EEET2610 – ENGINEERING DESIGN 3

Project Proposal

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1. Abstract

Drones and quadcopters represent flexible unmanned aerial vehicles (UAVs), finding applications in diverse fields such as delivery, agriculture, and military operations. These innovative devices are poised to revolutionize various aspects of our daily lives. Despite their widespread use, fundamental elements of drone design, including motor efficiency, power consumption, and control system balancing, continue to be improved.

This paper concentrates on investigating the design of the drone and remote controller, as well as testing the control system and power utilization of the driving unit and sensor. The specific emphasis is on developing accurate and minimally disruptive controls for the quadcopter. The project, spanning a duration of 12 weeks, aims to establish a standardized procedure for testing all components, such as ESC, IMU, GPS, and so on, while concurrently designing and controlling the drone and the remote controller. The objective is to integrate all the components to accomplish the final drone.

The research seeks to contribute to the improvement of drone technology by addressing key difficulties in motor efficiency and control system precision, opening the way for enhanced performance and reliability.

2. Introduction

In the realm of unmanned aerial vehicles, the quadcopter stands as an outstanding and adaptable innovation and revolutionizing a variety of industries. A quadcopter, short for quadrotor helicopter, uses four motors to fly, which power each propeller individually and offer incredible stability and agility in flight [1].

Quadcopter applications are diverse, such as aerial recognition, search and rescue, and industrial missions among others [2]. For example, General Atomics manufactured the Predator and Reaper drones, utilized by the US Air Force for reconnaissance and combat operations across multiple countries [3].

Figure 1: The General Atomic MQ-9 Reaper in flight

Figure 2: The General Atomic MQ-1 Predator in flight

The above pictures show the General Atomic MQ-9 Reaper and the General Atomic MQ-1 Predator. They are pivotal advancements in unmanned aerial vehicles, each designed to fulfil distinct military requirements [4]. Designed to perform both attack and surveillance missions, the MQ-9 Reaper has a greater payload capacity, and longer endurance of up to 27 hours, and the ability to carry several sensors and weapons simultaneously. The Reaper offers enhanced operational flexibility thanks to the increased speed, altitude, and sophisticated satellite. However, one of the first unmanned aerial vehicles, the MQ-1 has a decent endurance of more than 20 hours and is equipped for both surveillance and reconnaissance. Even having a lower payload capacity than the Reaper, the MQ-1 remains a formidable force armed with precision-guided weapons.

Figure 3: XAG's drone in flight

More specific use of UAVs involves agricultural monitoring, exemplified by XAG Australia, a company that has designed various aerial vehicle configurations to map different types of plantations [5]. The above picture illustrates the XAG's drone in flight. This drone features a spraying system that allows users to target treatment regions quickly. The benefit of using XAG's service and drone platform is that it can operate in complicated conditions that traditional ground-based or aerial spraying cannot approach, ensuring the safety and productivity of the users in time of need. By using targeted spraying, it can keep customers safely out of harm's path while using fewer chemicals and water.

2.1. Literature Review

According to [6], the essential components of a drone encompass a power source, such as a battery or fuel, along with rotors, propellers, and a frame. To enhance manoeuvrability and minimize weight, drone frames typically utilize lightweight composite materials. Additionally, a controller is necessary for operating the drone, allowing the operator to launch, navigate, and land the aircraft via the remote controls. These controllers often use radio waves, like Wi-Fi, to connect to the drone.

The classification of drones based on the number of propellers has resulted in distinct categories, including Bicopters (2 propellers), Tricopters (3 propellers), Quadcopters (4 propellers), Hexacopters (6 propellers), Octacopters (8 propellers), or Coaxials which feature 2 motors and 2 propellers that are mounted one above the other on the same axis [7]. Each type of drone serves a specific purpose, such as scientific or military applications.

In general, drones are primarily identified by the number of motors and arms they possess. Variations in sizes and functions can result in different performance characteristics for the drone.

The top-rated drone overall is the DJI Mavic 3 Pro [8], well-known for its exceptional aerial photography and videography capabilities. Similar to other drones, the DJI Mavic 3 Pro is comprised of a central body, wings, power source, control electronics, various sensors, and a positioning system. In addition to its high-resolution aerial photography, this drone features omnidirectional sensors, a built-in GPS, and an advanced auto-return feature to assist the pilot in avoiding obstacles in complex environments. Utilizing DJI's ActiveTrack technology, it accurately identifies and locks onto moving objects on the ground, effortlessly tracking and recording them. Users can enjoy an exceptionally immersive first-person view during flights when using VR glasses like DJI Goggles [8]. However, it's worth noting that this drone comes with a premium price tag and has expensive accessories.

When designing a drone, it's crucial to consider various factors that can impact its stability and performance, with wind conditions being one of the most important elements. According to [9], enhancing the drone's ability to withstand wind involves focusing on the design aspects, such as incorporating folding arms that can adjust during flight, optimizing the thrust-to-weight ratio, refining the drone's aerodynamics, managing its weight, upgrading the control system and sensors, and optimizing the size and efficiency of the propellers.

A quadcopter drone typically uses Brushless Direct Current (BLDC) motors as rotors due to high efficiency, low maintenance cost, and compact size. Precise control of the BLDC motor speed is crucial for determining the drone’s position and velocity [9]. Nevertheless, achieving optimal speed requires efficient control of both speed and torque. According to [10], the PID (Proportional-Integral-Derivative) algorithm stands out as the most effective for regulating the BLDC motor, providing superior control, precise speed regulation, ease of adjustment, stable operation, and a simple design.

2.2. Problem Statement

The most critical component of a quadcopter is its propulsion system, which typically consists of four motors and propellers. Due to high complexity of the quadcopter’s control systems, they should be fully researched and developed for the drone to operate properly with high precision and little error. The drone not only needs to lift itself from the ground but also be allowed for effective manoeuvres such as hovering, forward movement and turning. Additionally, the motors and propellers must be precisely controlled and fully accessed by an operator. This requires sophisticated control algorithms and fast response times, which could be difficult to achieve.

Balancing is another major problem that should be carefully considered. Stabilizing the drone gets exponentially difficult with the number of propellers the drone holds, more challenges have to be dealt with. This requires accurate weight distribution across the drone's frame and precise control of the motors' speed. Any imbalance can cause the drone to tilt or spin uncontrollably. Furthermore, environmental factors such as wind can upset the drone's balance, requiring the control system to constantly adjust the motors' speed to compensate. These challenges make the process of building a quadcopter a complex task that requires a deep understanding of aerodynamics, control systems and electronics.

2.3. Contribution

The project proposal is delivered through three work packages (WPs). WP1 is delivered within the first few weeks of the semester for the design of the drone, followed by WP2 for unit testing and finally WP3 for control and validation of the drone:

1. **WP1 – Design of the drone:** Wooden frame of the drone is provided, CAD modelling of 4 structures to fix the 4 motors to the drone's arms must be designed. Wiring diagrams and PCB design also be learnt and implemented. Finally, there will be a step-by-step assembly guide of how the drone should look overall.
2. **WP2 - Unit testing:** Remote controller, driving unit and sensors are provided. All components must be fully understood and tested individually before assembly. This includes the design of the remote controller, calibration and functioning of the driving unit, finally testing and validation of the sensors.
3. **WP3 – Control and validation of the drone:** All components will be integrated and further troubleshooting will proceed such as PID tuning, safety implementation and drone manoeuvres. At this stage, the drone should operate as intended.

2.4. Report Structure

This project will propose a plan consisting of three work packages that include time and resources management, risk analysis, stakeholders as long as team introduction and contract. The report has a brief introduction of the project, followed by a more detailed description of how every process is handled, and how the drone is designed and implemented so as to meet the requirements with little issues. Finally, an analysis of the test results of the whole system behaviours and the conclusion with future improvement and innovation for the drone.

3. Project task description

Clear task descriptions are crucial to not only easily keep track of all the tasks done between team members, but also any stakeholders. We will be breaking down the tasks from all 3 work packages into clear and simple milestones based on the project description provided by the lecturer to help keep track of the progress, and each milestone will have a list of objectives that need to be completed before moving to the next one. Each work package will also have a defined objective to help the team members assigned to do the work visualize what their final result should accomplish. The tasks do not have to be done in the order listed and should be done in the order that is most convenient and quickest to progress the project.

