EEET2610 – ENGINEERING DESIGN 3

PROJECT PROPOSAL

**Instructor:** Vu Dinh Son

**Tutorial Session:** Thursday (12:30 – 14:00 pm)

**Group B**

Nguyen Le Quoc An – s3695739@rmit.edu.vn

Do Bao Long – s3869056@rmit.edu.vn

Nguyen Le Cong Hieu – s3927462@rmit.edu.vn

Tran Quang Tuan - s3916854@rmit.edu.vn

Mai Chieu Thuy - s3877746@rmit.edu.vn

Trinh Thanh Thanh Truc - s3927089@rmit.edu.vn

Luu Nguyen Bao Tran – s3926340@rmit.edu.vn

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# Abstract

* Abstract: Recommended length: 1 page (Hieu)   
  The abstract summarizes briefly your document. One should understand the scope of the project from it.

An abstract is a brief summary of the report. Its main purpose is to provide readers with a concise and accurate overview of the content of the paper, enabling them to quickly understand the key points and decide whether to read the full text.

Overall, an abstract should be clear, concise, and well-written, with a focus on providing the reader with the most important information about the report.

A screenshot of a research report

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# Introduction

* Introduction: Recommended length: 10 pages (including figures)  
  The introduction should give context, literature review, problem statement, contribution, and structure of the report. In-line citation should clearly appear in this section.

An introduction is the opening section of a report. Its purpose is to provide the reader with an overview of the topic and to set the tone for the rest of the work.

The content of an introduction typically includes the following elements:

* Background Information: This section provides context and background on the topic, explaining why it is important or relevant. It should include in-line citation from external sources that helps the reader understand the significance of the topic.
* Thesis Statement: This is the main point or argument that the author will be making in the rest of the work. It is usually one or two sentences long and should be clear and specific.
* Scope: This section outlines the scope of the work, explaining what will be covered and what will not. It may also provide an overview of the structure of the work.

Overall, an introduction should be concise, engaging, and informative, setting the stage for the rest of the work and enticing the reader to continue reading.

This section provides a general perspective of the project’s details through the provided background information, literature review, problem statement, contribution, and report structure.

## Context and Background Information

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An Unmanned Aerial Vehicle is a 4 VTOL (vertical take-off and landing) vehicle with 4 propellers that can be maneuvered without human interference. The first quadcopter “Gyroplane” originally created by Jacques and Louis Breguet during 1907 where the design was unstable yet managed to take-off. Following these designs were Etienne Oehmichen with the “Oehmichen” quadcopter that managed to fly with “a distance of 360m” and 1km” for the second attempt. This revolutionary discovery led to the “Curtiss N2C-2” by the U.S Navy after WW1 and the mass manufactured “Radioplane OQ-2” by Reginal Denny and Walter Righter. However, the radio-controlled aircraft by Edward M.Sorensen had developed an aircraft that could be tracked controlled out of flight by implementing a “ground terminal”.

Nowadays, drones can be used for various purposes varying from: delivery, videography, photography, surveillance, or military purposes. As the increase in demand for drones increases to 2.4 million or 66.8% annual growth rate by 2023, several industries such as: construction, mining, insurance, telecommunications, and agriculture are also predicted by “Business Insider” will find drones as an essential technology to be integrated within their business [2]. For instance, within the

Within this project, the main purpose of the project is to “design and control” a quadcopter. Through the design and development of the quadcopter, it is also essential to understand its operative process while also be informed about individual components from the driving unit, sensors, and remote controller. The main mechanism chosen for this study is “The Skywalker quadcopter” which consists of a drone that can traverse on air and ground. The design consists of a wheel that can navigate and support the drone’s structure on ground while the drone mainly is controlled on air by its pitch, roll and thrust. In attempting to recreate certain aspects of the quadcopter within twelve weeks, the design team has decided to mainly build the drone with the intention of understanding how the mechanism functions through its design and control system.

