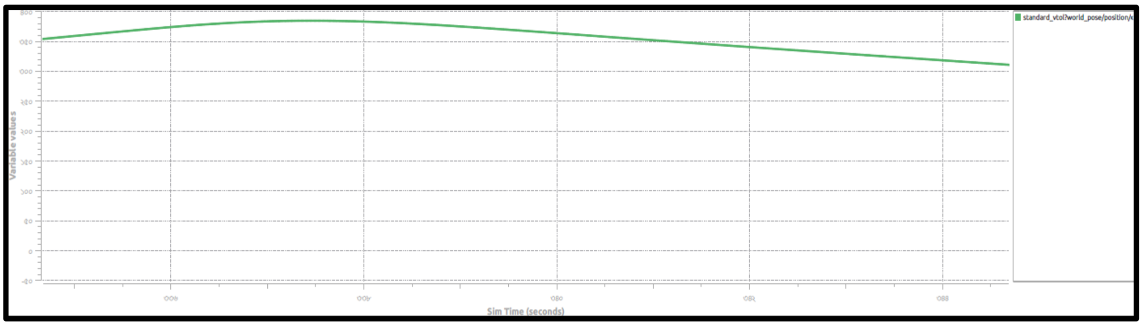
This shows a sudden change in horizontal velocity over time, which is essential to preserving the stability of the aircraft during flight. When the aircraft switches from drone to plane mode, it is seen to rapidly slow down from its starting speed of 50 meters per second. It also shows how difficult it is to keep moving at a constant 50 meters per second in order to keep the object in the air.

Acceleration in x axis



This implies an abrupt shift in the horizontal axis acceleration rate over time, which is required to keep the aircraft moving at a constant speed. However, it immediately stops speeding further in accordance with the predefined constraints of the px4 design as soon as it achieves its initial acceleration once more.

Position changes in x axis



This implies that, while having trouble maintaining its height, the aircraft's position shifts as the simulation goes on.

The (final approach) Design Approach 3 (Hexacpter):

Robot operating system (ROS Simulation):

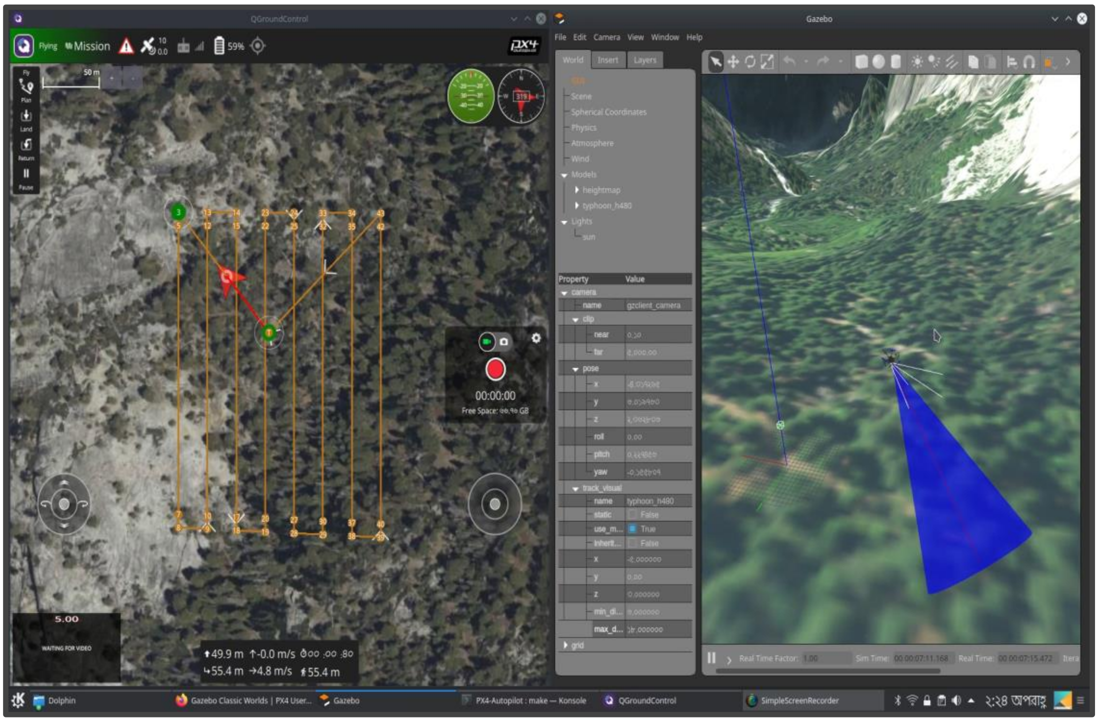
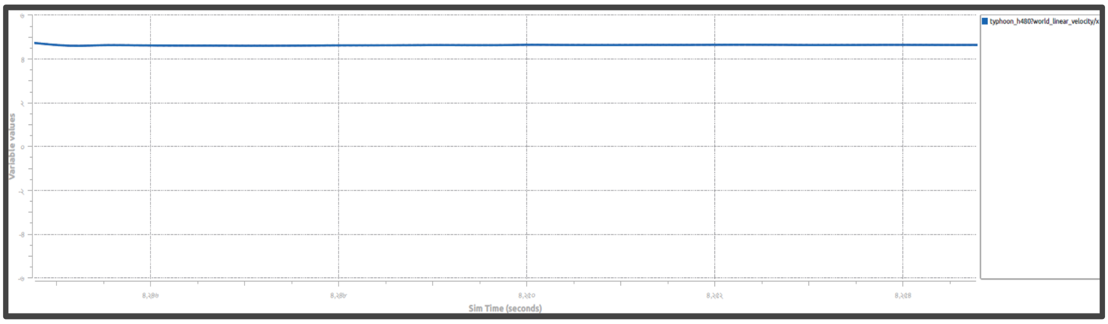


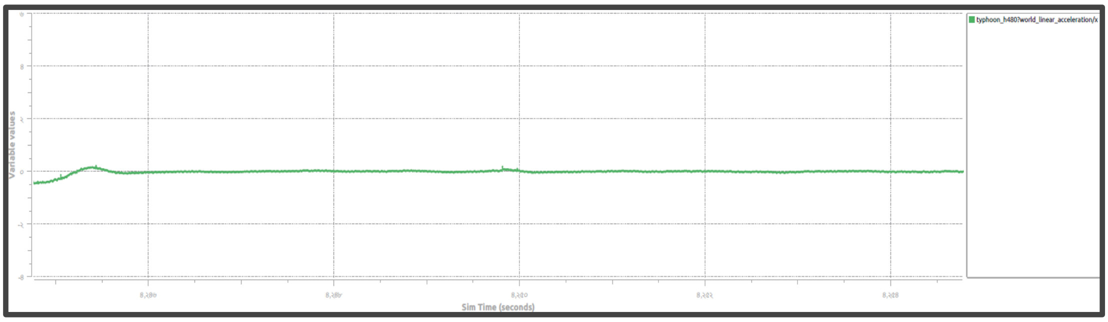
Figure: The flight simulation in robot operating system (gazibo)

Velocity changes in the X axis:



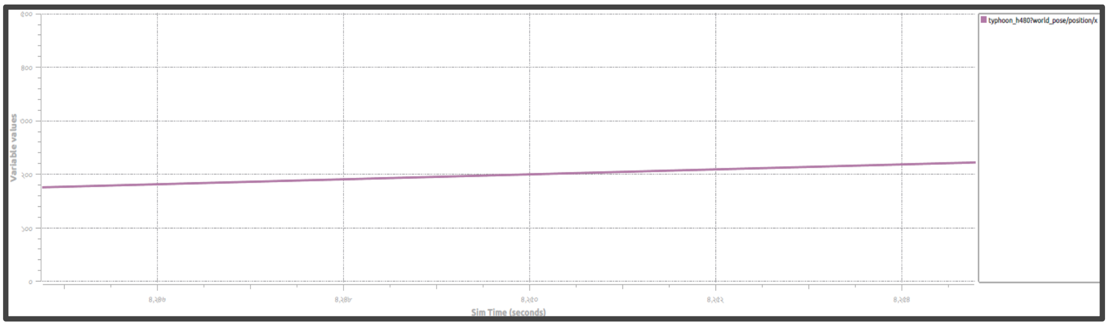
It moves forward without experiencing any sudden acceleration, suggesting that the air conditions are steady enough for it at this time.

The Acceleration changing in X axix



Since there is no air resistance, there are no sudden accelerations or decelerations that may cause vehicle instability. The car is quite stable due to this aerodynamic condition.

Changing the position of x axis:



4.3 Identify optimal design approach

After doing some theoretical analysis and hand calculations, we got the following:

For the fixed wing plane calculation, we got:

Outline:

Power	Speed Controller	BLDC	Prop	mass	Flight time
magnitude: 20000 mAh	Normal current : 80A Burst current : 90A Continuous current : 80A So, 1motor x 80A	Watt: 1820 Watt KV: 270 rating	1245 model	Total: **5500 gram approaximate**	**91 minutes** **(**50% throttle**)**

For the hybrid system (VTOL):

Outline:

Power	Speed Controller	BLDC	Prop	mass	Flight time
magnitude: 20000 mAh	Normal current : 80A Burst current : 90A Continuous current : 80A So, 6 motors x 80A= 480A	Watt: 1820 Watt KV: 270 rating	1245 model	Total: 5680gram approaximate	**52 minutes** **(**50% throttle**)**

85% of its magnitude: 18000 mAh Weight: 1750g	Cells: 2-6 S Weight: 41g	Weight: 30.6g	4.5 inch pitch	50% throttle lift weight: **12000 gram**	

For the hexacopter:

Outline:

Power	**Speed Controler**	**BLDC**	**Prop**	**Mass**	**Flight time**
magnitude : 20000 mAh	Normal current: 80A Burst current : 90A Continuous current : 80A So, 6 motors x 80A= 480A	Watt: 1820 Watt KV: 270 rating	1245 model	Total: **7376 gram**	**79.4290 minutes** **(**50% throttle**)**
85% of its capacity: 17000 mAh Weight: 1750g	Cells: 2-6S Weight: 41g	Weight: 30.6g	4.5 inch pitch	50% throttle lift weight: **18000 gram**	

4.4 Performance evaluation of developed solution

Comparison Criteria	**Fixed Wing Plane**	**Hybrid Aircraft**	**Hexacopter**	**Source**
Made of	Aluminum cast	Aluminum cast	**Carbon fiber**	analysis
Time for one flight	**91.6 minutes**	67 minutes	81.6 minutes	theoretical calculation
Flight Planning:	mild Complex	Most complex	**Less Complex**	analysis
Speed in the air	**24m/s**	15m/s	6.5 m/s	Solidworks simulation
Takeoff	Run	**Vertical**	**Vertical**	analysis
Maneuverability	Less	Mild	**Best**	ROS simulation
Payload	1.6 kg	2.00 kg	**4.3 kg**	theoretical calculation
Stability	Mild	Average	**Highest**	ROS software
Mechanical complexity	less complex	most complex	medium complex	Solidworks software
Energy efficient	**Best**	Lowest	Average	analysis
Maintenance	more extensive	most extensive	**least extensive**	analysis

Budget	126,000 taka	164,000 taka	**118,800 TAKA**	analysis
Covered Distation	**83.6km**	58.5km	22.7km	theoretical analysis

The suggested approach offers an autonomous drone-based remedy for the issue at hand. These drones come in three different models, each with unique structural, mechanical, and electrical components. The first of these ideas suggests using a fixed-wing aircraft with a segmented distribution mechanism. The second type adopts a hybrid strategy, fusing fixed-wing aircraft with quadcopter capabilities. It is made up of four arms. Lastly, a robust six-armed hexacopter architecture with dual-axis mechanical grippers is presented in the idea.

- It's critical to maintain stability, particularly in coastal areas where wind gusts may approach 50 mph. Based on ROS and CFD simulations, which indicate that the hexacopter is the most stable of the options, it is evident that this is the ideal choice.

- When budgetary considerations are taken into account, it becomes evident that, although not having the lowest initial cost of all the options, the hexacopter's many characteristics eventually make it the most economical choice.

- Effective Power Usage: For a total of 29.6 volts and 20000 mAh at 45 degrees Celsius, eight batteries functioning at 3.7 volts each were used in our evaluation. The fixed-wing, hybrid, and hexacopter models' flight times could be calculated using these characteristics; the results showed that the durations were, respectively, around 92 minutes, 65 minutes, and 85.5 minutes. When it comes to energy efficiency, hexacopters are on par with or even more efficient than fixed-wing aircraft. Furthermore, it's critical to remember that fixed-wing aircraft use more energy to perform aerial maneuvers, especially on missions that require frequent twists like supply and surveillance. In light of this, choosing a hexacopter might be beneficial in terms of power efficiency.

- Maximum cargo capacity: Fixed-wing aircraft employ a chamber system powered by servos, whereas hexacopters and hybrid aircraft carry cargoes using mechanical claws with two degrees of freedom. Calculations show that a hexacopter can carry up to 4 kg of cargo, compared to just 2 kg for fixed-wing aircraft and 1.5 kg for hybrid aircraft. Thus, the hexacopter is the preferable choice in this scenario.

- Maximum maneuverability: The ROS simulation demonstrates that the hexacopter is the most maneuverable and fluid-moving vehicle.

- Max Vertical Performance: The hexacopter exhibits state-of-the-art virtual landing and takeoff capabilities. The hexacopter outperforms conventional fixed-wing aircraft and hybrid aircraft, which require a short runway and have trouble with simulated takeoff, respectively. Blender simulations show that its decreased voltage need enables more nimble flying motions.

- Extended Flight Duration: Manual calculations indicate that fixed-wing aircraft could remain in the air for around 92 minutes, hybrid systems for 68 minutes, and hexacopters for 80.5 minutes, based on the voltages provided. Even while the hexacopter's 80-minute flight time is a little less than that of fixed-wing aircraft, it is still a very helpful substitute.

a) The CFD simulation analysis demonstrates that the hexacopter's body has greater structural integrity and is more resistant to air resistance than other designs from a mechanical standpoint.

b) A central station will oversee the aerial vehicle's operations in terms of control systems. It is highly challenging to maintain a hybrid system for this station since it requires two radio controllers with a minimum of eighteen channels. Moreover, a fixed-wing aircraft's engine adjustment is a highly difficult process. However, hexacopter administration is comparatively simpler because Ardupilot and Mission Planner allow for simple arm calibration.