3.1. Work package 1: Design of the drone.

3.1.1. Objectives

This is the first package and will mostly focus on the conceptual phase of the drone, which includes:

- Building the component list to build the drone and acquire them.
- Building the drone's frame with the requirement of approximately 50cm wingspan.
- Designing the wiring diagrams and PCB.
- Designing the component placement map onto the drone's frame in a way that does not over imbalance the drone.

3.1.2. Task breakdown and milestones

Table 1: Work package 1 tasks

No.	Action	Deliverable	Member	Priority
0	Read the work package description	Understand the objectives of work package 1	Everyone	High
Milestone 1: CAD modeling				
1	Create and check bill of material with the lecturer for all of the components and adjust if needed	Have a list of all the needed components to start working on the project	Everyone	High
2	Gather the components	Acquire all the components	Everyone	High

3	Measure all components	Have precise measurements of all components	Mina	Medium
4	Draw the components in Fusion360 or SolidWorks	Have a CAD file for each component	Mina, Huy	Medium
5	Decide the placement for the beams in Fusion360 or SolidWorks	The beam placement should result in a wingspan of 50cm	Mina, Huy	High
6	Translating the beams' placement onto the physical frame and attaching them	All the beams are attached, and the wingspan is approximately 50cm	Everyone	High
7	Design the 3D-printed parts to hold the motors and print them	Have both the files and the attachment piece	Mina, Huy	Medium
8	Load test the beams with given components and adjust if needed	The beams do not break when loaded with motors and their attachment pieces	Everyone	Low
9	Decide the placement for the electrical components in Fusion360 or SolidWorks	All of the delicate components must fit in the frame, the battery can go on top of the drone	Everyone	Low
10	Mark the placement for each component on the wooden plate	A precise marking map for where each component will be attached	Son	Low
Milestone 2: Wiring diagram and PCB design				
1	Measure the space available for PCB	Have the maximum potential space for PCB	Son, Nhan	Medium
2	Design the conceptual wiring schematic for electrical components and check with the lecturer	Know how each component is going to connect in the system	Everyone	High
3	Learn to use EasyEDA	Learned the basics of EasyEDA	Mina, Huy, Nhan	High
4	Find or draw the electrical components in EasyEDA	Have the parts ready for the wiring design	Mina, Huy, Nhan	High

5	Design the PCB wiring diagram and check with the lecturer	A complete wiring plan for PCB	Mina, Huy, Nhan	Medium
6	Finalize and print the PCB	Have the PCB ready to connect to other electrical components	Mina, Huy, Nhan	Medium
7	Mark PCB placement on the frame	Have a clear idea of where PCB will be placed	Son	Low
Milestone 3: Assembly				
1	Using the placement map, design the attachment system used to attach components to the frame	Decided which part can be attached by nut and bolt or can be zip-tied to the frame	Son	Low
2	Drill the holes used to attach components	Have the frame drilled and ready to attach components	Son, Huy	Medium
3	Solder the electrical components	Soldered all the electrical components	Nhan, Son	Low
4	Attach all components to the frame	Have the drone assembled	Nhan, Son	Low

3.2. Work package 2: Unit testing

3.2.1. Objective

This work package’s tasks can be done in parallel to the previous one as well as between each milestone and is highly recommended to achieve optimal time. The main objectives of this second work package are:

- Designing and prototyping a functional remote controller with a joystick to control the pitch and roll of the drone, 2 push buttons to control the yaw, and a potentiometer to control the thrust.
- Assembling and coding the driving units for the drone using ESCs, a battery, motors and propellers, gathering data over the lift force generated to later allow smooth control of the drone.
- Learning to use the IMU and GPS, gathering data from them and later controlling the drone with the gathered data.

3.2.2. Task breakdown and milestones

Table 2: Work package 2 tasks

No.	Action	Deliverable	Member	Priority
0	Read the work package description	Understand the objectives of work package 2	Everyone	High
Milestone 1: Design of the remote controller				
1	Research about SoC microcontroller, potentiometer, and wireless communication through the ***ESPNOW*** protocol	Understand the basic requirements and how to use them	Duy, Long, Tu	High
2	Setup the hardware required for the SoC microcontroller	Have the equipment ready to run	Duy, Long, Tu	High
3	Setup the potentiometer, a joystick and 2 buttons for the controller	Have the equipment ready to run	Duy, Long, Tu	Medium
4	Design and implement code to receive input from the controller.	The outputs can be read in the terminal	Duy, Long, Tu	Medium
5	Design and implement code for the SoC microcontroller to receive input signal	The inputs can be read by the SoC controller	Duy, Long, Tu	Medium
6	Design and implement code for wireless communication between the controller and ESP32 microcontroller	The inputs from the controller are received by the SoC microcontroller	Duy, Long, Tu	Medium
Milestone 2: Calibration and functioning of the driving unit				
1	Research about propeller, motor, ESC, battery	Understand the basic requirements and how to use them	Huy, Long	High
2	Design and connect the wiring between the battery, ESC and motor	All components are connected and powered	Huy	High

3	Design and implement code to make a single motor spin	Have the motor spin	Huy, Long	Medium
4	Measure the motor's RPM and compare it to the input code	Know whether the motor spins at the correct RPM	Huy, Long	Medium
5	Designing and connecting the wiring for 1 PBD and 4 ESC	All components are connected and powered	Son, Nhan	Medium
6	Design and implement code to make multiple motors spin simultaneously	Have the motors spin simultaneously without any motor stopping	Huy, Long	Medium
7	Measure all motors' RPM and compare them to input code	Know whether all motors spin at the correct RPM	Huy, Long	Medium
8	Analyse the results and optimize the system	Using the measured RPM to adjust the code if needed	Everyone	Medium
Milestone 3: Testing and validation of the sensors				
1	Research about IMU and GPS	Understand the basic requirements and how to use them	Duy, Long, Tu	High
2	Setup the hardware required for IMU and GPS	All components are connected and powered	Duy, Long, Tu	High
3	Design and implement code to receive data from IMU and GPS	Data sent from both IMU and GPS can be read on the terminal	Duy, Long, Tu	Medium
4	Perform test runs to confirm the data	Data obtained from the terminal should match the one from the tests performed	Duy, Long, Tu	Medium
5	Collect and analyze the data received from the IMU and GPS	Understand the gathered data and how they can be used to later control the drone	Duy, Long, Tu	Medium

3.3. Work package 3:

3.3.1. Objective

This work package should be done after the previous 2 packages since it requires integrating the units from the previous ones together. It also has 3 sub-tasks that can be done simultaneously like the previous work package, which are:

- Tuning the PID controller to achieve the best control over the drone's pitch and roll.
- Implement safety measures for when the drone needs to make an emergency stop.
- Controlling the drone thrust to change the drone's altitude and yaw to make it spin while staying still.

3.3.2. Task breakdown and milestones

Table 3: Work package 3 tasks

No.	Action	Deliverable	Member	Priority
0	Read the work package description	Understand the objectives of work package 3	Everyone	High
Milestone 1: PID tuning of the drone for the pitch and the roll				
1	Read the PID manual to understand and get the default value provided	Understand how to access and use the necessary parameters	Huy, Duy, Mina	High
2	Design and implement code to let the controller receive input from the joystick and send it to the SoC microcontroller	The inputs can be received by the SoC microcontroller	Huy, Duy, Mina	High
3	Test to see if the SoC microcontroller receives the correct value sent from the controller	All output values should match the inputs'	Huy, Duy, Mina	Medium
4	Perform Proportional (P), Integral (I) and Derivative (D) tuning by gradually changing the default value	• Drone is responsive after P tuning • Drone does less overshooting after I tuning • Drone is stable after D tuning	Huy, Duy, Mina	Medium
5	Perform controlled testing after each tuning	Drone satisfies the wanted outcome of each PID tuning	Huy, Duy, Mina	Medium