## Literature Review

Tran

Comparison between different drone models (indicate benefits and drawbacks) then compare with recent model that is studied within ED3. It is mandatory to include literature from journal articles (not only commercial products). Moreover, a drone is just a part of the project (the main part indeed), but there are other aspects that must be considered: application, control, AI, privacy concern, etc. You may need to pick those that are aligned with your project.

**TRAJECTORY TRACKING SYSTEMS**

Multi-copters are known for their complex control systems that have the capability to either track its trajectory or to be calibrated for optimal flight control performance. For instance, one of the concepts of flight control is its use of Artificial Intelligence (AI), more specifically, Reinforcement Learning (RL) [1]. Since drones usually operate in a “non-linear dynamic motion”, it is essential to find a reliable way of controlling the system. Hence, AI proves to be an advanced and sturdy system to control the drone without the need of using a remote controller. Reinforcement Learning in a machine learning method that when an agent (drone) observes its surrounding environment, it will receive its data and fine tunes the results to better match with the expected outcome of the user. Reinforcement learning can be applied to various expertise, including medical, game training and strategy. Within this study, RL will be used to determine the landing condition of the quadcopter with the additional use of Q-Learning, a Reinforcement Learning policy and main algorithm to improve the take-off, flying forward and landing conditions of the quadcopter. To use reinforcement learning, it is essential to determine hyperparameters or external variable inputs so that it can potentially improve the system’s accuracy. Hyperparameters include:” alpha, gamma, epsilon, epsilon discount, number of episodes and number of step loop.” Within this study, gamma (discount factor of future reward) and alpha (learning rate of agent) will be chosen to optimize the system to gain a higher reward output. The simulation of the chosen drone called “Parrot Ar. Drone” is conducted within a simulation platform called “Gazebo” and Robotic Operating System using Q-Learning algorithm. Based on the Markov Decision Process (MDP), the agent will carry out the action (input taken from current stage) that was given by the “environment” (scenario in the current state) to which the environment will generate an output to which the process will be looped until the desired outcome is achieved. The value of gamma and alpha will be established between 0 to 1 for maximum optimization and the simulation will continue until the hyperparameters are optimized for the drone to operate. From the results, it can be observed that when alpha equals 0.7 and gamma equals 0.7, it generates the highest reward score of 6600 with a time learning rate of 216 seconds. However, when alpha equals 0.2 and gamma equals 0.6, the reward score is lower with a value of 3350 and a learning rate of 45 seconds. After various trials, the values of the parameters that have the highest optimization for the algorithm are 0.1 for alpha and 0.8 for gamma, which produces a high reward score of 6100 and 49 seconds for the learning rate [1]. Based on this study, Artificial Intelligence can be an effective method within flight control since the system can be trained through iterative processes that could produce optimal results in a short amount of time.

**Source 1:** <https://ieeexplore.ieee.org/document/9265381>

An alternative method comprises of the use of Linear Quadratic Gaussian Tracking (LQGT) by Mung and Hong to control the rotational and lateral movements of the drone [2]. To further minimize potential tracking error, the firefly algorithm will be used along with the LQGT control. With the use of LQGT, it is possible to determine unknown state variables through the process of estimation without needing to purchase sensors to determine unknown state variables for a complex system. In addition, if needed, the system can add disturbances to the output to simulate uncertainties presented within the system. Within LQGT, it is essential to determine the weighting matrices Q and R since these matrices can be used within the firefly algorithm to solve optimization problems to improve the trajectory tracking and response time. The LQGT is operated by combining two processes from a Kalman Filter and Linear Quadratic Tracking (LGT). The Kalman Filter will filter potential noises within the data collecting process and predict unknown state variables that will be then collected for the LQT control. The control design will consist of a continuous time Kalman filter and LQT control design through weighting matrices Q and R that has been optimized by the firefly algorithm. The LQT determination process involves defining the vectors of Q and R to be optimized. Then an objective function called ITAE (integral of the time weighted absolute error) is chosen for optimization process since it can produce smaller overshoot and oscillation that other function types. Based on the light intensity I of x within the code presented, light intensity will be calculated based on the function ITAE. Then, x will be used evaluate Q and R for LQT. For the trajectory tracking test, the quadcopter is tasked with moving from 0 and 10 meters in the x and y direction with a system response time: rise time, settling time, and overshoot. From the results gathered, it is proven that the firefly algorithm is an effective algorithm to determine weighting matrices Q and R. Within the LQGT control, the system can predetermine that trajectory with minimal error while maintaining a low lagging time where both x and y are approximately 0.6 seconds in lagging time. In addition, for trajectories: square, triangle, both values of x and y maintained a low RMSE value ranging from 2.3439 x 10^-17 m for x and 5.9 x10^-3 m for y in the square trajectory to 2.5 x 10^-3 m for x and y in the triangle trajectory [2].