After accounting for these factors, it is evident that our proposed design approach, which revolves on the hexacopter, is the most appropriate for our project.

4.5 Design and Setup experiments:

4.5.1 description of Individual parts

Frame: The frame, the hexacopter's structural component, is essentially flexible; it can adjust its shape and material composition to accommodate variations in arrangement and size. Larger frames are commonly made of a combination of metal and carbon fiber, whilst smaller frames are frequently made of plastic. Additionally, bigger frames often have more arms than smaller frames. In the case of our hexacopter we have used “S550 Hexacopter Frame With Landing Gear”. The frame was 550 mm in diameter, height was 288mm and weight was 445 grams for the frame only. the motor mount bolt holes are 16-19-25 mm.

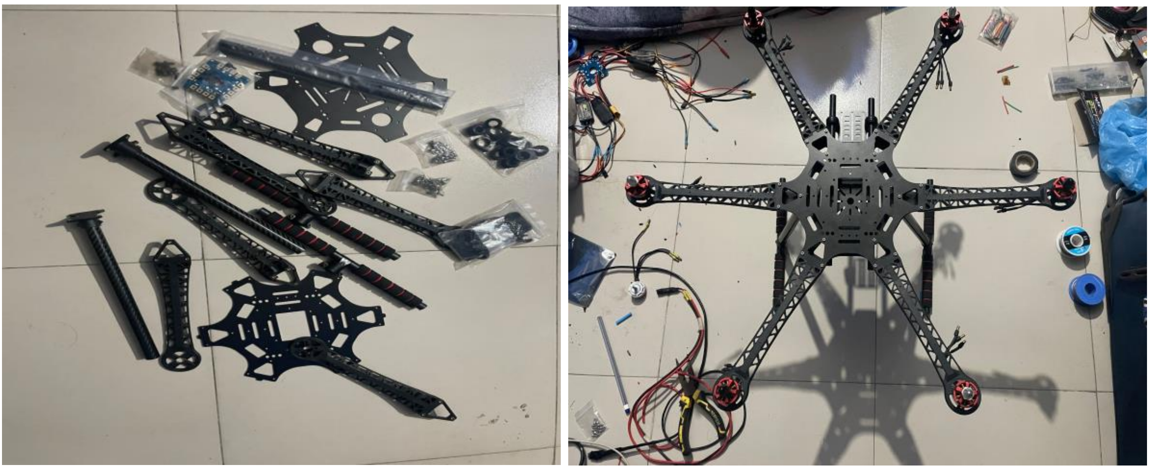


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Figure: Frame of the Hexacopter

Propellers:

Propellers are frequently selected based on their rotation and size; their four-digit number is an indication of these characteristics. The radius and pitch are represented by the first two and last two digits, respectively, and are both given in inches. Pitch is the distance a propeller would go in a single revolution if it were to pass through a solid material that yields, such as wood being passed through by a screw. In our system we have used 1045 self locking propellers. It is 10 inch in length and 4.5inch width and the material was high quality plastic. We needed a total of six propellers and the assembler of the propeller is alternatively clockwise and anti clockwise. The orientation of the propellers was a very crucial part of our UAV as the clockwise orientation rotates and generates clockwise torque causing the vehicle's body to rotate in the opposite direction (anti clockwise) that counteract this torque and maintain stability and vice versa. this opposing torque generated by differently oriented propellers cancels out each other to a certain extent

In our case the torque created by one propeller was,

$$F = \frac{mv^2}{r}$$

F= 6166.78 N

So, the opposite oriented propellers cancel out 6166.78N force to stabilize the acceleration of the whole system.

- The ratio of thrust to weight is an important point of reference while building a multicopter. It requires that the total thrust produced by all of the motors be equal to double the drone's weight. This idea is used to ensure that the motors can continuously deliver sufficient push, especially in situations requiring quick movements or in the face of high wind gusts. Thrust Weight = Thrust-to-weight ratio is the formula used to calculate this ratio.

- KV: When choosing a motor, it's crucial to take the KV rating—which is measured in Revolutions Per Minute (RPM) per Volt (RPM/Volt) and indicates the motor's rotational speed in relation to the provided voltage—into account. For example, if driven by 22.2V, the previously mentioned Sunnysky X4110S 460KV motor would rotate at: $KV \ast V = RPM \Rightarrow 460 \ast 22.2 = 10212$ RPM. Similarly, $KV \ast V = RPM \Rightarrow 2300 \ast 16 = 36800$ RPM would be the rotation speed for the higher KV Arris X2205 2300KV power supply. When no external load is present, this parameter displays the motor's speed; when a propeller is added, the speed decreases in line with the propeller's specifications. A motor with a lower KV rating will probably provide more torque when driving bigger propellers than one with a higher KV rating. Because of its speed, a motor with a high KV rating is ideal for lightweight racing drones, whereas a motor with a low KV rating creates a multicopter that is slower but still capable of heavy lifting.

Electronic Speed Controller (ESC):

An electronic speed controller (ESC) circuit modifies an electric motor's trajectory and acts as a dynamic brake to modify the motor's speed. Six ESCs—more precisely, the 'HW30A ESC Brushless Motor Speed Controller'—control the six motor speeds in our hexacopter. Here, the constant current is 30 ampere, input voltage is 11.1-11.7 V, lipo battery: 3s. the onboard BEC(battery eliminator circuit) provides regulated 5V to power the flight controller and other onboard modules.

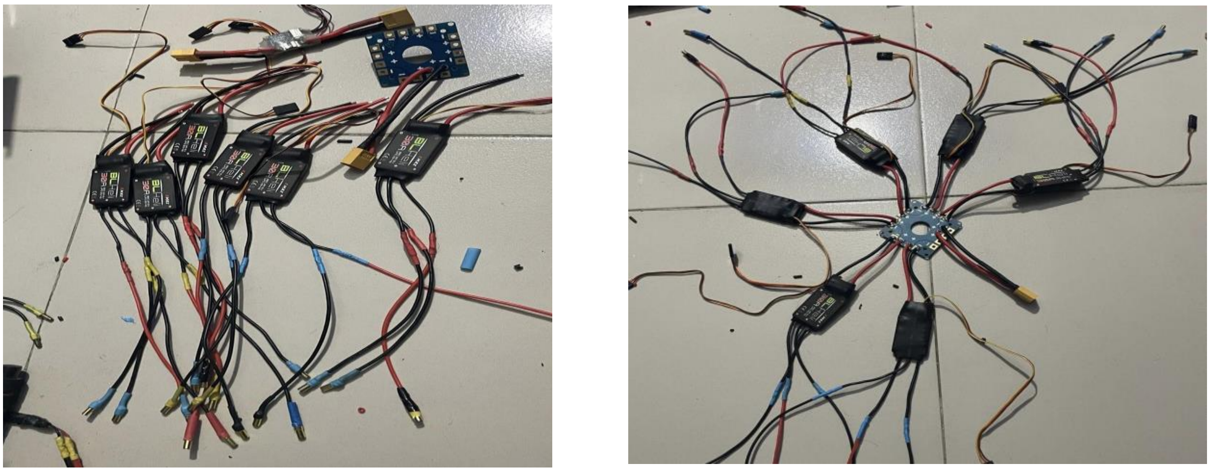


Figure: Connection assembly of ESC

Brushless DC motor:

A BLDC or brushless DC motor is used for the propellers to rotate and these are used for various specific advantages such as efficiency, high power to weight ratio, durability, reduced vibration and noise. We are using ‘DJI 2212 920KV Brushless Motor CW & CCW’ where the voltage rating is 920kv, 4s battery, shaft is 8.0mm, weight is 56g(with propeller adaptor), standard current: 15-25A, Maximum current is 30A, Max power: 370W, Maximum thrust: 1200g.as we are using six motors it has the capability of lifting 7200g or 7.2 kgs of weight. The weight of our hexacopter alone is 3.5 kg. So,by this calculation we currently can lift up to 3,7 kgs of payload.

Figure: Brushless DC motor

Lipo Battery:

In the case of our main power source of the copter we have used both 10000mAh 4s lipo battery as well as 5200 mAh lipo battery.

The 10000mAh lipo battery has 14.8v battery capacity, 120C continuous discharge Rate means it can safely discharge its energy up to 120C without overheating and damaging itself. discharging plug is EC5, balance connector is JST-XH, battery dimension is 169*48*42mm and lastly weight is 713g.

the specifications of the 5200 mAh lipo battery is dimensions are 6.06 x 1.75 x 1.36 inches, weight 520 grams, discharge rate 60C, voltage 14.8V, connector type: deans plug

Figure: lipo battery

Flight controller/ Pixhawk:

It is the main flight controlling system for our hexacopter as it handles stabilizing, navigation and control of our aerial vehicle. in short pixhawk as the brain of the UAV. it works in bellow mentioned ways:

It is equipped with a variety of sensors such as accelerometer, gyroscope, magnetometer, barometer and gps receivers that provides essential data of the hexacopters orientation (roll, pitch) altitude, velocity and position. It also runs sophisticated algorithms that process the sensor data to calculate the vehicle's current state. the specific flight controller that we used is ‘Pixhawk 2.4.8 32 bit with M8N GPS POWER MODULE, Shock Absorber. The microprocessor it uses is a 2 MB flash STM32F427 Cortex M4 with a hardware floating point processing unit. its frequency is 168MHZ, 256K RAM.

Figure: Flight controller/ Pixhawk 2.4.8

Radio Controller:

For practical and safety reasons, the hexacopter's radio controller is used to manually disable the motors. Turning on a switch allows the hexacopter to become independent and self-sufficient. Since our pilot operates the vehicle manually during takeoff and landing, a radio controller is given. The 16-channel radio transmitter we used was the 'FRSKY ACCST TARANIS Q X7 2.4GHZ 16 CHANNEL RADIO TRANSMITTER,' designed specifically for multirotor aerial vehicles and drone racing pilots. This RC gadget has an operating current of 210 mA and can run between 6 and 15 volts. There's also a haptic vibration feedback gadget.

Figure: FRSKY ACCST TARANIS Q X7 Radio Controller

Microprocessor:

The NVIDIA Jetson Nano is a power computing embedded system developed for AI and Computer vision applications such as object detection and features an impactful GPU with CUDA cores that are designed to do the parallel processing. It runs an inference engine that takes a pre pre-trained object detention model and performs real time inference on input data such as images or video frames. as soon as the object is detected the system gives the information by bounding box coordinate and labels the detected object

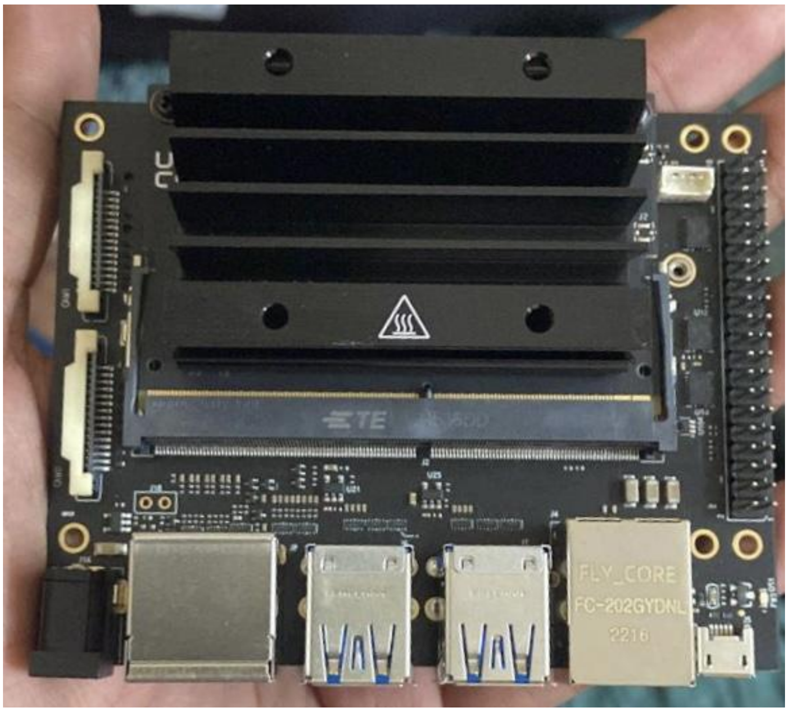


Figure: Microprocessor Jatson Nano

4.5.2 System Architecture:

An overview of how the hardware is connected can be seen in the figure 4.5.1. We connected our pixhawk with a mission planner which is a powerful ground control station(GCS) software that is used to interact with and control pixhawk.

Here, the battery will provide power directly to the power module and to the FPV transmitter chronologically of 16.8V and 12.6V. The pixhawk is connected with the GPS, radio telemetry, safety switch, claw, kill switch, buzzer and ESC. all the esc's power flow is 16.8 volt that is why we are providing that much power.