6	Perform outdoor testing	The drone can perform basic manoeuvres when accounting for outdoor weather conditions	Everyone	Low
7	Collect and analyze data from the tuning process	Understand the data and see if the drone needs further tuning	Everyone	Medium
8	Optimize and fine-tuning	Drone is fine-tuned and now performs with the best possible performance	Everyone	Low
Milestone 2: Safety implementation for the drone emergency stop				
1	Research about automatic stopping for motors when having too much resistance	Understand how to stop the motors automatically	Son, Nhan	High
2	Design and implement code to stop the motor when there is too much resistance	Motors must stop automatically when having resistance to prevent burning	Son, Nhan	Medium
3	Design, implement and perform tests on mechanical safety features to protect delicate components	Components must not suffer irreversible damages	Son, Nhan	High
4	Take risk analysis, design prevention and protection against propellers before attaching	Fully understand risks involved with propellers and ensure prevention and protection methods are ready	Son, Nhan	High
Milestone 3: Thrust and yaw of the drone				
1	Setup value range for the thrust and yaw	The values setup must not let the drone fly too high or over spin and each value increment must be within a reasonable range of the previous one	Tu, Long, Duy	Medium
2	Design and implement code to get input for thrust from the	The potentiometer can change thrust value and the	Tu, Long, Duy	Medium

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	potentiometer and yaw from the 2 buttons	buttons can change yaw value		
3	Test to see if the SoC microcontroller receives the correct inputs	The output values should match the inputs'	Tu, Long, Duy	Medium
4	Perform controlled test	The motors' RPM can increase and decrease, and drone can spin while staying relatively still	Everyone	Medium
5	Perform outdoor test	Drone can ascend descend, and spin when accounting in outdoor weather conditions	Everyone	Low
6	Collect and analyze data	Understand the data and see if the drone needs further tuning	Everyone	Medium
7	Optimize and fine-tuning	Drone is fine-tuned and now performs with the best possible performance	Everyone	Low

4. Time management

Time management is an indispensable part of any project. It helps the team to stick to the schedule and meet the deadlines to generate the project's final deliverable. Moreover, establishing a good strategy on how to allocate the amount of time for each task not only saves resources but also maximizes productivity for the project when issues or risks are found early.

A Gantt chart is a useful tool to be employed to visually represent the project schedule. A Gantt chart typically contains the following information:

- **Timeline:** A sequence of milestones presents the time that should be taken to complete a project which is illustrated by the start and end dates of the project.
- **Task:** A specific activity or a unit of work that is assigned to each member of a group and must be done to accomplish the project.
- **Assignee:** A person who is responsible for completing a task. This person is expected to carry out essential actions, meet deadlines, and ensure the performance of assigned tasks.
- **Progress:** Progress is formatted as a percentage to guarantee the performance of each task. It is estimated based on the allocated time for each task.

- **Allocated time:** The amount of time that is assigned for a specific task. Having a structured framework, members are more flexible with their assigned tasks, guaranteeing the right resources are available at the time.

4.1. General Gantt chart

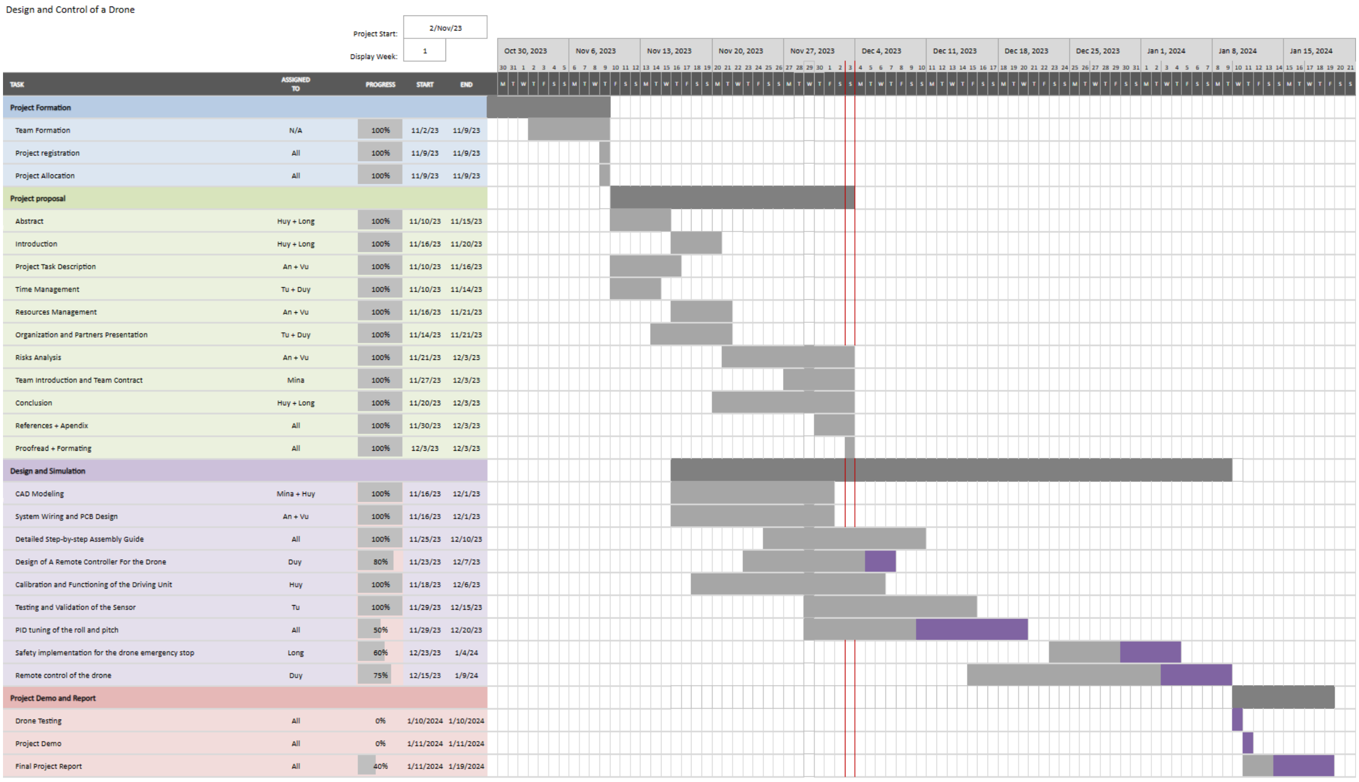


Figure 4: Gantt chart for the entire project

The project is being operated within 12 weeks. The project is divided into 4 stages Project Formation, Project Proposal, Design and Simulation, Project demo and Report. In terms of Design and Simulation, it is broken down into 3 smaller projects called work packages (WP1, WP2 and WP3) as mentioned above.

On top of that, the red lines in the Gantt chart display the correct time the user opens the application.

The general Gantt Chart includes the following:

- **Timeline:** 12 weeks, starting from Dec 10, 2023, to Jan 19, 2023. The end of the project is the submission of the Final Project Report.
- **Task:** Tasks are feasibly categorized and arranged according to each stage in the first column.
- **Assignee:** Assignee is shown in the second column "Assigned to" which could be a specific person, a group of members or all members.

- **Progress:** Progress presents the performance of each task in percentage. It is adjusted depending on the allocated time bar.
- **Allocated time:** The estimated duration for completing a specific stage is illustrated by the dark grey bar, while the light grey bars indicate the time already expended on individual tasks. In contrast, the purple bar visually represents the remaining time required to complete the respective task.

4.2. The Project Formation

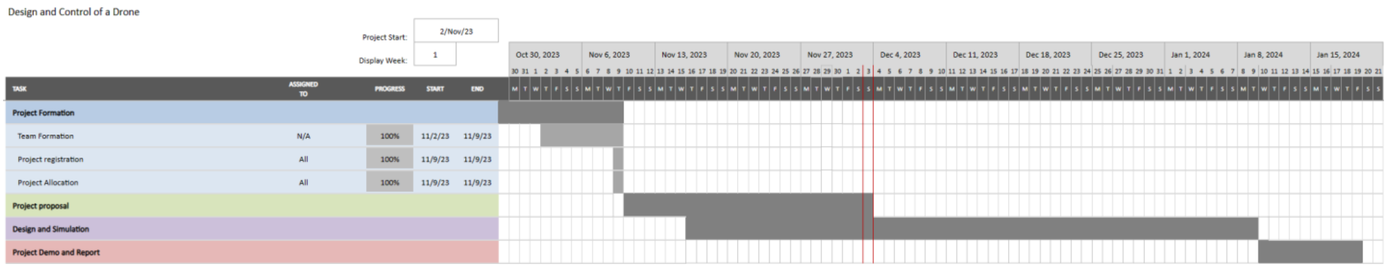


Figure 5: Gantt chart for team formation and project allocation process

The timeframe for assembling a project team relies on the willingness of members to volunteer or may be determined by the lecturer. This phase typically lasts approximately one week, allowing for team formation and familiarization with peers.