**Source 2:** <https://ieeexplore.ieee.org/document/9855290>

A white paper with black text

Description automatically generated

**FLIGHT CONTROL AND LOCATION TRACKING SYSTEMS**

Quadcopters can be controlled using image processing techniques through an eye tracking system. Using the “Viola-Jones algorithm”, developed by Paul Viola and Micheal Jones, it is possible to detect a face image from its non-face counterparts using Haar features and cascade classifier [3]. The Haar features uses a set of human faces to detect their features using a set of rectangles obscuring parts of the face. From here, the eyes can be classified as the darkest rectangle comparing to the upper cheeks, nose bridge, and forehead. This identification process can help form the location, gradients, pixel intensity and size for the facial features. From here, the cascade classifier will process and combine all features to create a human face. The Hough Transform algorithm uses “image analysis, computer vision and digital image processing” to detect the iris of the eye. The eye-movement comprise of three modes: left, forward and right gaze which corresponds to the turning left, going forward and turning right of the quadcopter. With a combination of the Viola-Jones algorithm, the human face can be detected and then processed within MATLAB. From MATLAB, if the left distance from the center of the eye is less than the right, it will be classified as the Left Gaze, then the current position will be transferred to the turning left motion of the quadcopter motion. The experiment is conducted where a camera called OmniVision OV5675 will track the eye movement of the participants with a distance of 30 cm. They are tasked to look into the camera for 5 seconds then gaze into different direction (left then right) with a fixed posture for 5 seconds for 3 times. From the experiment, it is shown that the system can be detect all the eye movements correctly and can even detect movements of the eye when the eyes are closed within 30 to 40% [3].

A diagram of eye with a circle and a circle with arrows

Description automatically generated with medium confidence

**Source 3:** <https://ieeexplore.ieee.org/document/8955346>

Drones can also have a real time map displayed through an Android phone that has a combination of a mapping algorithm and a SLAM algorithm to localize and create an unknown map of the environment [4]. The quadcopter consists of the LIDAR horizontal, vertical navigation and autopilot. The Android phone will conduct the Mission Control (MC) segment to process data and communication. For the control segment, the commands between Android phone and IOIO must be established. The phone will have the capability to interact with the LIDAR through IOIO board. In addition, the SLAM algorithm will be separated into two sub algorithms: mapping and localization of the drone. The mapping algorithm will be tasked with improving information for localizing will the localization process improves that mapping information presented within the data. The mapping algorithm used called “Thrun’s occupancy grid” helps create the grid cells with the sensor range of the drone and update the values to identify the location of where the grid cells are occupied by its surrounding environment. Three conditions are presented where the occupation of the cell will increase if the sensor reading is within range of the grid cell center. The grid cell’s chance of being occupied will decrease if the sensor passed through the cell grid and the grid cell remains the same if the sensor reading does not reach the cell grid. Based on these conditions, the SLAM algorithm can generate a grid map of an indoor space [4]. Using the SLAM algorithm with the LIDAR sensing method, it is possible to control the drone without the need for implementing a GPS to navigate unknown terrain within the environment.