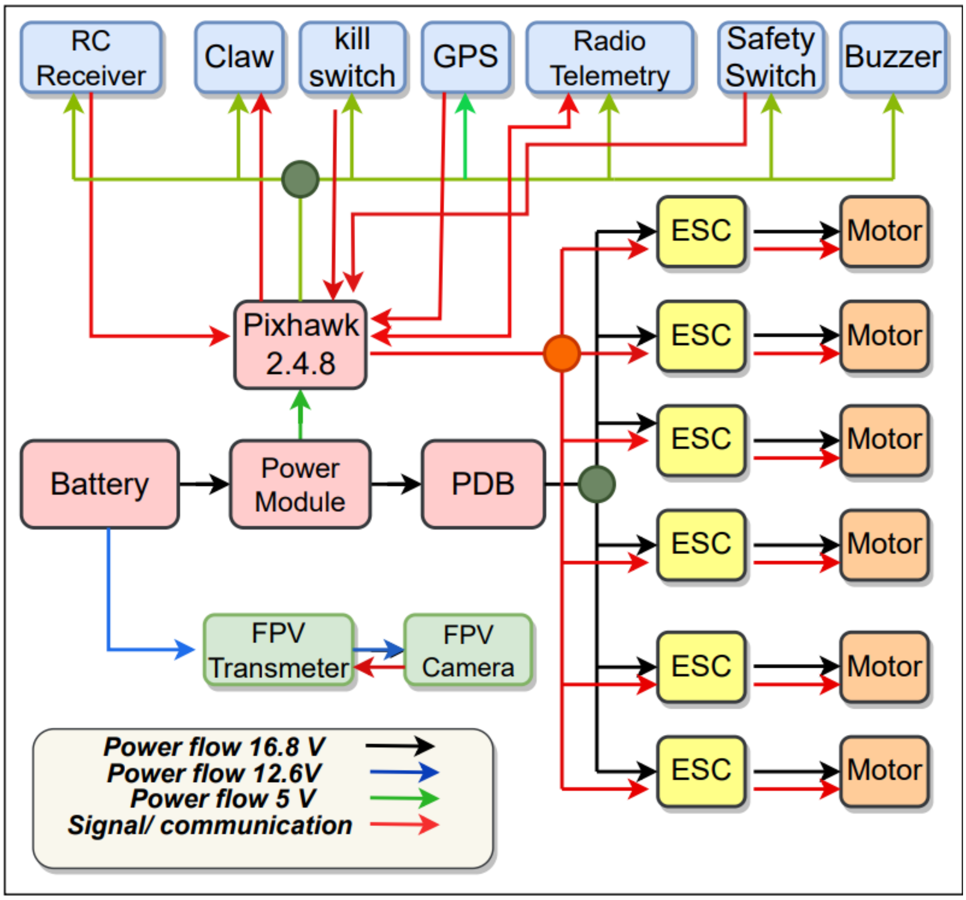


Figure 4.5.1: Detailed power and signal flow diagram of the system

Assemble of the Hexacopter:

Figure: Prototype of The Hexacopter

In order to assemble our hexacopter we gathered necessary tools that are important such as

- Carbon-fiber Frame
- Six bldc motor
- Six electronic speed controller(ESC)
- Six 1045 propellers
- Pixhawk
- Power distribution Board(PDB)
- Lipo battery and battery connector.
- Radio transmitter and receiver
- Landing gear
- Mounting hardware(screws, nuts, etc)
- Soldering Iron
- Wire connectors, wire and heat shrink tubing.
- Fpv Camera
- Mechanical claw

Constructing the Frame: We layed out the hexacopter frame components and picked out the main body and arms and assembled them according to the manufacturer's instructions through attaching arms securely to the body.

Mounting Motors and ESCs: we attached the motors into the motor mounts with the help of screw and connected each esc to the designated motor, securing them with duct tape and zip ties.

Installation of the Flight Controller/ Pixhawk: we mounted the flight controller in the center of the frame and connected the Pixhawk with the GPS, radio telemetry safety switch, buzzer, mechanical claw and kill switch.

Wireworking and power distribution: Firstly we connected the power distribution board to esc, connected pdb to the battery. Lastly, we carefully laid out the wiring to minimize signal interference.

Attaching Propellers, Radio Transmitter, Receiver, Mechanical claw and FPV Camera and battery mounting: We installed the correct orientation of propeller to each motor and maintained the propeller rotation direction and attached the lipo battery with the help of zip tie.

Safety Check: we double checked all the connecting wires, made sure neither of the wire were overlapping or intact in the right place and went through a pre-flight checklist of checking motor directions, flight controller orientation by taping paper on to the motors instead of propeller and calibrating sensors.

Test Flight: We conducted test flight at first by loosely binding the landing gear with rope to a cork sheet and giving thrust and noticed whether it is calibrating upwards straight or not. We followed each government drone's guidelines, so that we do not stumble upon any unfortunate accidents.

Fine-tuning and Configuration: We used reliable flight controller software called mission planner to configure the parameters , such as PID settings and flight modes.

Work-Flow Chart of The Hexacopter:

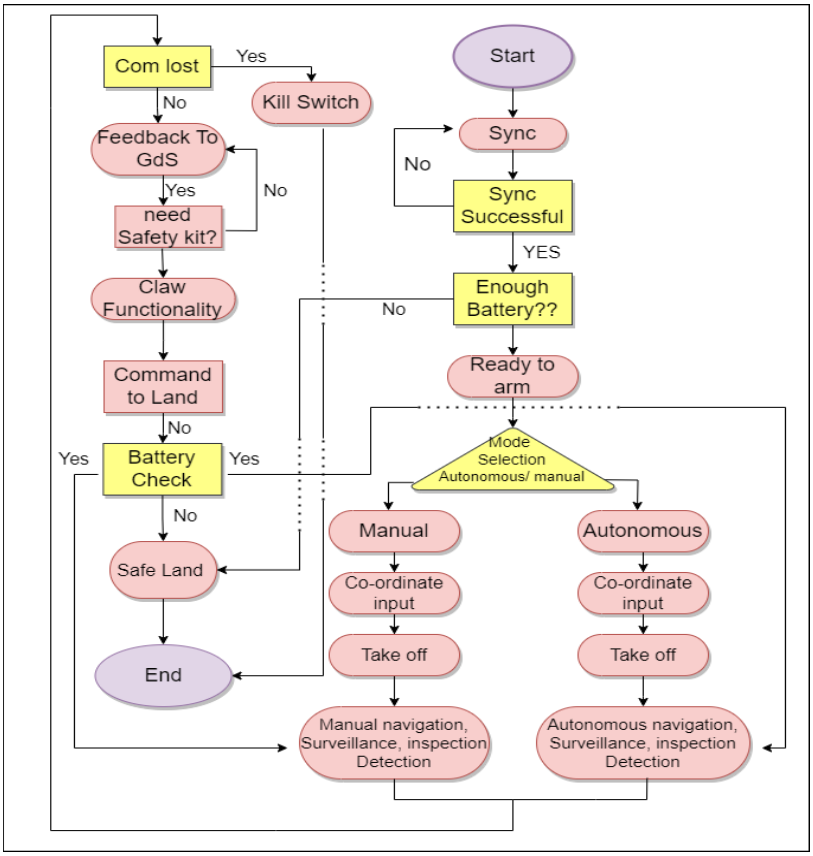


Figure 4.5.1: Workflow diagram of Hexacopter

In the workflow diagram it is seen that the system will start and synchronize all over, then it will check if it has enough battery or not, battery efficiency will lead into arming otherwise the copter will safely land. Otherwise, it will get the signal of selected flight mode from the ground station and fly under either manual or autonomous mode. If the flight happens smoothly without communication loss it will check the battery and continue flying until it has sufficient power supply. If any kind of communication loss happens to the UAV the kill switch will be pressed as an emergency measure and the copter will decline its flight and return to the ground station immediately.

4.5.3 System Explanation:

Autonomous Navigation Using Mission Planner:

It serves as a central center for managing UAVs and accomplishes tasks related to configuration and instantaneous control enhancement for autonomous vehicles.

In our project we have loaded the firmware software into the ardupilot board and have controlled our vehicle. We have set up, configured the performance and we planned our autonomous mission into ardupilot by clicking the way points on google map and we have interface with a PC flight simulator to get the aerial vehicle's cockpit view of our uav. Our copter mission starts with a manual takeoff to 10 meters altitude, then the craft holds itself to way point 1 and moves along 2nd, 3rd and 4th waypoint maintaining previously fixed longitude and latitude and will continue the surveillance procedure. We also monitored the vehicle's status while in operation and recorded telemetry logs and viewed and analyzed the logs. We have connected our mission planner with pixhawk and calibrated our Esc. In general, there are three variations of calibration electronic speed controllers(ESC) and those are listed below:

- **All at Once Calibration**: at this instance, before connecting the lipo batteries, make sure the transmitter's throttle lever is at the highest position. When the Autopilot is attached, its LEDs will light up in a precise pattern of red, blue, and yellow, indicating that it is ready to enter ESC calibration mode. Until the LED stays red for a considerable amount of time, signifying that the autopilot has effectively entered the ESC calibration mode, the safety switch has to be in the engaged position. During this calibration process, all ESCs synchronize simultaneously to calculate the vehicle's maximum throttle position.
- **Manual ESC-by-ESC Calibration:** this is also known as individual ESC calibration, that is used in the setup and in the configuration of multirotor aerial vehicles. Sometimes ESC's may have slight malfunction or their default setting may not be accurately the same for all of them. Manual calibration allows the pilot to take count of these differences and ensure that they are set up correctly. In this setup, a three-core cable connects one ESC to the throttle slot of the RC receiver. The battery is then connected. Unlike with LED patterns, the user is not alerted by a series of beep signals that conclude with a prolonged beep that indicates the successful completion of endpoint adjustment and ESC calibration.
- **Semi Automatic ESC-by-ESC Calibration:** By merging parts from automated and manual methods, this calibration technique preserves the option to make customized alterations while streamlining the ESC calibration process. Prior to operating, the autopilot has to establish a connection with a ground station, such "Mission Planner," and set the ESC calibration parameter to 3. The battery needs to be disconnected and then reconnected in order for the UAV's buzzer to emit a warning. Pushing the switch will cause a red LED light to momentarily glow, indicating that the safety switch has been disengaged after a few seconds. A sequence of beeps indicates that the ESC has been calibrated once end points have been determined.

In the matter of this project, we have used the Semi Automatic ESC -by-ESC Calibration mode for the flexibility of slight customized and manual control as we are aiming towards having manual 'Take off' and 'landing' of the UAV for maximum safety.

In the following figure 4.5.3.1, we can see the pointed waypoints that we have selected and the hexacopter is maneuvering according to the waypoints. We are getting logs from the mission planner data screen.

Altitude (m) 18.93

GroundSpeed (m/s) 2.45

Dist to WP (m) 0.00

Yaw (deg) 174.63

Vertical Speed (m/s) 0.80

DistToMAV 15.84

WP Radius 2.00

Loiter Radius 30

Default Alt 10

Relative

☐ Verify Height

Alt Warn 0

☐ Spline

☐ MAVFTP

	Command	Delay				Lat	Long	Alt	Frame	Delete			Grad %	Angle	Dis
1	WAYPOINT	0	0	0	0	23.8707148	90.4928184	10	Relative	X	🡅	🡇	13.6	7.7	74.
2	WAYPOINT	0	0	0	0	23.8706902	90.4931402	10	Relative	X	🡅	🡇	0.0	0.0	32.
▷ 3	WAYPOINT	0	0	0	0	23.8713574	90.4930973	10	Relative	X	🡅	🡇	0.0	0.0	74.
4	WAYPOINT	0	0	0	0	23.8713672	90.4929042	10	Relative	X	🡅	🡇	0.0	0.0	19.

Figure 4.5.3.1: autonomous navigation using mission planner

Control Modes of Hexacopter: Within the Mission Planner we have access to different types of flight modes for multirotor UAVs as these offer different adeptness and are designed for predetermined purposes.

- **Stabilize Mode:** This is basically a fundamental mode for flight as it provides manual control on the UAVs roll and pitch angle. meanwhile it maintains auto-leveling for sturdiness and preferable for manual and practice flight purposes.
- **Altitude Hold:** This is the mode for the UAV to hold its current altitude along with allowing manual control of roll and pitch and important for maintaining consistent altitude while performing various tasks.
- **Loiter Mode:** This particular mode combines the GPS positioning and altitude hold together and enables the UAV to hold its position and loftiness autonomously. This mode is very useful for surveying and inspection purposes as it facilitates the pilot to hold the UAV in a fixed position.
- **Auto Mode:** This mode facilitates autonomous navigation as the waypoints are determined from the base station, the uav will follow the predetermined path, including altitude changes.

- **RTL(Return to Launch) Mode:** When this mode is activated the UAV will automatically return to its launching point and land, it is a most important mode that ensures safety if the operator loses control of the copter.
- **Land Mode:** This mode instructs the vehicle to decline and land at its present location. It is used in manual landing of the UAV.
- **PoseHold Mode:** This mode combines GPS position holding of the vehicle along with the altitude control.

In our project, we used three modes of flight, auto mode, posehold/stabilized mode and altitude hold mode. As we can see in Figure 4.5.3.2, the first picture shows our hexacopter is in position hold mode, as it is holding its position at our predetermined altitude which is 10 meters. We also can notice there is a disarmed sign on the screen which indicates the hexacopter is not armed yet because we mostly did practice runs with this particular mode.

The second picture shows the ‘AUTO’ mode working and it stipulates that our vehicle is flying autonomously through the predesignated way points. While our hexacopter goes to waypoint 1 with 10 meters of altitude, we changed its mode from ‘PosHold’ to ‘Auto’ through our radio controller. Once it gets the command of auto the hexacopter begins to navigate autonomously until it passes waypoint 2, waypoint 3 and finally waypoint 4. After reaching at waypoint 4, the finishing point, we switch the mode back to ‘PosHold’ and the copter remains at that altitude until the next command comes.

In the third picture we can see the ‘AltHold’ mode is operating and helps the hexacopter to hold the altitude and enable manual control. This mode was mostly used at the time of inspection of hazardous situations on waters or while the vehicle was dropping the emergency kit with the mechanical claw.

Figure 4.5.3.2: Three Used Flight Mode: Position hold, Auto and Altitude hold

Manual Flight Controlling: At the beginning of our flight attempts we implemented manual take off and flight for our hexacopter. In order to do so, we used a 16 channel transmitter radio controller that covers a 5 kilometer distance range. The radio controller was in our base station and our receiver was on the hexacopter at RC-IN PIN. Moreover, there was a buzzer, GPS and safety switch with our pixhawk at designated pins. The hexacopter's GPS receiver communicated with multiple satellites. By receiving signals from at least four satellites, our GPS receiver could calculate the latitude, longitude, altitude and accurate time. In order to maintain its stability and position GPS works by triangulating signals from multiple satellites which is crucial for autonomous flight and accurate positioning.