4.3. The Project Proposal stage

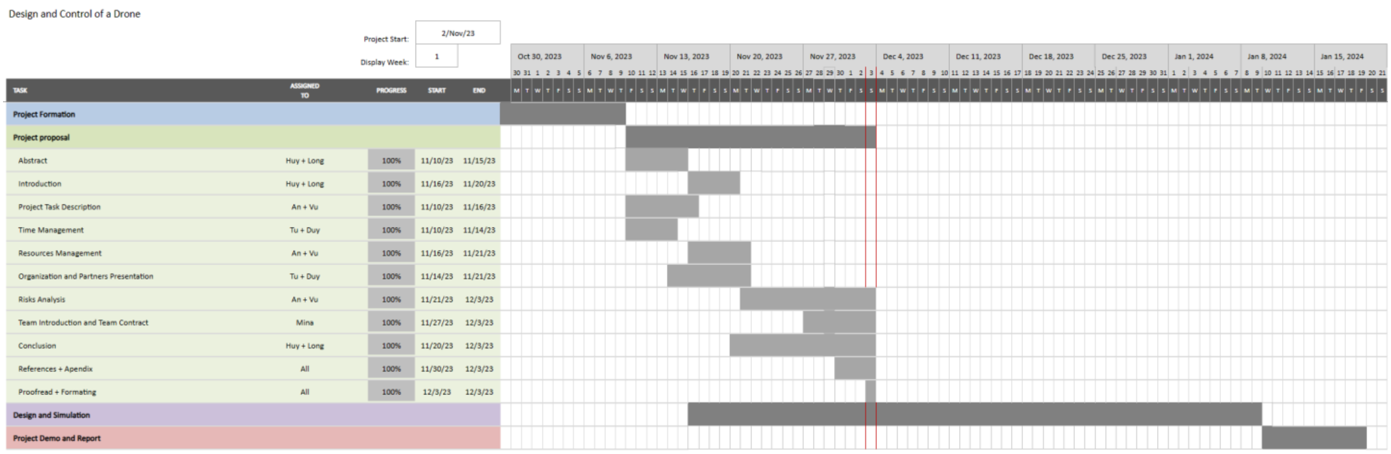


Figure 6: Gantt chart for Project proposal process

The presentation of the project proposal to the instructors aims to offer a comprehensive outline and offer everyone a glimpse into the project. Commencing on November 10 and extending for over three weeks, this phase requires the submission of the project proposal by December 3.

The Gantt chart lists all primary tasks, each necessitating the involvement of the entire team. There is a likelihood that the project proposal is concurrently undertaken with the Design and Simulation stages, ensuring a clear understanding of the required content for the proposal and optimizing time efficiency for subsequent phases. The variance in allocated time for tasks is evident. In response, we have chosen to prioritize additional time for individuals handling challenging tasks or for those who might be burdened with their projects. As indicated in Figure 6 shown that the Risk Analysis and Conclusion are responsible respectively for An and Vu, Huy and Long, the duration for their assigned tasks has been extended to accommodate the time they require to meet their respective deadlines. In addition, to guarantee the quality of the project proposal, we have decided to allocate 3 to 4 days before the deadline for a thorough review and correction of any errors in the proposal.

4.4. The Design and Simulation stage

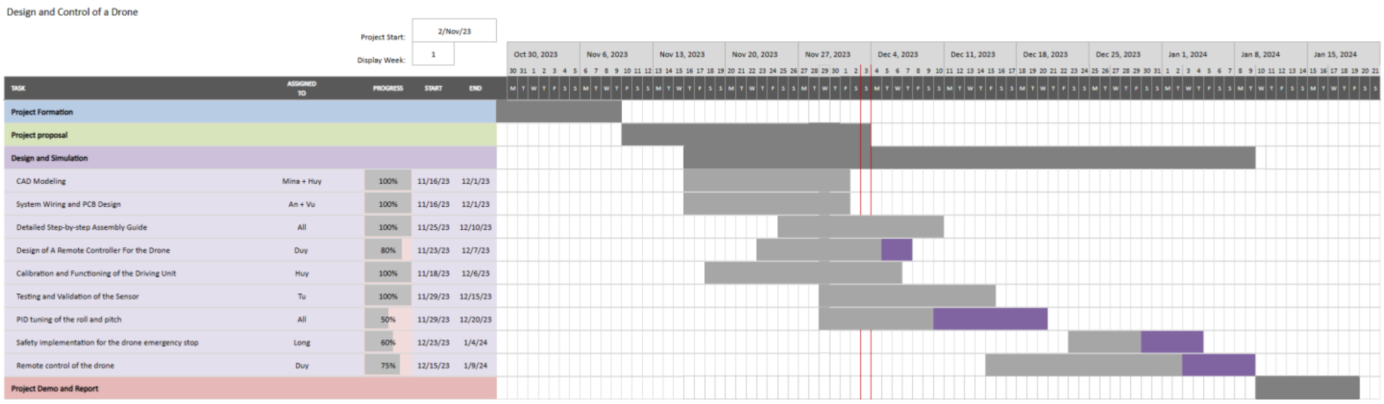


Figure 7: Gantt Chart for Design and Simulation process

This Design and Simulation should be started as soon as possible. Hence, we have planned to incorporate this stage starting on November 16, operating concurrently with the project proposal phase. The deadline for this stage is set for January 9, just over a week before the report submission deadline. The entire duration for this phase spans approximately 6-7 weeks.

In finer detail, we have segmented this phase into three distinct work packages, as outlined in the project task description.

Work Package 1 lasts for 3 weeks from November 16 to December 10 is about the Design of the Drone containing 3 main tasks CAD Modelling, System Wiring and PCB Design, Detailed Step-by-Step Assembly Guide. Moreover, all team members will collaborate during this phase, certain minor responsibilities will be assigned to individuals based on their expertise and the specific requirements of the tasks. For example, Huy and Mina are responsible for CAD and PCB Design are assigned to An and Nhan.

Work Package 2 also lasts for 3 weeks from November 23 to December 15 is about Unit Testing which is broken down into 3 primary tasks Design of the remote controller, Calibration and functioning of the driving unit, finally Testing and validation of the sensors. With most of the essential components provided, Duy, Huy and Tu have to check whether those components are working well without errors.

However, Work Package 3 lasts for 5 weeks from November 29 to January 9 is about the Control and validation of the drone. During this phase, Long and Tu are working with the IMU and GPS to show the correct data on the terminal. After that, Duy has to work with the remote controller setup, connecting buttons and joysticks to manage the drone. This is also the preparation to accomplish the final of this stage.

A more comprehensive explanation of each task is provided in the task description section.

4.5. Project Demo and Report

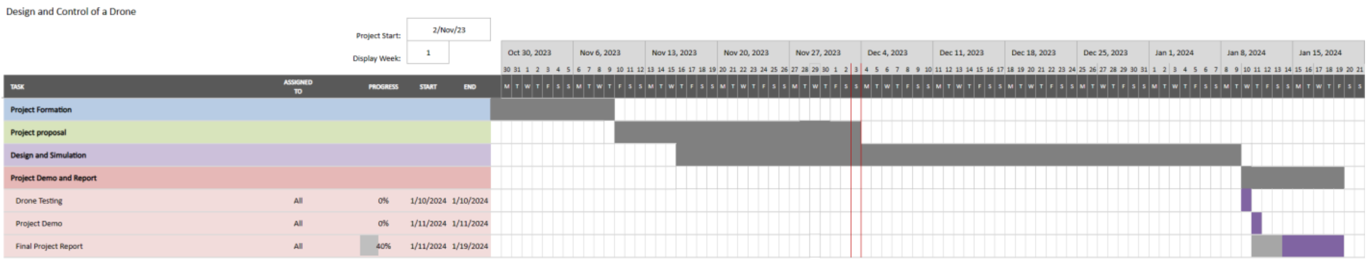


Figure 8: Gantt chart for Project demo and report process

In terms of the project demo and report, we have to conduct the Drone Test on January 10 to confirm that it works well. Next, we will spend more than a week on the Project Demo and submit the Final Project Report before January 20.