A green screen with a blue and yellow object

Description automatically generated with medium confidence

**Source 4:**<https://ieeexplore.ieee.org/document/7117003>

**QUADCOPTER DESIGNS AND APPLICATIONS**

Multi-copters vary in their design, function, and application. Nowadays, quadcopters are mainly used in surveillance, military purposes, delivery tasks, agriculture, and research development. The SplitFlyer Air quadcopter is a versatile vehicle that can transform from a quadcopter to a bi - copter that uses two propellors within mid-flight [5]. This can be achieved by installing an undocking mechanism for the two bi - copters to be detached safely during flight. This approach can be beneficial during rescue missions if there are multiple SplitFlyer Air can be separated and operated as a swarm. Each bi – copter consists of two sets of clockwise and counterclockwise propellers. To maintain stability and control after disassembly, the bi – copters can be provided with initial angular momentum to supply ample elastic energy to supply the yaw rate and reaching its hovering state with the assistance of the SMA-actuated elastic catapult mechanism. To test the mid-air undocking sequence of the drone, the flight will initiate with a take-off as in quadcopter model. When it reaches desired altitude level, the SMA will be released to which supplies the bi – copters with initial revolving rates. After undocking, the horizontal position control on the bi – copters will be disabled to ensure a smoother control sequency until the yaw rate reaches more then 26 rad s^-1. In this sequence, both Bicopter CCW and Bicopter CW are located within 1.5 and 0.2 m to prevent collisions. Afterwards, the bi – copters can be regulated using the horizontal position method when the yaw rate reaches between 26 and 44 rad s^-1 [5]. With a large revolving speed, the Cascade controller can work more effectively and generate optimal output. Once the yaw rate reaches more than 44 rad s^-1, the Cascaded controller will be replaced with the proposed controller and both bi – copters return to their setpoints. The systems’ flight method proves to be stable since the undocking mechanism has been successfully applied repeatedly to four SplitFlyer Air flights during midair disassembly with a high similarity in its flight characteristics [5].

**Source 5:** https://ieeexplore.ieee.org/document/9761971

A close-up of a drone

Description automatically generated

Flight control is an essential factor in drone maneuverability; however, they do not have the capacity to operate in windy, rainy conditions or tunnels, pipes, ventilation ducts and other narrow spaces. One of the proposed solutions introduces a hybrid flying-driving robot that utilizes built in wheels during scenarios where the drone cannot take flight [6]. The hybrid flying robot FCSTAR can transform from a quadcopter to a driving robot using a sprawling mechanism. The motors can be reusable for flying, driving where the driving mechanism has a bidirectional thrust mechanism that can grasp onto vertical surfaces or slopes. The wheels are activated using the back motors of the drone. There is a 20:1 reduction spur gearbox that increases the torque while reducing the speed of the system. Timing belts and 4 pulleys are used to harmonize the motion between the front and back wheels while keeping the belts off the ground and stable. In addition, the “3D propellers” produces an equal thrust downwards and upwards based on the rotation chosen with a symmetrical airfoil. As established, there are 2 operating modes: flying and driving mode. When flying, the controller will stabilize the drone with potential corrections executed with accelerometers and gyroscope sensors. Within driving mode, the flight control will be disabled by the PWM switch and another remote control will take command of the motors from the secondary receiver. In driving mode, two motors will be used to generate thrust to increase the drone’s grip onto the surface with a variation such as: front thrust, rear thrust and centered thrust. For driving, there are variations presented such as: front drive, rear drive, diagonal drive and 4-wheel drive. Based on these specifications, the quadcopter proves to be a robust system that does not require any form of excessive maintenance [6].

**Source 6**: https://ieeexplore.ieee.org/document/9424378

A close-up of a drone

Description automatically generated A diagram of a robot

Description automatically generated

Drones not only can be used for surveillance, and rescue missions, they can also be utilized within the commercial delivery industry. Amazon’s MK30 Prime Air delivery drone that can deliver under 5 pounds in under an hour that can traverse in light rain conditions [7]. Since MK30 drone will be delivering packages within Lockeford and College Station, this operation requires constant maintenance. Therefore, the MK30 has a range increase with temperature tolerance and safety features implemented to fly during light rain. To reduce the noise that accompanies the drone, the MK30 has implemented custom designed propellers to reduce 25% of the perceived noise. Furthermore, the system can detect other people, pets and obstacles by the sense-and-avoid system that also helps the drone operate at a high distance while operating autonomously. The design proves to be reliable and safe since it has been evaluated by the Federal Aviation Administration [7].