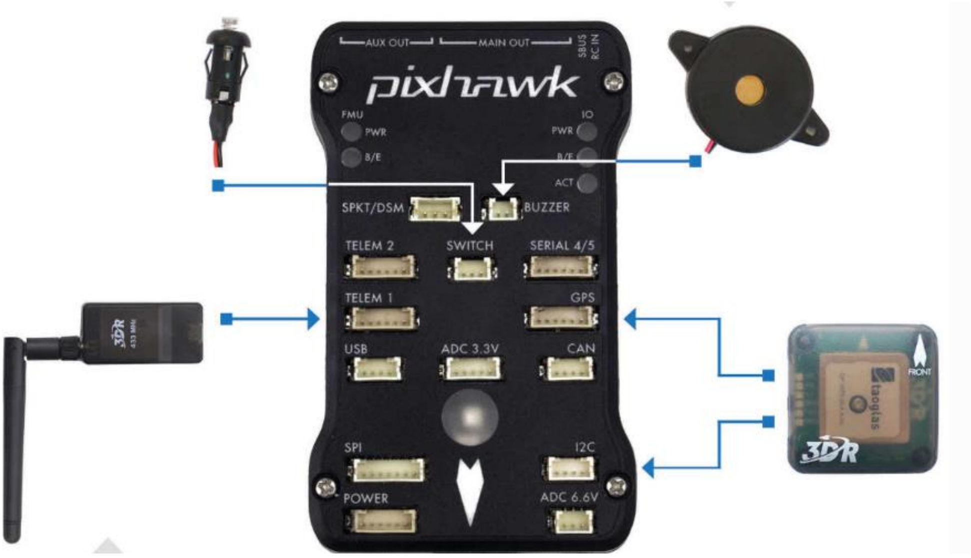


Figure: Pinout of a Pixhawk 2.4.8

4.5.4 Features of Hexacopter

Payload Carry and Drop:

The attached mechanical claw is mounted to carry and drop the necessary payloads. Flirty, we used a 12V servo motor to operate the claw and the servo was controlled by the flight controller/ Pixhawk. The pixhawk got the signal from our transmitter that was in our hand, then connected the claw with a specific channel of our transmitter. When the servo motor was getting 5 voltage, it rotates 90 degrees and when we click the switch in the opposite direction 5 voltage gets cut off, meanwhile the servo motor rotates back to 0 degree. Basically when the servo gets voltage and rotates to 90 degrees the claw opens, at 0 degree rotation of the servo the claw closes.

In order to save power, we executed the claw's working in such a way that, when it does not have any power it will remain open and whenever it needs to be closed it will consume power.

Figure: Controlling Mechanical Claw with Radio Controller

Functionality of the Mechanical Claw:

Figure: Payload is being carried with Mechanical Claw

Figure: Claw Dropping the Payload

Object Detection:

There are several different ways to execute object detection, and in this project we implemented object detection via live feed. This can not be particularly counted as an onboard object detection, as we are receiving the live feed with a few seconds of delay in our ground station and then the feed is being processed and detecting the troublesome object such as sinking or endangered ships boats or drowning people. as an objective of this project was to inspacing an accident prone place, that is why identifying people or water vehicles that need immediate attention is crucial

We did object detection through a first person view(FPV) analog system, which works through radio frequency. While the camera is capturing the video feed it is being transferred to the transmitter and then transmitter is sent that data to the ground station. Here we used 5.8gHZ transmitter and the transmitter is processing the data within this range and broadcasting to the ground station.The receiver we used in here is also a 5.8 gHz dual antenna receiver, and with the help of double diversity it can collect data from different frequencies. Firstly, the data we are receiving from the transmitter, the receiver is taking data and denoising them and that denoised data is partially showing in our receiving monitor.

Figure: Received video feed in the Ground Station

As we can see in the figure the receiver is providing a pc webcam-like feed. as we are taking analog video feed, we were receiving an excess amount of noise which tends to an unclear video feed. As a result, the resolution of which the feed is transmitted gets distorted while we receive those. In such a situation we had to take some measures like, denoise the feed by hyperparameter tuning that involves optimizing the hyperparameters of the YOLO V5 algorithm to achieve better performance, also by grounding like making a cox-wire cable to avoid noise interference. It helped the received video feed to be clearer.

Boat detection:

We identified the commonly used water vehicles in the locality such as Shampan, Kayak ,Speed boat ,Moon boat and humans in various drowning situations to train the model to identify drowning people in accidents..

Here, the YOLO V5 algorithm was used as we are working with Jatsen Nano as our main microprocessing unit that works well in lesser computing power. The S model of yolo v5 works as an algorithm and although at first we were getting feed of 1-3 fps but after some hyper tuning we were able to get almost 5-6 fps data speed.

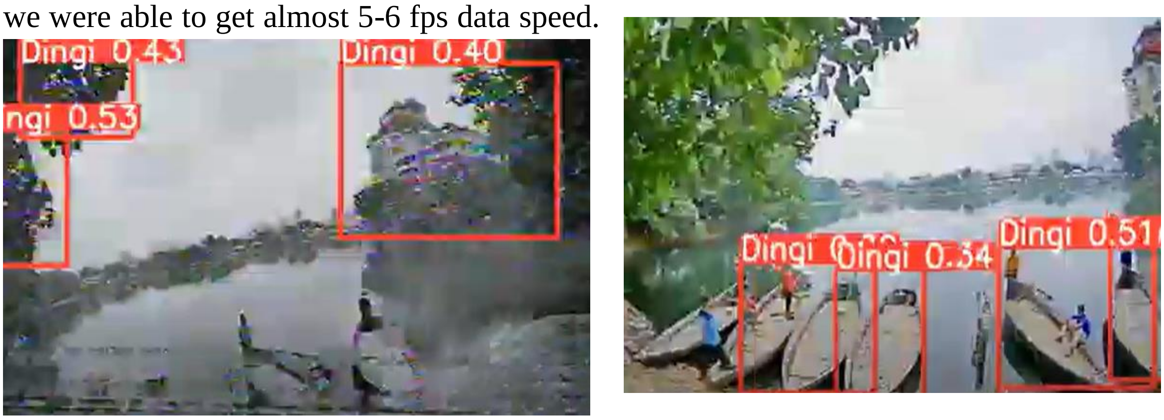


Figure: FPV feed Before and after noise reduction of boat detection

Process of making Data Set: In the case of, creating dataset from an analog video feed involves capturing video frames, annotating or labeling them and saving them in a format for object detection. Firstly, or create an image box for each frame in the time of labeling as, in the bounding box method we create a rectangular box surrounding the specific object and we use robo flow for annotation. Around 1800 pictures were annotated and defined by their classes like Shampan, Kayak, Speed boat, Moon boat.

Here, we also dealt with augmentation and preprocessing that plays a crucial role for the noise issue. The transceiver broadcasts the data into broad frequency thus the data gets corrupted as no filter circuit is used in this process.

Human Detection: We used an universal dataset on Robo Flow in this case and we have found human drawing can happen in various positions and it does not have a specific pattern to follow.[21]. This universal dataset had almost 7000 pictures. The data set was made using available video feeds in public platforms such as youtube, twitter etc. there we saw the accuracy rate to be almost 85%, after implementing this dataset in our model training we have got almost 42% accuracy.although the accuracy rate is poor but after analyzing we found that their resolution and view of camera angle were much better than us. The reason this happened is because they took the feed from a steady camera feed but we took the feed from a camera that was mounted on a hexacopter and the copter was anything but a sturdy platform to take the video feed from.

Figure: FPV feed Before and after noise reduction of Human Detection

4.5.5 Experimental Fault and Troubleshoot:

Experimental Fault: Once during a test run we tried to achieve an altitude of 70 meters with rapid maneuvering and faced trouble in controlling the hexacopter. As we did all of our test runs in time of heavy cloud, the clouds were hindering the GPS signals, leading to inaccuracy in the vehicles position and navigation. also the weather conditions were disrupting the radio frequency communication between the hexacopter and the ground station and resulted in delayed and lost commands or maneuvering, making it difficult to maintain control of the copter.

This causes a major safety concern for our project as our hexacopter will be used as a disaster response assistant, it may face similar or worse weather conditions in such rescuing operations.

Troubleshooting: In order to nullify such emergency outcomes we designed an emergency cutoff switch or wireless kill switch that is designed to quickly shut down the system in cases of emergencies or malfunctions.

Mechanism of the Kill Switch:

In order to initiate the kill switch we made a custom made transmitter and receiver and the receiver was mounted on the copter and transmitter was on control of the ground station pilot. We generated the communication through the HC12 communication module and it was controlled by a microcontroller. In the transmitter circuit it had arduino uno as microcontroller and in the receiver we used arduino nano as microcontroller. In the receiver circuit we cut off the power source of the Pixhawk by a relay. When we sent data to the receiver it sent the data through arduino and it passed the data to HC12 com module and broadcast it to the receiver circuit that is situated on the hexacopter. and the receiver HC12 modules's antenna picks up the data and sent the common to its arduino and then that command is passed down to the relay and the relay will turn on and cut power off from pixhawk.

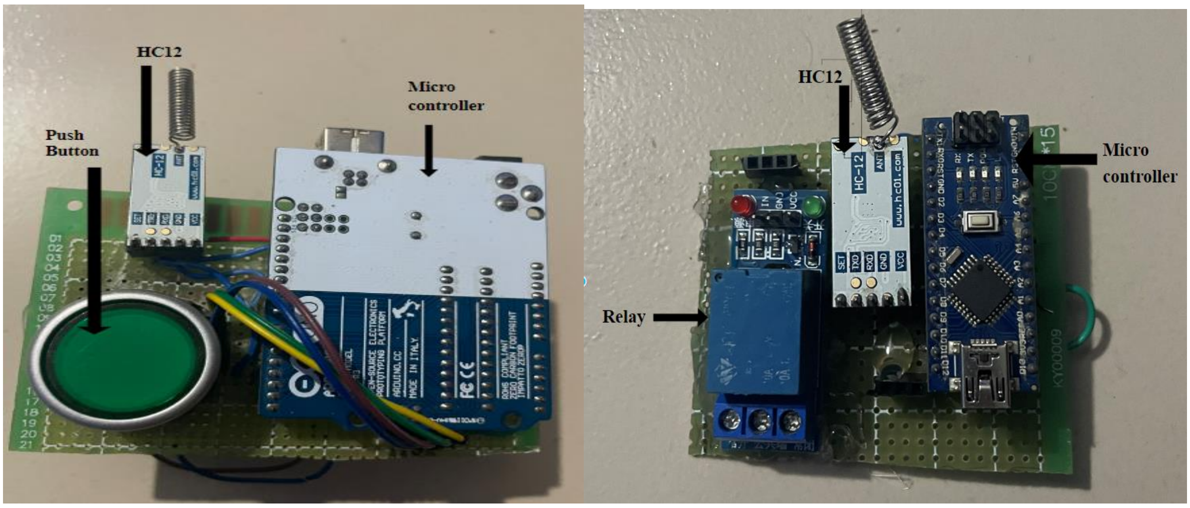
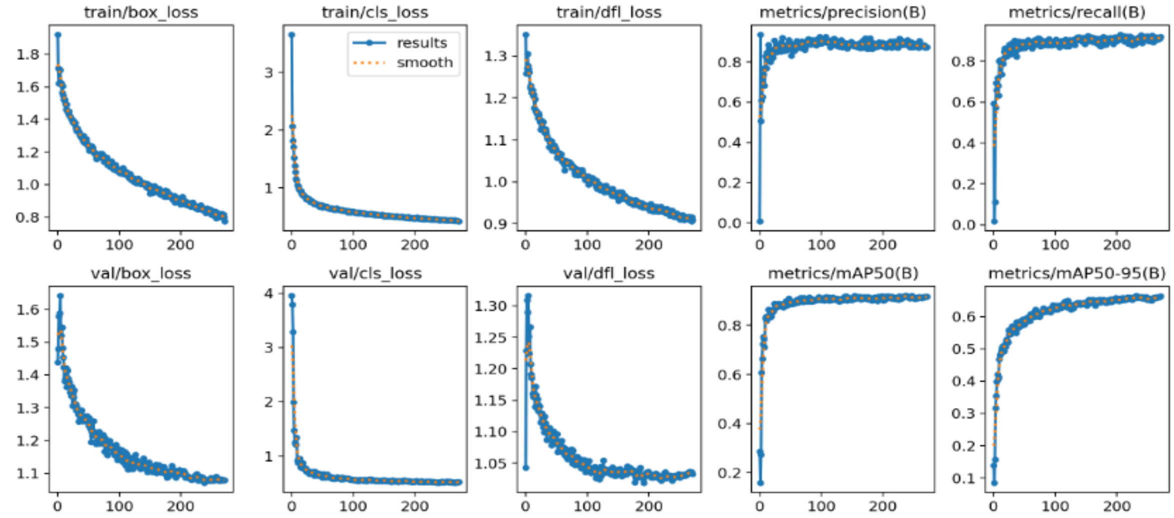


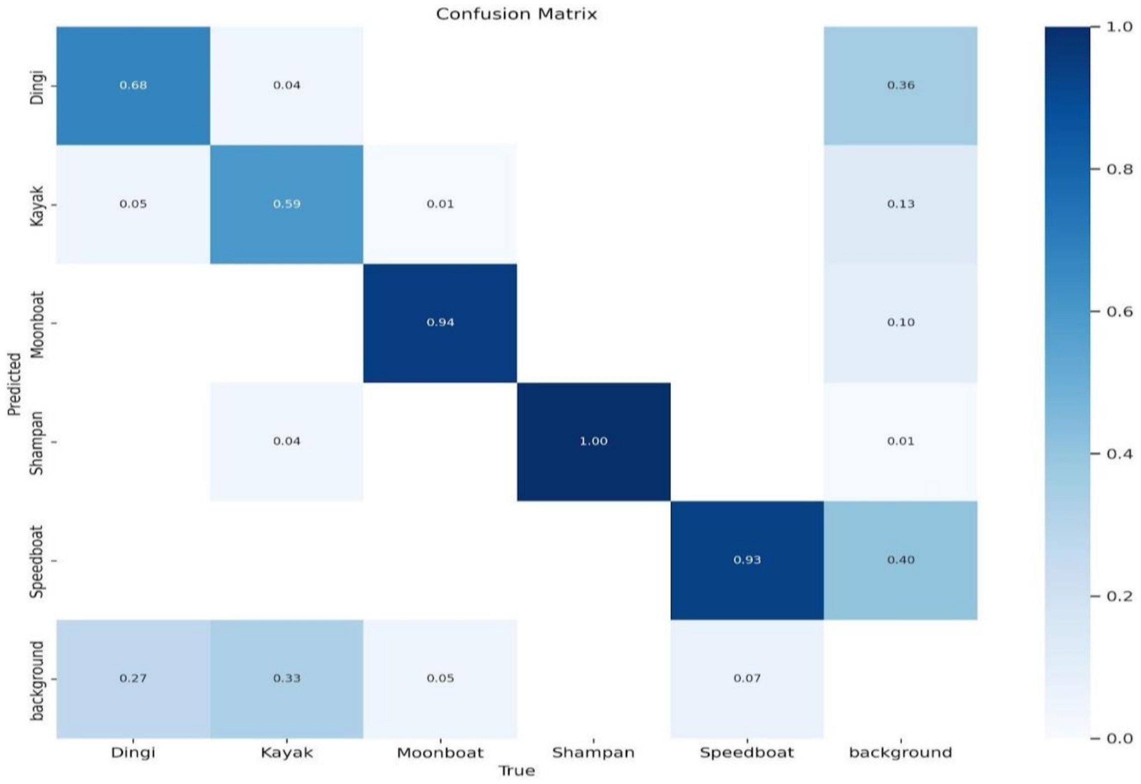
Figure: Transmitter and Receiver Circuit of the Kill Switch