5. Resources Management

This section of the proposal will list out all of the first draft theoretical components by our team members needed to build the quadcopter drone. The bill of materials table below will list all of the components, both given by the lecturer and bought by the team members, not counting backup or replacement components cost. As the project goes on, there will be more components needed to fully complete the drone, whether they are parts given to us by the lecturer in the future that we currently do not know of or that our team needs to adapt some extra components to our design to make it easier to build the drone. We will also be combining the components needed from both Work Packages 1 and 2 together in a single BOM, to sum up all of the potential costs of the drone for easy management and replication, the reference pictures for all of the components will be available at the appendixes section of the proposal. Aside from the components provided to us by the lecturer, the ones we have to buy ourselves will be sourced from popular e-commerce platforms such as Shopee, Tiki, Lazada, etc., as well as any local electronics shops or remote-controlled vehicle hobby shops. At the end of the semester, when we will be finishing up the drone construction, the final documentation of the building process will be published and the BOM will be adjusted accordingly.

Table 4: Project Bill of Material

Name	Specification	Description	Quantity	Price of 1 unit in VND
Wooden Board	Dimensions: 15x15x5mm	Serve as the base of the drone's frame	2	Provided by lecturer, estimated 50.000
Wooden Bar	Dimensions: 20x1.5x1.5mm	Serve as the drone's arms to attach the motors	4	Provided by lecturer, estimated 10.000
Propeller Pair	Length: 1045 mm	A pair of clockwise and counterclockwise propellers.	2	Provided by lecturer, estimated 32.000
Motors	Motor Himodel XXD A2212-1400kV Brushless	Spin the propellers to create lift	4	Provided by lecturer, estimated 125.000
ESC	Model: XW-30A	Serve as power regulator and speed controllers of the motors	4	95.000
Drone's Battery	- Battery type: Lithium Polymer rechargeable battery - Output power: 14.8V - Capacity: 1550mAh - Size: 76x40x32mm	Ovonic 1550mAh 4S 100C 14.8V LiPo Battery XT60	1	380.000

GPS Module	Model: GPS NEO8M	For navigation and positioning	1	125.000
IMU Module	Model: MPU6050	Include accelerometer and gyroscope that measure force, angular velocity and attitude to balance the drone	1	34.000
SoC Microcontroller	Model: ESP32-WROOM-32	Integrated with Wifi and dual-mode Bluetooth	1	150.000
Potentiometer	Resistance: 1kΩ	Integrate into the controller to change the drone's motor speed	1	30.000
Connectors	A pair of ESC-Motor 4mm jack	Soldered on to ESCs and motors' wire for connection	12	12.000
Jumper Wires	Male-male, Male-Female, Female-Female, A pack of 25 wires	Connect all circuit boards	1	28.000
Heat shrink tube	A pack of 164	Cover the open wires and connectors to isolate them, and prevent short circuit	1	25.000
Breadboard	Size: 8.5x5.5cm, 400 holes	For testing the motors and ESC circuit before the PCB is printed	1	16.000
3D Printed Model	Size: 50.5x31x20mm	4 parts serve as the motor holder to attach the motors to the drone's arms; 2 parts serve as the frame of the controller	4 to attach propellers, 2 for controller	Estimated 100.000

PDB	Model: Matek XT-60 PDB	Power Distribution Board that distributes power from the battery to other components through an XT-60 port.	1	120.000
PCB	Will be designed by team members	Serve as a circuit board to attach other modules. There will be 2 PCBs: one for the drone, one for the controller	2	Estimated 350.000
Press button	Arduino press button	For controlling the drone yaw	2	10.000
Joystick	Black Arduino thumbstick	Maneuver the drone	1	10.000
Zip tie	A pack of 100	Used to tie any loose parts if needed	1	10.000
Electrical wires	1 meter of 18AWG electrical wire	Used to extend the ESC wires	1 of red, 1 of black	10.000
Male header pin	A row 1x40 of gold-plated male header pins	Used to solder onto the GPS module	1	1.900
Total cost in VND	3.509.900			

Reasons behind some of the resources chosen for the project:

Note: For some items in the BOM we had to estimate their prices since there were notable price differences between sellers, and for 3D printed parts and PCB we based them off the price of some manufacturers who had listings for items of similar sizes.

1. Wooden boards and bars for the frame: they were chosen because they are easier to access than having a fully 3D printed frame, being lightweight and more durable than the 3D printed material accessible to us through the university-provided resin materials, so in case there is any accident happening to the drone when we carry out our tests, they can be easier to replace.

2. PDB model: since we are not well-versed in electrical design and soldering, the Matek PDB XT-60 model already comes with the XT-60 port that matches the one on the battery, making it easier for us to connect the twos rather than the other available PDB that requires a soldering connection.
3. Male header pins can be either gold or brass plated, we chose gold because of the better conductivity and the price difference was marginal (~400đ).

6. Organization and Partners presentation

In the dynamic landscape of technological innovation, our project has provided a groundbreaking drone prototype that can please some big companies not only in Vietnam but also worldwide in some domains such as military, education, entertainment and services.

Military: One of the primary sectors where our drone prototype can bring a huge advance in technology is military. With the capability of range scouting [11], it provides better reconnaissance and surveillance that help the military in gathering crucial information about hostile forces without risking soldiers' lives.

- Saab AB, an 86-year-old leading military and security company with its headquarters located in Sweden [12]. With their advanced military and commercial aircraft technology, particularly in radar, signals intelligence and self-defence. They would be interested in this project and become a potential stakeholder that will bring many opportunities for cooperation and funding.

Education: Our drone has a potential to redefine the learning experience, particularly in software and electrical engineering and robotics. Our drone offers students an opportunity to learn and arouses students' curiosity.

- RMIT University, a leading technology school that has thousands of talented lecturers and students coming from STEM disciplines, equipped with world-class facilities would be a good stakeholder for this project. By giving us deeper knowledge and resources, they will enhance project quality. In exchange, RMIT University will own a drone project that will provide a better visualization for students on how a drone works which will enhance the overall quality of that particular course.

Entertainment: This is another domain where our prototype can play a crucial role. Especially in recent years, the ability to record stunning footage from a bird's eye view has revolutionized how movies are filmed [13].

- Marvel Disney, an entertainment titan, has dug its name into worldwide audiences' hearts as one of the best superhero movie companies, has recently made one of their newest movies "Thor: Ragnarok" by drones [14]. Since 90% of their movies are post-production VFX, aerial shots play a crucial role in making a Marvel film. While a helicopter or a techno crane would be very heavy and hard to transport, drone is their best solution. By becoming a stakeholder in this drone project, they will bring many funding opportunities.

Services: In the services sector, there are a lot of aspects that a drone project can use such as delivery and agriculture. According to Tropogo, the global drone market in agriculture will reach $5.7 Billion by the end of 2025 [15]. As a Vietnamese, I know that our country is a poor agriculture one, so we don't have much opportunity to use drones for agriculture like other countries. By using drones for spraying fields, companies can save a lot of time and human resources.

- Hoang Anh Gia Lai Agricultural Join Stock Company, a 13-year-old company that specializes in rubber and fruit trees. Their project is located in Vietnam – Laos – Cambodia with a total distance of up to 200km [16]. As one of the biggest agricultural companies in Vietnam, they would be interested in our drone project. With the unlimited capabilities of drones in agriculture from soil and field analysis, crop monitoring, plantation, livestock management, crop spraying, checking crop health, avoiding overuse of chemicals, and preparing for weather changes [15] this project would be a stunning force in helping Vietnam become one of the best fruit export countries.

By identifying potential stakeholders and partners interested in this project, a group can gain a lot of support not only in funding but also in advanced technology. Solid support from companies with different types of domains will help this project in further development.

7. Risk Analysis

To yield the desired results, it's crucial to have a meticulously planned risk assessment and mitigation strategy. It is essential for every team member to fully understand the possible risks that could arise during the drone building process to ensure their own safety and minimize equipment damage.

Table 5: Risk impact and probability

Risk table			
	Impact (Low to High)		
Probability (High to Low)	Moderate	High	Critical
	Low	Moderate	High
	Extremely low	Low	Moderate

There are potential risks in the project work. Each has its probability (how likely risks occur) and impact (how severe it impacts the project), ranging from **Low** (Unlikely to occur), **Medium** (Possibly to occur) and **High** (Likely to occur).