A white and blue drone with blue legs

Description automatically generated

**Source 7**: https://www.aboutamazon.com/news/transportation/amazon-prime-air-delivery-drone-reveal-photos

In general, drones can be applied in various ways within military industry, farming industry, research, and other specialized fields with the purpose of carrying out missions in hazardous environments without the need of human interference. This results in an efficient method varying from gathering crucial data, accessing harsh environments, and assisting humans with accelerating their businesses or operations. Based on its advanced control systems such as: Reinforcement Learning, Linear Quadratic Gaussian Tracking (LQGT), the drone can predict its path through various iterations while fine tuning its tracking accuracy. Drones can also be accessible for people with disabilities since eye tracking technology with Viola-Jones algorithm can detect eye movements with a high accuracy rate. Besides, drone tracking can be easily controlled when the SLAM algorithm is utilized along with the LIDAR to generate a 3D model of an enclosed space, substituting the need of using a GPS to identify and map unknown terrains and environments. Furthermore, with an innovative design, drones can traverse not only during flight, but also can navigate on slopes or vertical walls with the FCSTAR drone or separate a quadcopter into bi - copters midflight from the SplitFlyer Air.

## Problem Statement Tran

Despite various solutions presented to have improved the drone in terms of design, control and application, there are still prevalent problems that are worth considering. For instance, substituting control system with Artificial Intelligence might help with autonomous drone systems and a quick method to generate desired outcomes in a short time response, however, the process requires an expensive and complex system setup that requires powerful sensors with an established algorithm to execute and process data [11]. Due to this factor, it is integral to discover novel methods that can address the control problems that are crucial to drone technology development.

**Source 11**: https://www.linkedin.com/pulse/how-ai-based-drone-works-artificial-intelligence-use-cases-shawky/

## Contribution An

With the literature review of the drones researched, identify the drawbacks of each drone and suggest solutions to tackle those drawbacks with what you had studied from your prototype drone. You should include how your work can contribute to the state-of-the-art of the drone technology. It can be because you are thinking about a novel application, or to help other young researchers to make a DIY platform.

## Structure of Report Tran

The structure of the report consists of project task descriptions, time management, resources management, organization and partners presentation, risk analysis, team introduction and team contract, conclusion, references, and appendix. The project task descriptions indicate to the reader the main deliverables and milestones that the design team will execute and fulfill. Time management section provides a complete schedule of the project completed within the assigned 12 weeks in which will be represented as a Gantt chart with comments, allocated tasks, and deadlines. The Resource management section includes a bill of materials containing all components of the prototype. The Organization and Partners presentation section identifies the potential stakeholders or companies that will have interest in the project. Risk Analysis present the potential “risks description, risk probability, risk impact, and overall score” that arises during the development stages of the project. Within the Team introduction and team contract, the team will be introduced through their resumes with the team contract established. Finally, the Conclusion summarizes the project proposal and introduces the next steps.

# Project task description

* Project task description: Recommended length: 6 pages  
  The task description should precisely describe the deliverables and milestones of the project.
* Within the deliverables, add milestones to each deliverable. An example is provided:
* From your assigned part, you can divide into smaller parts so that it will be clearer and more precise to the reader.
* For the Deliverable, each Deliverables needs to include milestones. An example is provided:

One of the deliverables is the design of a remote controller. Milestones would be:

- Integration and testing of a joystick with ESP32

- Integration and testing of the push button with ESP32

- Integration and testing of a potentiometer with ESP32

- Remote control testing with espnow

- Visualization with MATLAB App Designer

Theo như thầy thì cái report này sẽ là những prediction mà mình sẽ làm trong thời gian sắp tới. Vậy nên vẫn chưa cần input những thành phẩm mình làm được mà sẽ viết những gì mình định làm trong cái project này. Ví dụ: CAD Modelling - mình sẽ viết như kiểu dựa vào các component mình nhận được, mình sẽ design như thế nào cho phù hợp.