In the process of making the kill switch we face several issues such as we are implementing these circuits on veroboard and facing several soldering problems as it was not that precise and the circuit was getting short circuited. To mitigate this problem we did soldering work several times and we also solved the jumper wire related issues as those seem to be quite loose.

we faced some issues in the working codes also as in the beginning we were sending the command as a letter instead of a character which did not work

4.5.6: Analyze and Interpret Data:





Predicted \ True	Dingi	Kayak	Moonboat	Shampan	Speedboat	background
Dingi	0.68	0.04				0.36
Kayak	0.05	0.59	0.01			0.13
Moonboat			0.94			0.10
Shampan		0.04		1.00		0.01
Speedboat					0.93	0.40
background	0.27	0.33	0.05		0.07	

Figure: Confusion Matrix of Boat Detection

The collection has 965 photographs that are categorized into three groups: "bigboat," "boat," and "small boat." These images were taken from Kaggle and then annotated with Roboflow to help with YOLOv5 training. The identical images were used to construct two versions of the dataset, but various preprocessing methods—such as rotations, bounding box flips, saturation and color modifications—were used. These adjustments were made to give the selected images new features. The initial version had lower performance metrics with mean Average Precision (mAP) of 8.7%, precision of 12.5%, and recall of 21.7%. Numerous factors, including subpar annotations, insufficient training data, and inefficient data augmentation methods, might be to blame for this. As a consequence, additional image data and a number of augmentation techniques were used to recreate the dataset. Subsequent evaluations of performance shown significant gains; the mAP, accuracy, F1-score, and recall increased dramatically to 91%, 92%, and 90.4%, respectively.

	Accuracy	**Recall**	**F1-score**	**Precision**
YOLO V5	0.90	0.90	0.92	0.89

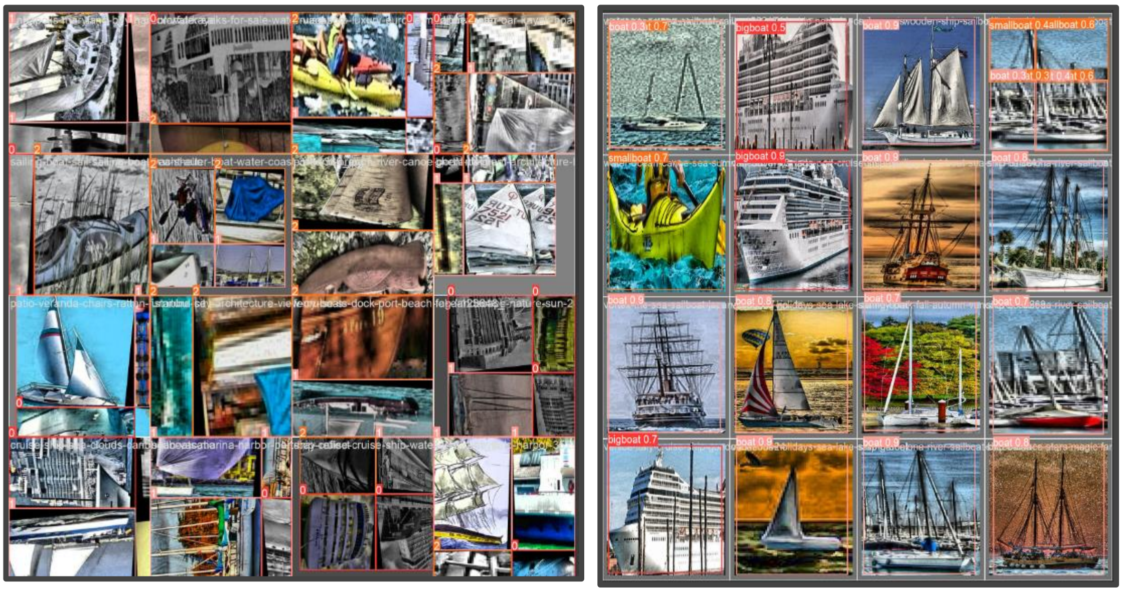


Figure: training data 1

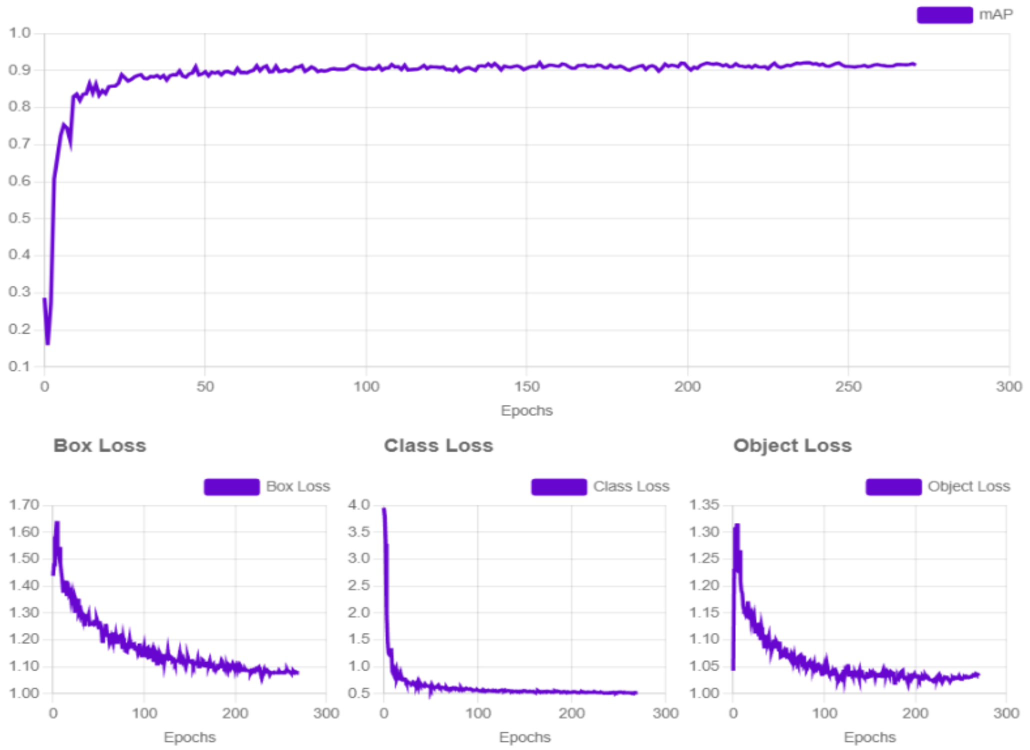


Figure: Result curves

Explanation

An unmanned aerial vehicle (UAV) surveillance camera captured the images, which were subsequently processed using an analysis model based on the YOLO architecture. Differentiating between the various boat types seen in the photographs was the goal. The findings showed an average F1-score of 0.748, indicating that the model performed better than a traditional CNN model. These findings suggest that the technology has a wide range of real-world applications.

Boat Detection Dataset

- 5 classes
- Shampan ,moonboat , dingi ,kayak ,speed boat
- number of images 2000+
- each classes contains almost 500 image data
- mAP result 91.4%
- precision 89.1%
- recall 90.8%

Future work: Even if the accuracy of the present model is very good, it can always be improved. To increase the accuracy of the model, researchers might consider methods like growing the dataset or enhancing the design. It is no longer unable to follow boats over many frames, but it can now accurately detect boats inside a single image. If the system included object tracking capability, it could track boats as they moved through various surroundings. Applications like marine surveillance require this functionality.

Despite the incredible speed of YOLOv5, real-time boat detection has many potential uses, particularly in maritime search and rescue operations. It would be beneficial to put in more effort to speed up the model or give hardware that runs on less power. Object detection is highly helpful in video surveillance systems to identify unusual activities or potential dangers, as demonstrated by YOLOv5. Its real-time detection capabilities allow for prompt responses to security issues by identifying objects or persons.

Chapter 5: Completion of Final Design and Validation. [CO8]

5.1. Introduction

The final design that has been chosen is the Hexacopter for emergency disaster response and inspecting hazardous areas in waterways is a complicated endeavor that demands both theoretical and practical analysis. As we came along the way we did our tests with diligence and found some comparable criterias when it comes to the simulated vehicle and the prototypes. here we are comparing these below:

5.2. Evaluate the solution to meet desired need

Evaluation pole	**Theoritical Concept**	**Prototype result**
Element	Local Carbon fiber	Local Fiber of glass
At a time Flight	81.50 minutes	28.5 minutes
Planning for Flight	**Complex**	**More Complex**
Opt./Max. speed	7.6 m/s	5-6 m/s
Takeoff system	**Vertical**	**Vertical**
Maneuver	Good	Better
Taking load	**4.8 kg**	**4.3 kg**
Stability	Highest	Good
Mechanical complexity	**Medium**	**Good**
Energy effective	**Good**	**Average**
Maintenance quality	**Average**	**Average**
Cost of the product	120,00 TAKA	130,800 TAKA

Range	**20.7km**	**2 km**
Emergency Malfunction Response	**NA**	**Kill SWITCH**
Object Detection Response	**89.1% accuracy**	**43% accuracy**

In our theoretical simulations we aimed for a carbon fiber body and frame for our copter which was not available in the current market so we needed to compromise our design with glass fiber. The flight time had a drastic difference as the vehicle's prototype was consuming copious amounts of power in time of maneuver, so the final flight time was up to 28.5 minutes. Some criteria were properly delivered such as vertical takeoff maximum speed, flight planning, payload capacity, mechanical complexity and maintenance ques were some of them. but the budget got higher due to some test run failure, where we had to repurchase several components such as landing gear, propellers. We also instigated safety measures and came up with the kill switch feature that provides the immediate power cut in the hexacopter and disarming the copter which also affected our budget.

5.4. Conclusion

The project has been amalgamation of several trials and errors but finally we did see substantial improvement through troubleshooting and attaching better features

Chapter 6: Impact Analysis and Project Sustainability. [CO3, CO4]

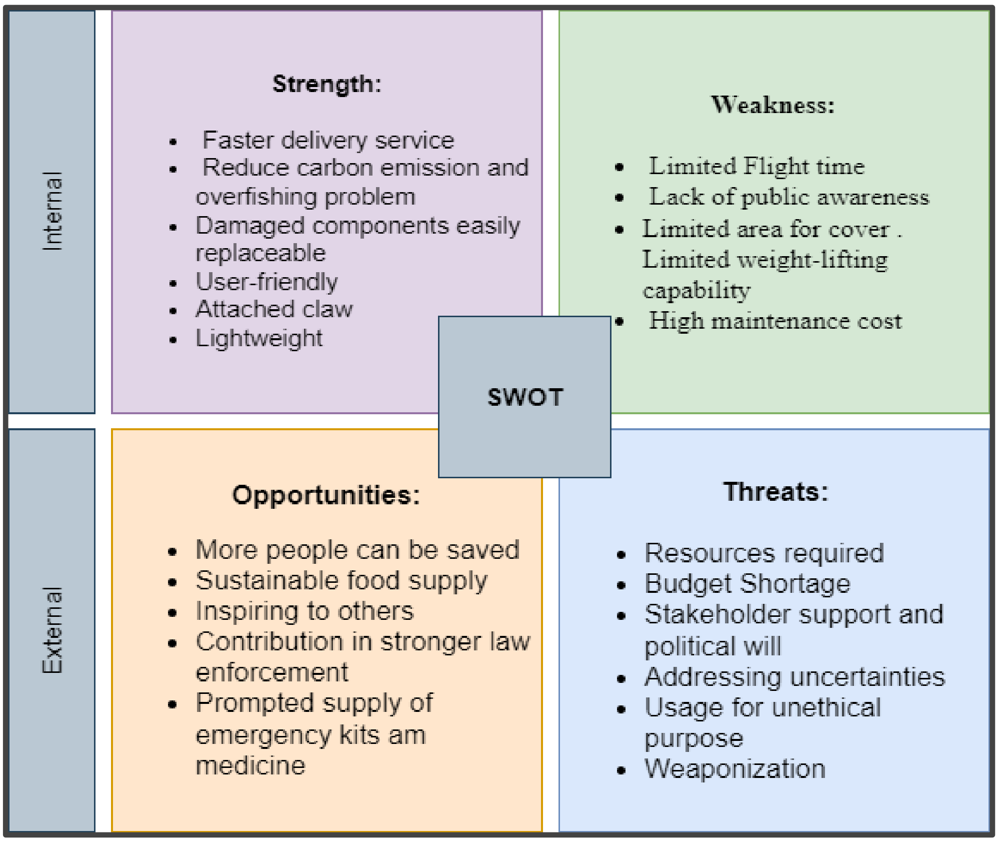
6.1. Introduction

Constructing and implementing a hexacopter as emergency disaster response assistant and the inspection of accident-stricken areas in waterways has a significant positive impact within the context of SWOT analysis.

6.2Assess the impact of solution

The construction of an unmanned aerial vehicle can be counted as a digitalized solution that capitalizes on strength, leveraging the newest technology and robotics expertise to quickly and efficiently access disaster-affected regions and enhances the capability of rapid response and aids resulting in saving lives. Additionally it showcases weaknesses by lessening human risk exposure in unsafe environments. This systemic build of the hexacopter initiates collaborative opportunities for the emergency response team, ensuring better efficiency in saving lives and property. Furthermore, collecting and providing real-time data and remote access to endangered zones enables effective disaster management. Overall, this solution offers flexibility, efficiency in disaster rescue missions that align with deliberate objectives.