Table 6: Risks analysis table

Task name	Risk description	Risk probability	Risk Impact	Overall score
Project planning				
Weekly meeting	*Meeting is not available / Meeting is not sustained*	*Low*	*Low*	*Extremely low*
Punctuality	*Being late for a project deadline*	*Low*	*High*	*Moderate*
Milestone: modeling	*Draft model (hardware): without inspection*	*Medium*	*Medium*	*Moderate*
Milestone: coding	*Draft model (software): without inspection*	*Medium*	*Medium*	*Moderate*
Manufacturing				
Hardware (CAD&PCB)	*Faults in technology (hardware)*	*Medium*	*High*	*High*
Software (coding)	*Faults in technology (software)*	*Medium*	*High*	*High*
Injuries	*Get injuries when manufacturing the model*	*Medium*	*Low*	*Low*
General				
Injuries	*Get injuries caused by components*	*Medium*	*Low*	*Low*
Material preparation	*Lack of materials*	*Medium*	*Medium*	*Moderate*

8. Team Introduction and Team Contract

8.1. Team Introduction

Our team – Team F – consists total of 7 members from different majors, but we all share the same passion and determination.

8.1.1. Truong Tan Gia Huy – Leader

Personal introduction: My name is Truong Tan Gia Huy, I am a third-year Robotics and Mechatronics student at RMIT University. I might not be the best leader, but I could do some management and arrangement. I am willing to share and receive feedback and opinions from everyone for further improvement. Despite majoring in robotics, I find myself more drawn to the field of manufacturing and production.

Name	Truong Tan Gia Huy
Studying	Robotics and Mechatronics Engineering
University	RMIT University
Expected graduation	2024
Expected career path	Manufacturing Engineer
Student ID	s3806881
Strength	Optimistic, Teamwork, Adaptability
Weakness	Coding, Indecisive
Specialty	CAD and PCB Design

8.1.2. Huynh Ngoc Duy – Member

Personal introduction: My name is Huynh Ngoc Duy, I am a second-year software engineering student at RMIT University. With 2 years of experience, I specialize in C, C++, and Java.

Name	Huynh Ngoc Duy
Studying	Software Engineering
University	RMIT University
Expected graduation	2025
Expected career path	Software Engineer
Student ID	s3924704
Strength	Adaptability, Teamwork
Weakness	Soldering
Specialty	Java, C, C++, CAD

8.1.3. Pham Trinh Hoang Long - Member

Personal introduction: Hello, I'm Long, a third-year software engineer dedicated to transforming ideas into robust and efficient software solutions. With 3 years of hands-on experience, I specialize in Java, C++, Python, OOP, and Web Developing. From architecting scalable systems to writing optimized code, I thrive in the dynamic realm of software development. My passion for innovation and commitment to excellence drives me to stay abreast of the latest industry trends.

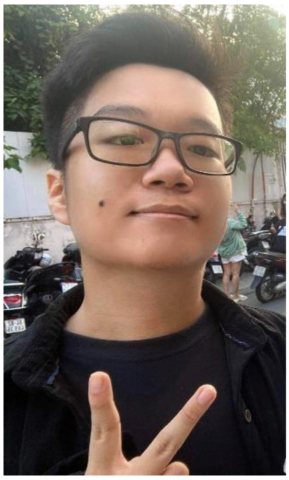
Name	Pham Trinh Hoang Long
Studying	Software Engineer
University	RMIT University
Expected graduation	2024
Expected career path	Software Engineer
Student ID	s3879366
Strength	Teamwork, Adaptability, Coding, Work Ethic
Weakness	Wiring, CAD Design, Soldering
Specialty	Java, C++, Python, OOP

8.1.4. Jeon Mina - Member

Personal introduction: Hello, I am Mina Jeon. I am a third-year robotics and mechatronics engineering student at RMIT University.

Name	Jeon Mina
Studying	Robotics and Mechatronics Engineering
University	RMIT University
Expected graduation	2024
Expected career path	Manufacturer designer
Student ID	s3764040
Strength	CAD
Weakness	Coding
Specialty	SOLIDWORKS

8.1.5. Tran Thanh Tu - Member



Personal introduction: My name is Tran Thanh Tu, I'm a second-year software engineering student at RMIT University. With 2 years of hands-on experience, I specialize in C, C++, OOP and web development.

Name	Tran Thanh Tu
Studying	Software Engineering
University	RMIT University
Expected graduation	2025
Expected career path	Software Engineer
Student ID	S3957386
Strength	Coding, Wiring, CAD design
Weakness	Soldering, Communication
Specialty	C, C++

8.1.6. Vu Thien Nhan – Member

Personal introduction: I am a fourth-year software engineering student with light experience in mechanical design and electrical. After 3 years of studying Software engineering specialization, I am confident that I can research and figure out solutions for most problems the team may encounter.

Name	Vu Thien Nhan
Studying	Software Engineering
University	RMIT University
Expected graduation	2024
Expected career path	Software Engineer
Student ID	s3810151
Strength	CAD, soldering, coding
Weakness	Physic, embedded system design and coding, lack of technical expertise
Specialty	Java

8.1.8. Tran Truong Son - Member

Personal introduction: As a fourth-year software engineering student, I have developed a robust foundation in software development and system design. Through entire time learning in SE, I have enhanced my skill in chasing bugs and celebrating successful compiles.

Name	Tran Truong Son
Studying	Software Engineering
University	RMIT University
Expected graduation	2024
Expected career path	Software Engineer
Student ID	s3818468
Strength	Soldering, coding, mechanical
Weakness	Writing reports and managing timeline
Specialty	Java, C, C++, Font end

8.2. Team Contract

EXPECTATIONS

Expectations	Descriptions
Attendance	Every member must attend every tutorial session and meeting
Punctuality	Every member must notice the deadlines and complete the assigned tasks on time
Respect	Every member should treat each other respectfully, and kind and be supportive
Communication	Every member should inform other teammates of their progress and always speak in English
Willing to share	Every member should be willing to share feedback on others' work or ask for assistance when dealing with difficulties

RULES AND POLICIES

- **Team meeting:** Every Tuesday at 5:30 pm, the team will have a compulsory online meeting via Microsoft Teams for discussion of member's working progress. Every meeting should last around 30 minutes or longer if the workload is intense. At the end of the meeting, personal meetings could be held between the members. Anyone who cannot attend the weekly meeting due to family issues, health or urgent problems must inform the team's leader at least one day before the meeting occurs. Every member must show up at least 5 minutes before the meeting starts. The meeting will commence at 5:35, any member who fails to attend on time will be considered absent from the meeting.

- **Communication and planning:** The team's main means of communication is via Facebook Messenger, where team members discuss and inform the working progress, updates and problems dealing with. After every weekly meeting, the team leader will distribute a summary of the meeting's content and outline the tasks for the following week.
- **Punishment:** Any member who fails to follow the contract will receive some warnings and penalties:
    - **First warning:** The person needs to buy everyone a bubble tea as a treat
    - **Second warning:** The person will negotiate with the lecturer and teammates, and might be considered for contribution deduction.
    - **Final warning:** The person will have contribution or mark deduction.

DIFFICULTIES

- **Time management:** Some members are studying up to 4 courses in this semester, therefore they have little or cannot manage their time properly to complete the assigned tasks on time.
- **Late updates:** Some members do not seem to be available to keep up to date with the latest messages constantly and remain offline for a rather long time.
- **Lack of technical skills:** Some members don't have experience in certain technical skills such as drilling or soldering.

SOLUTIONS

- **Time management:** Members must acknowledge each other's schedule to ensure they are manageable within their given time frame.
- **Late updates:** Members must pay more attention to group messages, turn on notifications or set reminders.
- **Technical skills:** Get training and practice under the instructions from the lecturer and other experienced members.

TEAM SIGNATURES

We all agree with the team contract and the potential consequences and will exert our utmost efforts to improve our current issues.