The goal of this design project is to create, build, and operate a quadcopter with four motors. The project is divided into three work packages with detailed tasks for each package will be listed below under the name of Work Package 1, Work Package 2 and Work Package 3.

Throughout the project, several software will be applied to help the team analyzed, calculated and simulated the system. Those include SolidWorks for drone design and model, MATLAB for data collection and graph generated, easyEDA for wiring diagram and PCB design, and last but not least, Visual Studio Code and Platform I/O for coding environment.

## Work Package 1: Design of the Drone

The first work package requires an in-depth understanding of the components used, their placement, connections as well as their impact on the whole system. This stage includes the CAD modelling design of the whole system, wiring diagram of each component as well as a guideline for drone assembly.

### Deliverable 1: CAD Modelling

A black and silver game controller

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Figure 1: Isometric view of the remote controller which is rendered in SOLIDWORKS. This model is going to look exactly like the final product.

A close-up of a drone

Description automatically generated

Figure 2: Isometric view of quadcopter which is rendered in SOLIDWORKS. This model is going to look exactly like the final product.

The project initiation phase consists of two thorough designs for the quadcopter and its controller as shown in Figure 1, and Figure 2. These designs are made by using SOLIDWORKS, an advanced computer-aided design (CAD) modelling application. The objective is to create two thorough models of every component that has been given (see Table 1). Then, measure, calculate and place every component within the SOLIDWORKS’s assembly environment, ensuring accuracy in dimensions and placement when attaching components in reality. This is a very careful process not only helps us fully grasp the structure of the system, but it also sets the stage for perfect integration and performance.

### Deliverable 2: System Wiring and PCB Design

To achieve the powering purpose for the quadcopter, an instruction of electrical wiring and PCB need to be designed. EasyEDA is the recommended tool to fulfill the requirement. The reason why using this application for the project is the online usage between multiple co-workers. By that, the team can communicate, edit the circuit simultaneously and effectively. In addition, the drone uses ESP32 as the “headquarter” to control and assign tasks for specific components. Therefore, the wiring system and PCB design will follow the ESP-WROOM-32 pinout development board [] to obtain the goal.