6.3Evaluate the sustainability



Strength:

- Faster delivery service
- Reduce carbon emission and overfishing problem
- Damaged components easily replaceable
- User-friendly
- Attached claw
- Lightweight

Weakness:

- Limited Flight time
- Lack of public awareness
- Limited area for cover .
  Limited weight-lifting capability
- High maintenance cost

Opportunities:

- More people can be saved
- Sustainable food supply
- Inspiring to others
- Contribution in stronger law enforcement
- Prompted supply of emergency kits am medicine

Threats:

- Resources required
- Budget Shortage
- Stakeholder support and political will
- Addressing uncertainties
- Usage for unethical purpose
- Weaponization

Figure: SWOT Analysis

Strength:

This project has several clear benefits. The UAV's claw attachment is one of its most remarkable features; it enables it to pick up things quickly and precisely move them to designated locations. When compared to using standard vehicles, this strategy greatly increases delivery efficiency. There are situations when choosing UAVs over motorboats might result in lower carbon dioxide emissions. Furthermore, no potentially dangerous cargo is carried by the approved UAV, protecting both humans and the environment. By putting specific safety precautions in place, the risks involved with moving potentially dangerous objects—like explosives, caustic chemicals, biohazards, or lasers—are reduced. The assigned unmanned aerial vehicle (UAV) is employed for inspections, surveillance, and pick-and-drop tasks. It weighs less than typical equipment. It also offers a unique advantage in that, in the event of a malfunction, just that particular element has to be replaced, ensuring the UAV will continue to operate. In addition, it's easy to make sure a UAV operates smoothly and securely by adhering to flight laws and receiving the necessary training.

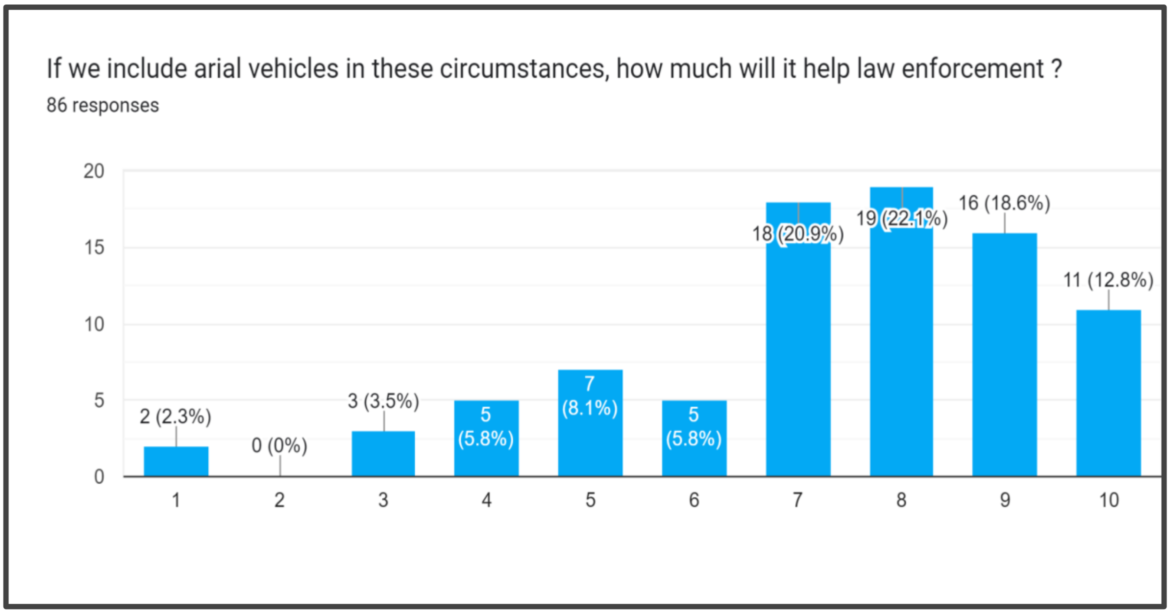


Figure: Our survey result

This study elucidates the potential benefits of implementing this approach in law enforcement. Of the 86 participants, about 54% think that applying this technology may help with the underlying problems.

Opportunities:

If factories were constructed as a consequence of this endeavor to produce cars in large quantities, Bangladesh would have additional job opportunities. This endeavor might serve as inspiration for aspirational people, particularly young ones who may be hesitant to pursue their interests and professions in this field. Additionally, it offers a significant chance to improve public safety. Unmanned aerial vehicles (UAVs) allow authorities to send supplies such as food, medication, and equipment to areas of risk more rapidly, which can help alleviate suffering and even save lives. By conducting extensive area inspections and surveillance, strict law enforcement protocols may be implemented, allowing for swift action against illicit activity. This tactic thereby encourages greater awareness in the community.

Weakness:

The project is subject to certain limitations. Initially, the thirty minutes that the UAV can fly might not be enough for every mission. It would be necessary to add weight in order to extend the flying time. Even while the UAV can carry payloads heavier than its own weight, its limited lifting capacity means that it may not be the best choice for jobs requiring the simultaneous delivery of large loads. The UAV's operating scope is further constrained by its short flight time and strict adherence to specific geographical coordinates, which may make it inappropriate for some activities. Furthermore, the general public's ignorance of UAVs may provide challenges and complicate operations, raising the possibility of avoidable issues.

Threats:

Due to the project's complexity, having enough resources on hand is crucial. The goal is to cross rivers, which is hazardous by nature, and the instruments are not very strong. This project is privately funded, therefore any harm to any of its constituent parts would make it extremely difficult to recoup its losses. Stakeholder involvement and political channels are essential for overcoming regulatory barriers. Securing a national permission is necessary for UAV operations. Since the vehicle is meant to be used over rivers, weather instability is a big concern. Since the development's live video recording camera may capture human activities, which elevates the risk of technology being exploited, privacy issues are also raised by this feature.

Chapter 7: Engineering Project Management. [CO11, CO14]

7.1 Introduction

Engineering project management is a fundamental part of this project that ensures effectiveness of the planning, resource allocation, risk dealing and timely execution of the individual tasks

7.2 Define, plan and manage engineering project

7.2.1 Work Plan and Distribution:

Project Plan of FYDP- P

Work management	Delegated to	Starts	Ends	Status
Theme Selection for FYDP	Ahad, Haque,Shams,Rahman	September 24, 2022	September 30, 2022	Done
Theme Selection for FYDP	Ahad, Haque,Shams,Rahman	September 30, 2022	October 2, 2022	Done
Theme Selection for FYDP	Ahad, Haque,Shams,Rahman	October 4, 2022	October 10, 2022	Done
Design approach discussion	Ahad, Haque,Shams,Rahman	October 10, 2022	October 17, 2022	Done
Requirements and Objectves discuss	Shams	October 17, 2022	October 24, 2022	Done
Concept note Final	Ahad, Haque,Shams,Rahman	October 24, 2022	November 5 24, 2022	Done
Prepare Slide 1	Ahad, Haque,Shams,Rahman	November 7 , 2022	November 17, 2022	Done
Progress Presentation ready	Ahad, Haque,Shams,Rahman	November 17, 2022	November 19, 2022	Done
Make layout for final proposal	Haque	November 19, 2022	November 20, 2022	Done
Methodology discussion	Ahad	November 20, 2022	November 20, 2022	Done

Code and Impact analysing	Ahad, Haque,Shams,Rahman	November 20, 2022	November 23, 2022	Done
Prepare Budget	Shams	November 23, 2022	November 24, 2022	Done
Slide ready	Ahad, Haque,Shams,Rahman	November 24, 2022	November 27, 2022	Done
SWOT Analysis ready	Ahad, Haque,Shams,Rahman	November 28, 2022	December 3, 2022	Done
Final Presentation preparation	Ahad, Haque,Shams,Rahman	December 7, 2022	December 24, 2022	Done
Finalizing Project Proposal to submit	Ahad, Haque,Shams,Rahman	December 8, 2022	December 24, 2022	Done

Project Plan of FYDP- D

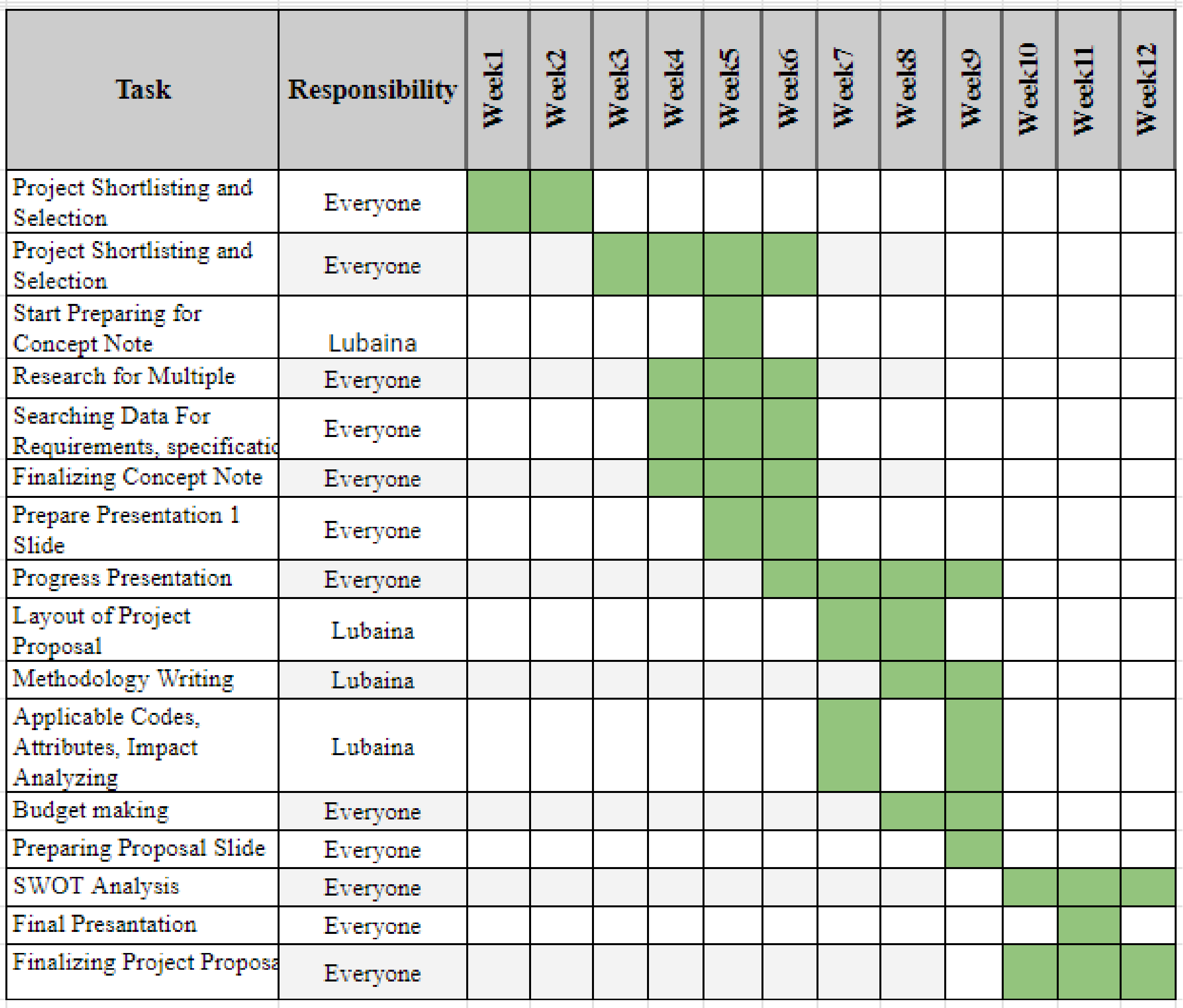
Work management	**Delegated to**	**Starts**	**Ends**	**Status**
Design planning	Ahad, Haque,Shams,Rahman	January 15,2023	January 20,2023	Done
Preparing 3D models	Lubaina Haque Lamim	January 20,2023	January 25,2023	Done
Design Finalizing	Ahad, Haque,Shams,Rahman	January 25 ,2023	February15,2023	Done
Calculations for Each Design	Ahad, Haque,Shams	February15,2023	February 22, 2023	Done
Cfd Simulation for each Design	Shams	February25 ,2023	February 26 ,2023	Done
mock progress presentation	Ahad, Haque,Shams,Rahman	February26 ,2023	February27 ,2023	Done
Prepare Presentation 1 Slide	Ahad, Haque,Shams,Rahman	February 28 ,2023	March 2 2 ,2023	Done
Progress Presentation	Ahad, Haque,Shams,Rahman	March 2 ,2023	March 7 ,2023	Done
Optimum Solution	Haque	March 11 ,2023	March 18 ,2023	Done
Working on Ros	Ahad	March 18 ,2023	March 25 ,2023	Done
Preparing Report	Ahad, Haque,Shams,Rahman	March 25 ,2023	March 30 , 2023	Done
Budget making	Shams	April 1 ,2023	April 6 ,2023	Done
Preparing Final Slide	Ahad, Haque,Shams,Rahman	April 7 ,2023	April 12 ,2023	Done
Mock presentation	Ahad, Haque,Shams,Rahman	April 15,2023	April 18 ,2023	Done
Final Presentation	Ahad, Haque,Shams,Rahman	April 15,2023	May 1, 2023	Done
Finalizing Project Proposal	Ahad, Haque,Shams,Rahman	May 5 ,2023	May 15,2023	Done

Project Plan of FYDP C

Work management	Delegated to	Starts	Ends	Status
Data set management	Ahad, Haque,Shams,Rahman	June 1, 2023	June 6, 2023	Done
Model training of dataset	Haque	June 6, 2023	June 15, 2023	Done
Component management	Ahad, Haque,Shams,Rahman	June 15, 2023	June 20, 2023	Done
Prototype making	Ahad	June 21, 2023	June25, 2023	Done
Flight permission taking	Shams	June 28, 2023	June 30, 2023	Done
Data Gathering	Ahad, Haque,Shams,Rahman	July 3, 2023	July 5, 2023	Done
Progress Presentation ready	Ahad, Haque,Shams,Rahman	July 7, 2023	July 14, 2023	Done
Test flight of our system	Ahad, Haque,Shams,Rahman	July 15, 2023	July 28, 2023	Done
Accuracy Documentation	Haque	July 28, 2023	July 29, 2023	Done
Report preparing	Ahad	July 30, 2023	August 5, 2023	Done
Data Finalizing	Ahad, Haque,Shams	August 5, 2023	August 16 , 2023	Done
Final slide making	Shams	August 20, 2023	August 23, 2023	Done
Practice Presentation	Ahad, Haque,Shams,Rahman	August 23, 2023	August 25, 2023	Done
Final Presentation	Ahad, Haque,Shams,Rahman	August 25, 2023	September 7, 2023	Done
Report Finalization	Ahad, Haque,Shams,Rahman	September 7, 2023	September 15, 2023	Done