Name	Student ID	Signature	Date
Truong Tan Gia Huy	S3806881		03/12/2023
Huynh Ngoc Duy	S3924704		03/12/2023
Pham Trinh Hoang Long	S3879366		03/12/2023
Jeon Mina	S3764040		03/12/2023
Tran Thanh Tu	S3957386		03/12/2023
Vu Thien Nhan	S3810151	Nhan	03/12/2023
Tran Truong Son	S3818468	Son	03/12/2023

9. Conclusion

Overall, UAVs are on a trajectory of further advancement. Their widespread adaptation is inevitable and it is fascinating to witness the extent to which their potential capability can be harnessed in various aspects. This project involves designing and fabricating a quadcopter drone that can be used for various purposes with detailed of research and troubleshooting work. The project aims to test the drone’s stability, manoeuvrability, and payload capacity. Students must gain a comprehensive understanding of each component of the drone and effectively integrate them within a closed system. This will ensure the drone’s optimal operation and self-balancing capabilities under different scenarios and environmental conditions.

The project proposes some future works and recommendations that could significantly improve the drone’s design, performance, and functionality. These include the integration of more robust and efficient motors and propellers to augment its speed, payload capacity and endurance.

By adding more sensors, it helps to enhance its navigation, obstacle avoidance as well as data collection capabilities. Moreover, conducting more experiments under varying payloads or environmental conditions could provide valuable insights for future improvements.

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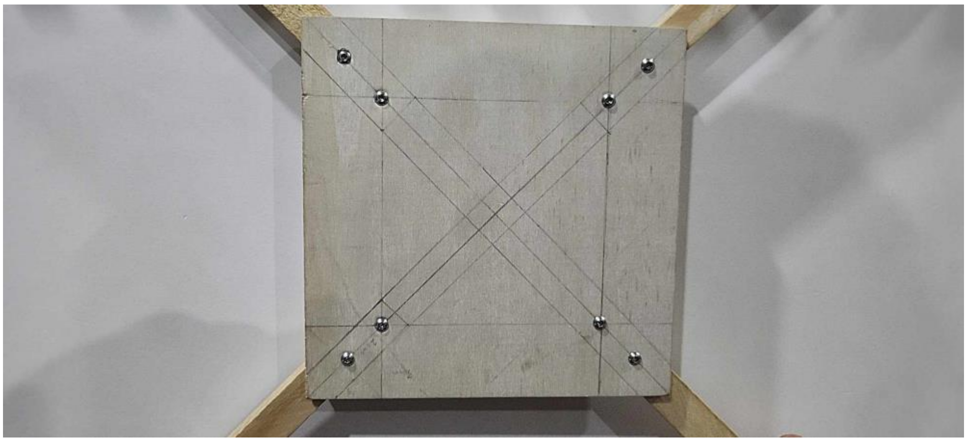
11. Appendix