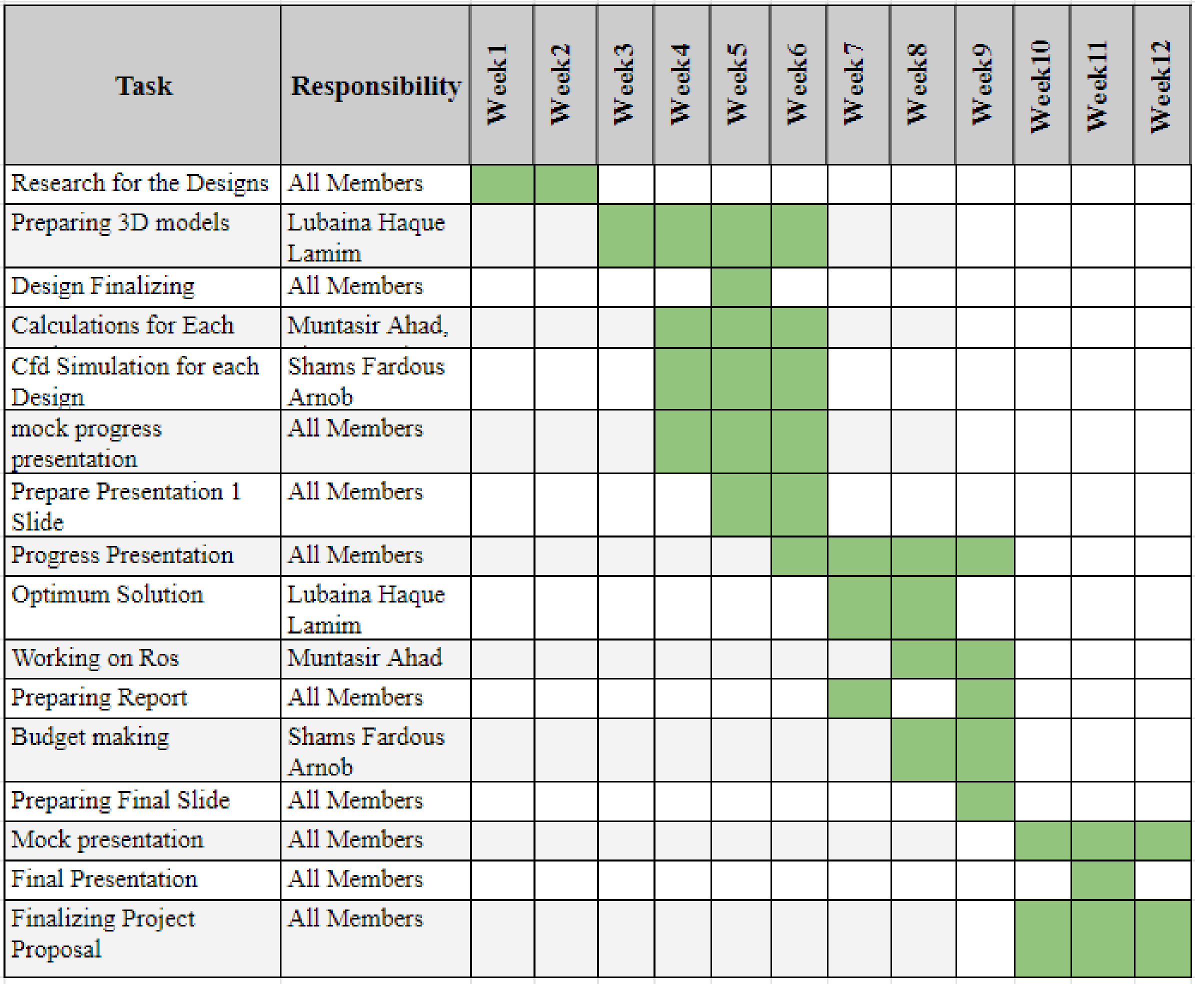
7.2.2 Evaluate project progress

FYDP P

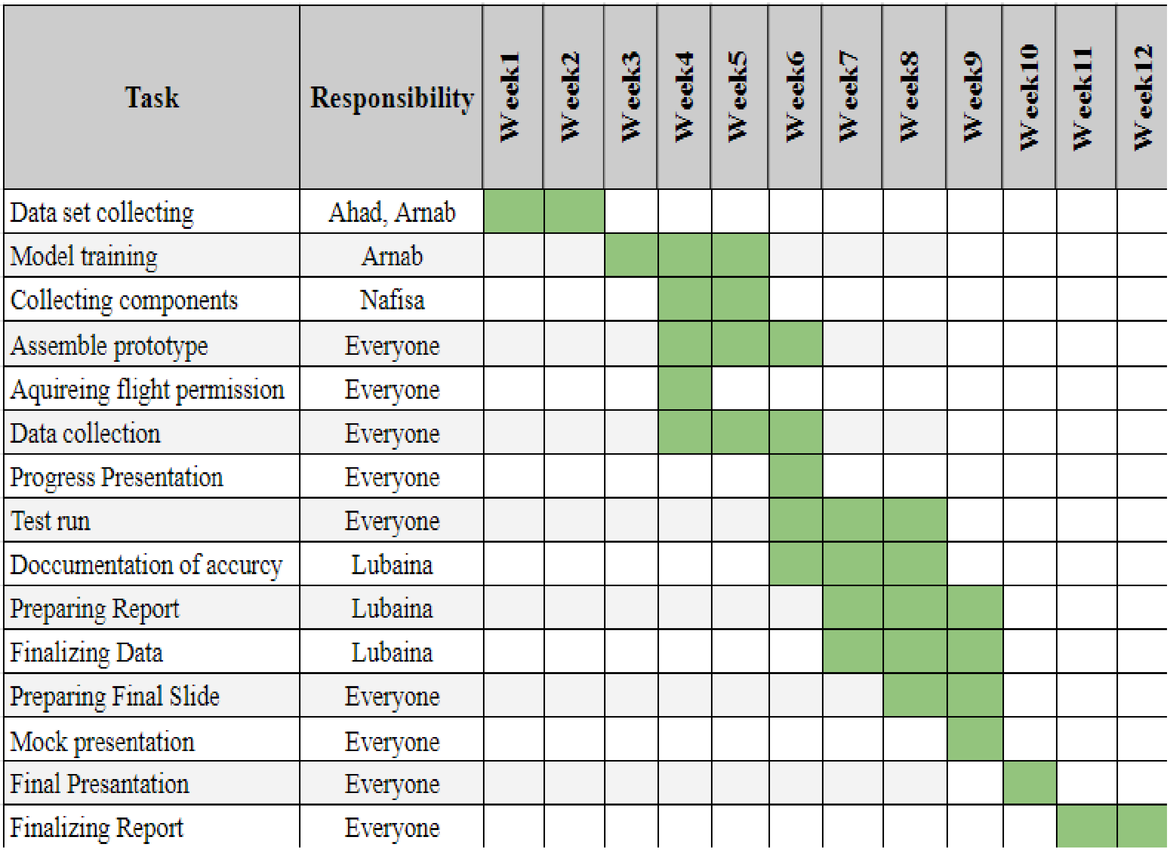


Task	Responsibility	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8	Week9	Week10	Week11	Week12
Project Shortlisting and Selection	Everyone	🟩	🟩										
Project Shortlisting and Selection	Everyone			🟩	🟩	🟩	🟩						
Start Preparing for Concept Note	Lubaina					🟩							
Research for Multiple	Everyone				🟩	🟩	🟩						
Searching Data For Requirements, specificatio	Everyone				🟩	🟩	🟩						
Finalizing Concept Note	Everyone				🟩	🟩	🟩						
Prepare Presentation 1 Slide	Everyone					🟩	🟩						
Progress Presentation	Everyone						🟩	🟩	🟩	🟩			
Layout of Project Proposal	Lubaina							🟩	🟩				
Methodology Writing	Lubaina								🟩	🟩			
Applicable Codes, Attributes, Impact Analyzing	Lubaina							🟩		🟩			
Budget making	Everyone								🟩	🟩			
Preparing Proposal Slide	Everyone									🟩			
SWOT Analysis	Everyone										🟩	🟩	🟩
Final Presantation	Everyone											🟩	
Finalizing Project Proposa	Everyone										🟩	🟩	🟩

FYDP D



Task	Responsibility	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8	Week9	Week10	Week11	Week12
Research for the Designs	All Members	🟩	🟩										
Preparing 3D models	Lubaina Haque Lamim			🟩	🟩	🟩	🟩						
Design Finalizing	All Members					🟩							
Calculations for Each	Muntasir Ahad,				🟩	🟩	🟩						
Cfd Simulation for each Design	Shams Fardous Arnob				🟩	🟩	🟩						
mock progress presentation	All Members				🟩	🟩	🟩						
Prepare Presentation 1 Slide	All Members					🟩	🟩						
Progress Presentation	All Members						🟩	🟩	🟩	🟩			
Optimum Solution	Lubaina Haque Lamim							🟩	🟩				
Working on Ros	Muntasir Ahad								🟩	🟩			
Preparing Report	All Members							🟩		🟩			
Budget making	Shams Fardous Arnob								🟩	🟩			
Preparing Final Slide	All Members									🟩			
Mock presentation	All Members										🟩	🟩	🟩
Final Presentation	All Members											🟩	
Finalizing Project Proposal	All Members										🟩	🟩	🟩



Task	Responsibility	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8	Week9	Week10	Week11	Week12
Data set collecting	Ahad, Arnab	🟩	🟩										
Model training	Arnab			🟩	🟩	🟩							
Collecting components	Nafisa				🟩	🟩							
Assemble prototype	Everyone				🟩	🟩	🟩						
Aquireing flight permission	Everyone				🟩								
Data collection	Everyone				🟩	🟩	🟩						
Progress Presentation	Everyone						🟩						
Test run	Everyone						🟩	🟩	🟩				
Doccumentation of accurcy	Lubaina						🟩	🟩	🟩				
Preparing Report	Lubaina							🟩	🟩	🟩			
Finalizing Data	Lubaina							🟩	🟩	🟩			
Preparing Final Slide	Everyone								🟩	🟩			
Mock presentation	Everyone									🟩			
Final Presantation	Everyone										🟩		
Finalizing Report	Everyone											🟩	🟩

Chapter 8: Economical Analysis. [CO12]

8.1 Introduction

Economical analysis plays a vital role as it evaluates the financial feasibility and cost-effectiveness of this project and helps determine the benefits like, if it is actually improving the disaster response or not, does it has the potentiality to save lives or not, exceeds the investment and operation costs.

8.2 Economic analysis

We have done a detailed budget analysis for our project where all of the components are listed with appropriate links where we have bought the components from. This is listed here to showcase our component based costs

8.2.1 Budget for Hexacopter:

Component list	Requirement	Price
4s lipo 50C	2	6000x2=12000 tk
270kv BLDC	6	4500x6=27000 tk
12×60 Carbon Fiber Propellers	10	1997x10=19970 tk
E80A ESC	6	3190x6=19140 tk
Carbon Sheet 500mm	1	4600 tk
Tube 14*16 mm	5	1400x5=7000 tk
Jetson Nano 4GB RAM 16G eMMC	1	42000 tk
Pixhawk pX4.2	1	12000 tk
433 mhz module	2	1200x3=3600 tk
CaddxFPV Turbo Micro FPV Camera	2	1800x2=3600 tk
FOXEER Pagoda 5.8	2	830x2=1660 tk
Radiolink GPS SE100 With GPS Stand Holder	1	3700 tk
FPV Drone Goggles	1	4300 tk
Radiolink R12DS 12 Channels Receiver	1	2300 tk
RadioKing TX18S/2.4G 16CH	1	15500 tk
Claw	1	3000 tk
Arduino Uno R3	2	1100x2=2200 tk
		127,000 TAKA

8.3 Cost benefit analysis

The cost of benefit is pretty significant in this. In the current way of disaster management coastal guards use speed boats and per midsize speed boat uses 5 gallons or petrol per hour which in this economical state costs 500 taka per hour. As rescuing jobs are tedious and time consuming, fuel price is a huge lead back for such missions. With the help of the UAV this can be done without any fuel cost as the vehicle is battery driven.

On the other hand, it will be controlled autonomous so it is cost efficient from the point of manual labor.

Chapter 9: Ethics and Professional Responsibilities CO13, CO2

9.1 Ethical Consideration (CO13)

- It was imperative that every member of the team follow the tight guidelines about plagiarism and make sure that all of the factual sources we used for our study were properly attributed. As we stated in our report, we adhered exactly to the guidelines issued by the Bangladesh Aviation Committee.
- An operator of an unmanned aerial vehicle (UAV) must be at least eighteen years old.Using a UAV negligently or recklessly in a way that puts persons or property in danger is strictly prohibited.
- Liability insurance coverage is required for any UAV operations in order to minimize any risks to the public's safety or property damage.
- The unmanned aerial vehicle (UAV) operator is not allowed to fly the aircraft for eight hours following an alcohol consumption, when impaired by alcohol, or while under the influence of any drug that might impair judgment and compromise operational safety.
- Before beginning any activity, all parties involved must become acquainted with pertinent aeronautical facts on the planned flight.
- Payloads that involve hazardous materials (such as explosives, corrosives, biohazards, or powerful light sources like lasers) or those have the potential to be discharged or dispersed should be avoided.
- A single UAV may only be utilized in tandem with another.
- Automated UAVs cannot be totally automated. Systems must allow pilot engagement in the case of unexpected flying behavior or technical problems, ensuring that pilots may always overrule pre-programmed processes.
- When using a UAV, the pilot or operator will have enough time to deal with any unanticipated situations that can occur, such a grass fire or harm to people on the ground.
- Access to all emergency and operational equipment, such as portable fire extinguishers that can put out small fires and checklists or signs that make it easier to abide by the manufacturer's operating restrictions, is guaranteed for the person operating the UAV.
- Bangladesh requires that permission from the air traffic control authorities be obtained before any movements be made in order to operate UAVs.
- The pilot in charge of operations must always have direct and active control over the UAVs.
- The UAV's pilot needs to direct it appropriately.
- Pilots are not allowed to operate a UAV's controls if there is any reason to believe that their use of devices that reveal weariness or possible fatigue, or if they display any other incapacitating condition that prevents them from carrying out their duties.