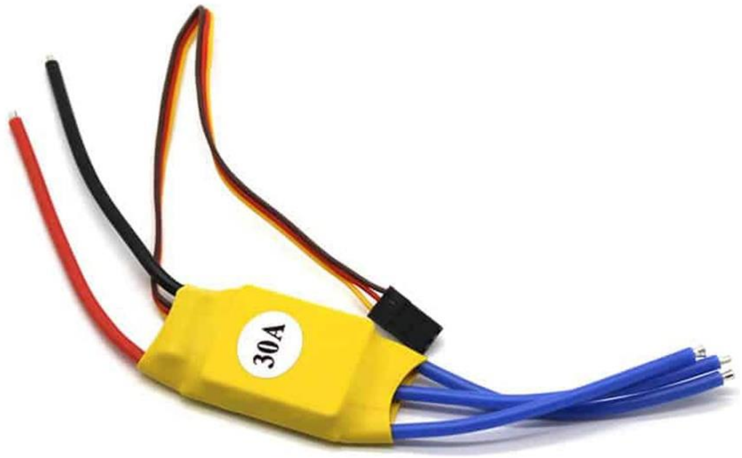


Appendix 1: Wooden Board

Appendix 2: Wooden Bar

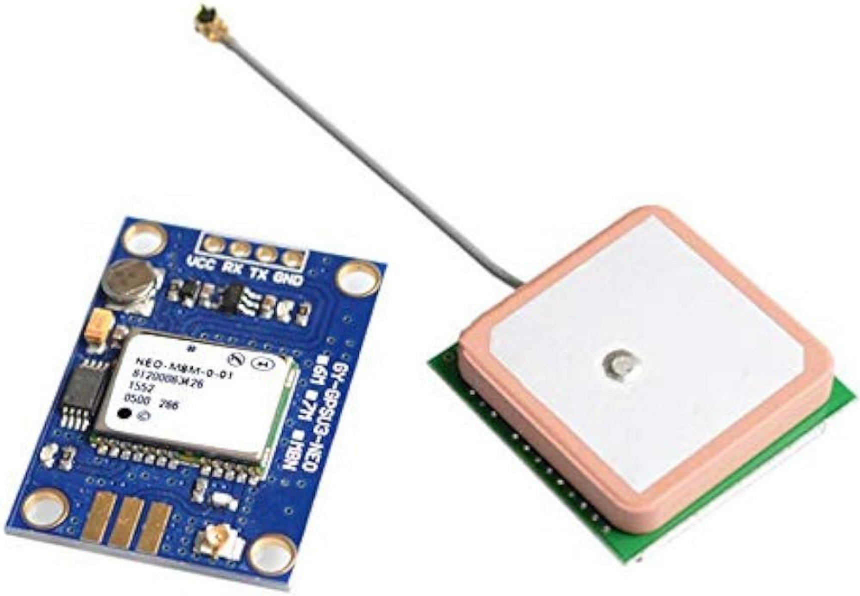
Appendix 3: Propellers

Appendix 4: Motors

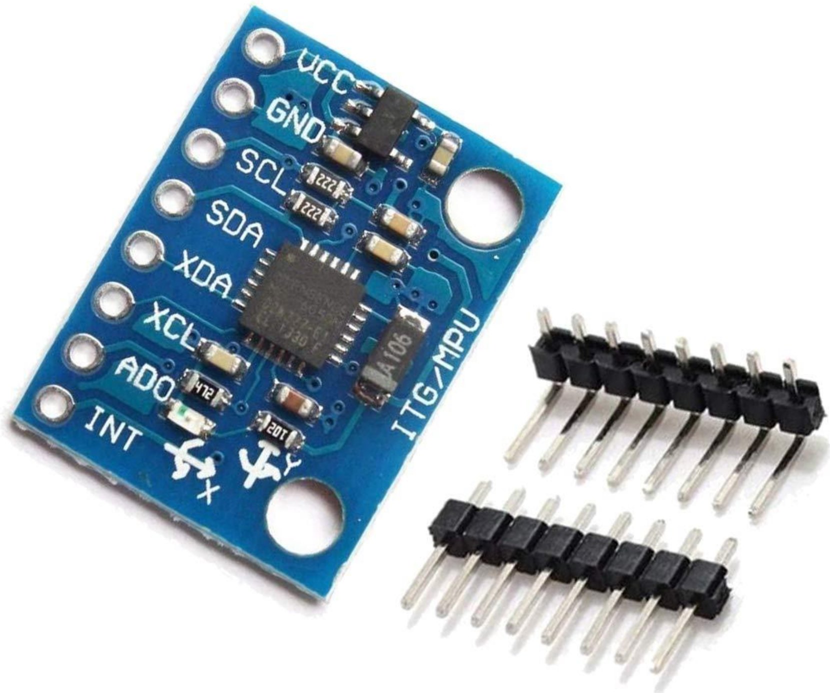


Appendix 5: ESC

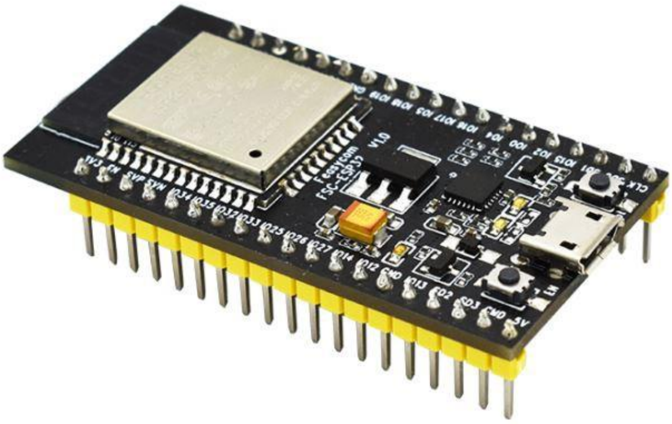
Appendix 6: Battery



Appendix 7: GPS Module



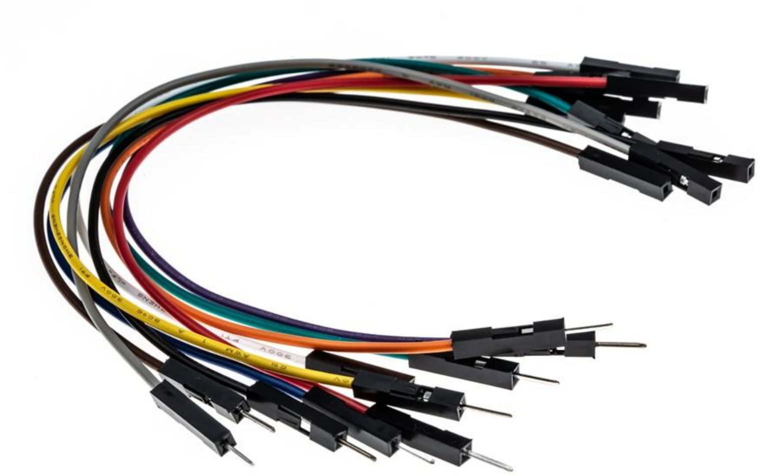
Appendix 8: IMU Module



Appendix 9: SoC ESP32-WROOM-32

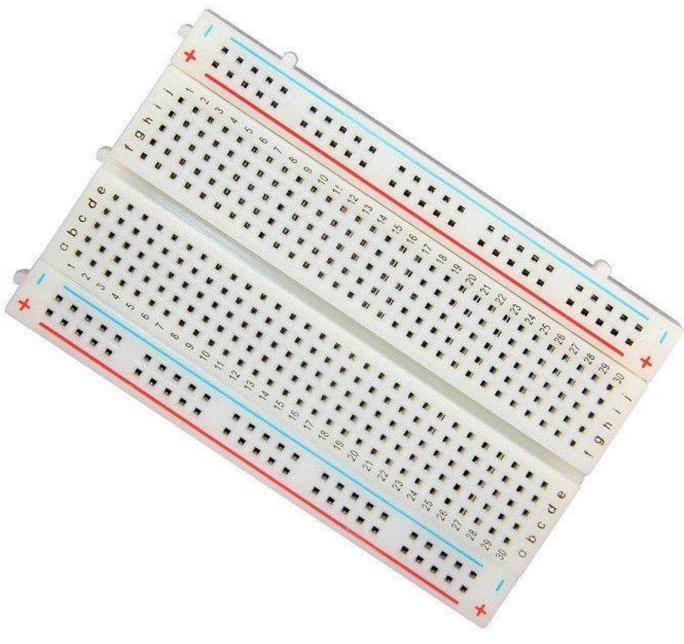
Appendix 10: Potentiometer

Appendix 11: 4mm Male-Female jacks

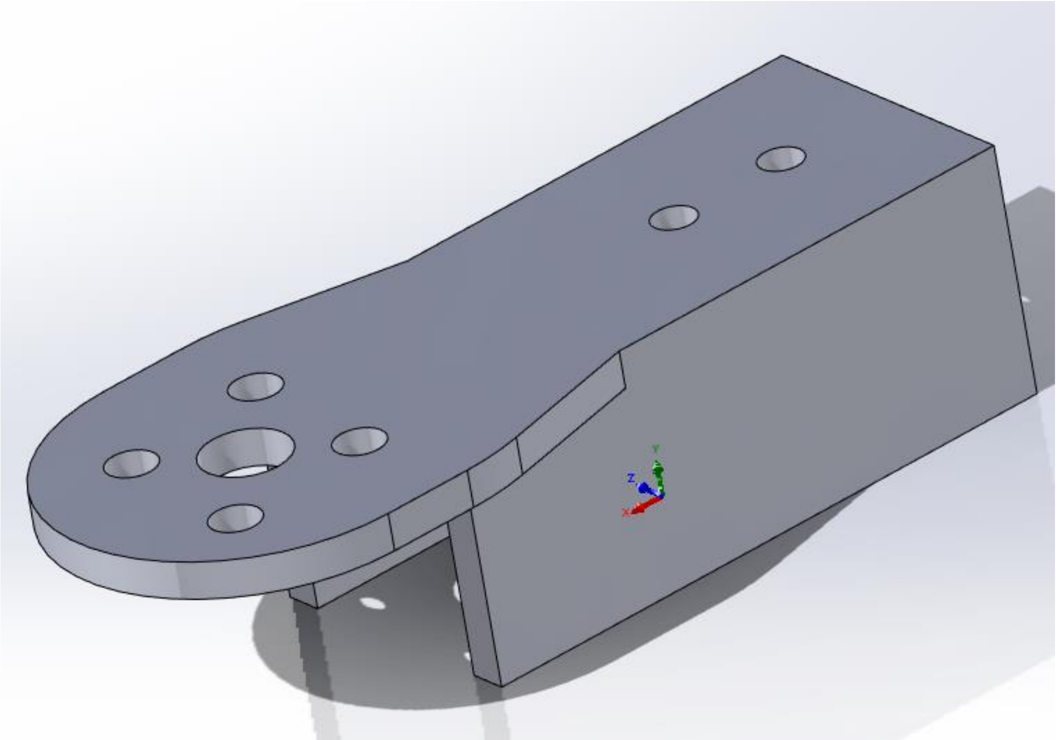


Appendix 12: Jumper wires

Appendix 13: Heat shrink tubes

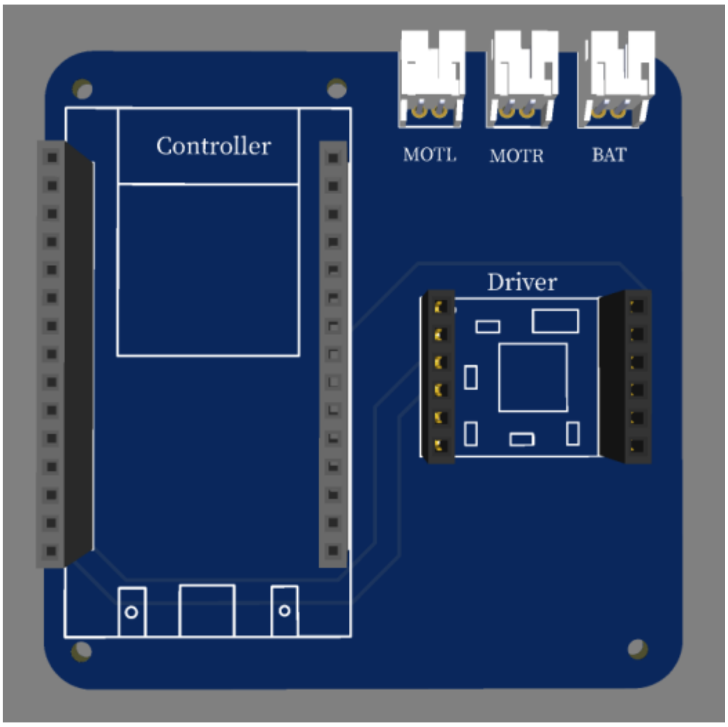


Appendix 14: Breadboard



Appendix 15: 3D Printed Parts

Appendix 16: PDB



(Not yet available at the time of the proposal)

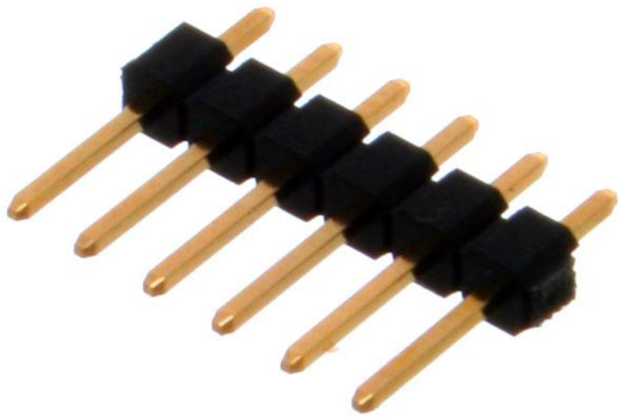
Appendix 17: PCB

Appendix 18: Arduino push button

Appendix 19: Arduino joystick

Appendix 20: Zip ties

Appendix 21: Electrical wires



Appendix 22: Male header pins