- In Bangladesh, there is a 200-foot maximum authorized height limit for UAV operations above ground level, and UAVs are not allowed to fly higher than 400 feet.
- In compliance with the conditions and limitations of airspace regulations, unmanned aerial vehicles (UAVs) are prohibited from flying over military installations, areas reserved for emergency response operations, locations of athletic events, national parks, sports arenas, sensitive government compounds (Prime Minister's Residence/Office, Secretariat, etc.), and other designated protected zones unless they have first received authorization.
- Operating a UAV inside a ten nautical mile radius of an air force base requires permission from an aerodrome administrator.

9.2 Following IEEE codes and standards -

1.IEEE SA - IEEE 1936.1-2021

This provides a framework for the utilization of unmanned aerial vehicle (UAV) applications. It covers a number of topics, such as the flight management system, controlled connection, cargo conveyed, flying apparatus, and terrestrial command center. Protocols for data classification, gathering, processing, logging, and review are also outlined, as is data formatting for documentation.

2.IEEE SA - IEEE 1118.1-1990

This is a protocol that is meant to be used in instrumentation, control devices, decentralized data gathering systems, and evaluation and measurement equipment. In addition to general-purpose communication services, system administration, network connectivity, and several physical media for transmission, it offers principles for a common framework.

3.IEEE SA - IEEE 1939.1-2021

A low-altitude airspace organizational structure for efficient UAV traffic management is described in this standard. It uses five key components to explain the structural structure of low-altitude airspace, with a focus on UAV routes: grid technology, remote sensing data, communication and networking systems, route planning techniques, and operation and management protocols.

4. IEEE SA - P1937.7

A standard for using polarimetric remote sensing techniques with unmanned aerial vehicles (UAVs) for Earth observation is outlined in IEEE SA - P1937.7.

5.IEEE SA - IEEE 1754-1994

A 32-bit microprocessor's architecture is outlined in IEEE SA - IEEE 1754-1994 and is accessible to a broad range of producers and consumers. Data types, register models, instruction op-codes, instruction set, and coprocessor interface are all defined in it.

6.IEEE SA - IEEE 1937.1-2020

This standard describes the specifications for the external power connections of Unmanned Aerial Vehicles (UAVs). It describes the fundamental features and attributes of payload devices used in unmanned aerial vehicles. Drone payload interfaces are made up of many classes of digital, electrical, and mechanical components. The mechanical interface facilitates the attachment of the drone's payload, while the electrical interface has an electromechanical mechanism for electrical connections. Without the power supply interface and bidirectional communication interfaces, the electrical interface is incomplete. The term "data interface" describes the communication protocol that is used. The standard also addresses the specifications and performance characteristics for the drone payload interface's protection against extreme weather, high humidity, water, dust, stress and vibration, mildew, and salt spray.

- The camera must be used with caution and only in approved locations when collecting data, making sure that no one's privacy is abused. The use of unmanned aerial vehicles (UAVs) for aerial surveillance activities such as picture or live streaming over residential areas may jeopardize people's privacy. However, there are more security concerns related to UAVs than just privacy concerns in houses; these concerns include the possibility of UAV hacking or its use as leverage to compromise other technological systems.
- Complete adherence to any further guidelines issued by the Federal Aviation Administration (FAA).
- Acquiring UAV insurance coverage.
- The obtained data will be given to the designated users or the competent authorities in the industry. There will be strict safety standards in place.
- Car designs will take conscience into consideration, especially when it comes to electrical wire connections made while traveling near bodies of water.
- Should an ethical discussion be necessary, the Ethical Consideration Committee will be consulted.
- Neutrality, equity, and honesty will be upheld; designs will take into account the moral obligations of mankind.

- The privacy of captured photos or videos must be maintained. Users will have the option to update as necessary and will be informed of any technical advancements.

Chapter 10: Conclusion and Future Work.

10.1 Project summary/Conclusion

In keeping with the Smart Bangladesh Vision 2041, this article describes our attempts to investigate three distinct approaches to our specific issue and improve the effectiveness of coastal areas' distribution and monitoring systems. We suggested three different design techniques, each including the construction of circuits, extensive computations, and simulations utilizing Blender, Solidwork, and ROS, to address the aforementioned difficulties. We also carefully planned our budget and reviewed all of the information we had obtained from simulations and computations. After examining three different design approaches—fixed wing aircraft, hybrid system aircraft, and hexacopter—we ultimately chose to proceed with the third one, utilizing a hexacopter equipped with a two-degree-of-freedom mechanical gripper. After giving our third idea some thought, we have decided to proceed with building a prototype as it seems like the most workable solution. After that, we tested the prototype and fixed any problems that arose while it was in use. Our decision-making has been driven by sustainable principles, careful risk management, and ethical considerations throughout the whole process. We immediately began discussing possible markets for our technology with "TILLER," a company well-known for its proficiency in mapping and coastal monitoring.

10.2 Future work

In this paper, through the analytical comparison, a hexacopter is proposed to use in surveillance, inspection, and delivery kits in emergency situations. In the future, more research can be done on this prospect, especially in ROS simulation based on rainy and speedy air conditions and also hardware-level analysis can be done. Power consumption limitations and flight time limitations are major issues in aerial vehicles. We analyzed the vehicles only in simu- lations. The vehicle can be implemented in hardware as well for doing real-life operations and research. The 3DR telemetry module can be used for the communication system as it has a greater communication range. Because of its being a high-level system architecture PX4 as well as the GPS module will be used for autonomous navigation. The high-performance processing unit is an integrated part of this system. For controlling and monitoring the UAV, an RF module will also be used.

Chapter 11: Identification of Complex Engineering Problems and Activities.

11.1: Identify the attribute of complex engineering problem (EP)

	Attributes	**Put tick (√) as appropriate**
P1	Depth of knowledge required	(√)
P2	Range of conflicting requirements	(√)
P3	Depth of analysis required	(√)
P4	Familiarity of issues	(√)
P5	Extent of applicable codes	(√)
P6	Extent of stakeholder involvement and needs	(√)
P7	Interdependence	(√)

11.2: Provide reasoning how the project address selected attribute (EP)

P1.The Depth of knowledge required to built the system :

- We used STEM knowledge to successfully done this project.
- Not only bookish knowledge, we used a deep understanding of mechanical , electrical and software knowledge while making the kill switch, claw system as well as the whole system.

P2. The actual range of conflicting requirements of this project:

There were some conflicting requirements in this project:

1. Time frame of fly: Our UAV has maximum 30 minute fly time. The conflict arries, when we neet at least 35 minutes flytime. Anyway, when when we will make the system for industry we will expand the time for fly by battery management system.
2. License for drone flight: The government rule is we can not fly a drove, if the drone is over 5 kg. But our drone was nearly 5 kg with weight. Thats why we took permission from the police station.

3. Excess Budget-
   - Some components were very expensive for our project
   - There was a conflict with the bidget, but it was managed by our own fund.
4. There were some restrictions in the city for drone flighting.
5. Keeping a maximum hight and time was defficut for our system..

P3. Depth of analysis required:

- We need a deep analysis for algorithm for detectionand autonomous navigation systems.
- We also analised about the social and economical impact of our system
- We needed to analysis the structural concept of the system as there was claw and kill switch automation system.

P4. Familiarity of issues:

- We are working to solve the issues of costal areas. Which is not directly a issue of electrical engineering department. But it was a common issue in the field that needed to be solved for smart rescue operations.

P5. Extent of applicable codes:

We have to follow some IEEE codes. for example -

- Obtain lisense from the civil aviation.
- Maintained the restrictions and commands by authority.

P6. Extent of stakeholder involvement and needs:

Our Target audience was Coast guard, defence military, Brac University and some government companies. Also, government company was interested to collaborate with our work.

P7. Interdependence:

The UAV's operating system and parts are interrelated.

- Like, microcontrollers was interdependente with pixhaw 2.4.8.
- The size of propeller was dependable upon the motors.
- Autonomous navigation is dependent on the required latitude and longitudede.

11.3 Identify the attribute of complex engineering activities (EA)

	Attributes	**Put tick (√) as appropriate**
A1	Range of resource	**(√)**
A2	Level of interaction	**(√)**
A3	Innovation	
A4	Consequences for society and the environment	**(√)**
A5	Familiarity	**(√)**

11.4 Provide reasoning how the project address selected attribute (EA)

A1. Range of resources:

To effectively implement our system

- A huge number deta was requires for detection.
- We ordered the motors and 16 channel radio controllers from India, as specific resources was not available in our country
- Not only the local devices, We used high configured processor named Jetson Nano.

A2. Level of interaction:

For this research we did regular meetings with our respected ATC panel members. Also we communicated with the engineers of Tiger It company who made aerial vehicles. Also we taled with a government aerial mapping company for collaboration. Our unofficial mentor was Jahid Uddin, Nimbus Lab, Nebraska Lincoln, USA.

A3. Innovation:

Our project is not presenting any brand new innovation. However, we have done the detection part by our own made dataset.

A4. The effect of our system on society and environment:

Depploying our system-,

- We can save the lives while accidents in water ways and contribute to rescue mission.
- We can pay to the law enforcement by servellence in the river during fish thefting season..
- Our UAV does not have any dangerous component. The UAV can save cost, fuel and time during any survaillence and inspection as well as it can emit greenhouse gan effect.

A5. Familiarity:

We addressing to solve some issues related to watedways, for example:

- Emergency aid delivery
- Survaillence axccidentsal areas and inspection after illigal actions..
  The problem that we planned to solve is a complex engineering problem and it is uncharted territory for our field.

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Appendix:

- **“PX4 User Guide,” docs.px4.io. https://docs.px4.io/main/en/**

- **Rossimulation:https://drive.google.com/drive/folders/11hv7aCew40BPpEsRu1tqKujGOPHS0Vhd?usp=share_link.**
- **Blender:https://drive.google.com/drive/folders/1CfL125nyQGNdJgnV3IoISO3emV80J2XQ?usp=share_link**

- **CFDSimulation:https://drive.google.com/drive/folders/1CfL125nyQGNdJgnV3IoISO3emV80J2XQ?usp=share_link.**
- **https://drive.google.com/drive/folders/1m47sM-_L9mldqvA7HSbVNGx9EJtFTTm0?usp=sharing**

FYDP-C (Summer 2023)				
Student List	**NAME**	**ID**	**EMAIL**	**Contact**
Student 1	Muntasir Ahad,	19321012	muntasir.ahad.sc@gmail.com	01718971496
Student 2	Lubaina Haque Lamim	19321014	lubainahaq90909@gmail.com	01787683888
Student 3	Nafisa Rahman Shamonti	19321016	nafisashamonti@gmail.com	01712334575
Student 4	Shams Fardous Arnab	19321030	shamsfardousarnab@gmail.com	01850106070

ATC Panel:	**Name**	**Email**
ATC Chair	Prof. Abu Hamed M. Abdur Rahim, PhD	a.hamid@bracu.ac.bd
ATC Member	Tasfin Mahmud	tasfin.mahmud@bracu.ac.bd
ATC Member	Md. Mehedi Hasan Shawon	mehedi.shawon@bracu.ac.bd

Logbook

Status	Students	Work Summary
June 15, 2023	**Students:** Ahad, Haque, Rahman, Shams	1. Introduction of FYDP_C 2.Discussed deadlines and timeline for EEE 400C 3. Explained report template 4. Discussed about two presentations of this semester 5. Explained the background research
July 20, 2023	**Students:** Ahad, Haque, Rahman, Shams	1. Discussed the process of preparing logbook 2. Instructed to update Gantt chart 3. Explained the process of preparing report & instructed to start preparing draft report
July 22, 2023	**Students:** Ahad, Haque, Rahman, Shams	Divided responsibility of preparing draft report Task 1: Project Title Task 2: Objective Task 3: Requirement Task 4: Constraints Task 5: Multiple Design Approaches

July 8, 2023	**Speaker:** Prof. Abu Hamed M. Abdur Rahim, PhD,Md. Mehedi Hasan Shawon **Students:** Haque, Shams, Rahman	1. Software discription 2. Budget proposal 3. Progress demonstration
July 20,2023	**Students:** Ahad, Haque, Rahman, Shams	Work: Simulation Start Work: Background research start Work: Discussion of optimum design Work: Risk management plan Work: Requirement modification

July 5, 2023 (Meeting: 3)	**Dedicated:** Ahad, shams, Haque, Rahman	1. Design approach discussion 2. Work progress discussion 3. Constraints changes
July 18, 2023 (Meeting: 3)	**Students:** Ahad, shams, Haque, Rahman	1. Discussion on the process on the way we going to train dataset 2. Discussion on progress presentation 3. Discussion about simulation done so far.
July 29, 2023 (Meeting: 3)	**Students:** Ahad, shams, Haque, Rahman	1. Preparing slide for progress presentation

Slide making		Progress presentation ready	
March 12, 2023 (Meeting)	**Students:** Ahad, shams, Haque, Rahman	Making Desision	Ahad, shams, Haque, Rahman
March 16, 2023 (Meeting)	**Students:** Shams, Haque, Rahman	1. Discuss UAV simulation 2. Making plan Table	Work1: Shams, Work 2: Haque **Work Update:** Work 1: Partially completed Work 2: Completed
March 16, 2023 (Meeting)	**Students:** Shams, Haque, Rahman	1. Hexacopter simulation display. 2. Training Dataset display.. 3. Discussion about feedback from ATC Panel,. 4. Discussion about presentation.	Ahad, shams, Haque, Rahman
March 16, 2023 (Group)	**Students:** Shams, Haque, Rahman	CFD simulation of three design approaches.	Shams and Haque
March 18, 2023	**Students:** Shams, Haque, Rahman	Robot Operating System simulation	Done by Shams

March 31, 2023	**Students:** Shams, Haque, Rahman	Result Operation	Done by Ahad Shams, Haque, Rahman
April 16, 2023	**Students:** Ahad Shams, Haque, Rahman	Final Pres Preparation	Done by Ahad Shams, Haque, Rahman

Related code/theory:

1) https://drive.google.com/drive/folders/1m47sM-_L9mldqvA7HSbVNGx9EJtFTTm0?usp=sharing.