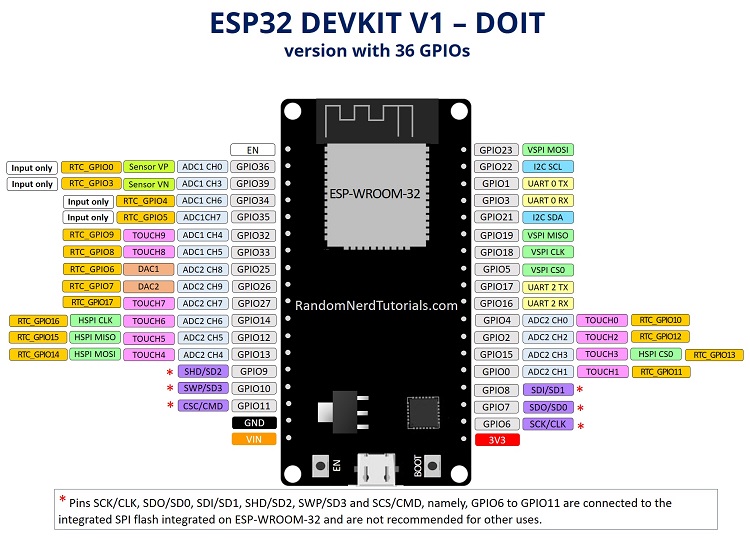


Figure 3: ESP-WROOM-32 pinout development board

### Deliverable 3: Detailed step-by-step Assembly Guide

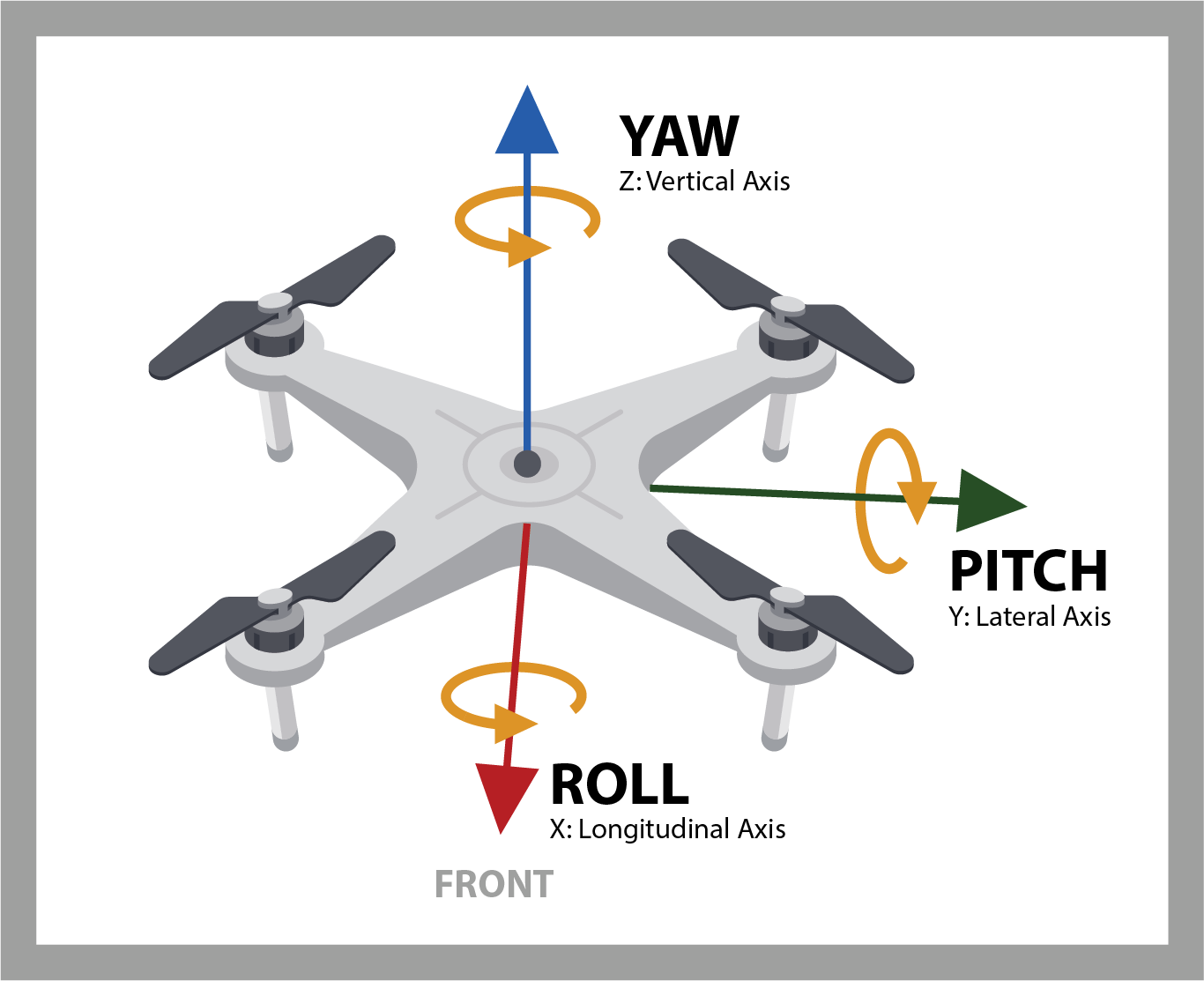
The drone is expected to have 4 motors with a propeller for each motor. The 4 motors will be connected to the body with 4 arms spaced appropriately to not interfere with each other. The motors are each controlled using an ESC. Electronics such as the microcontroller, acceleration and gyroscope sensor, battery and power distribution unit can be stored within the drone body.

The drone arms and body are made of wood, which is easy to acquire, and sturdy enough to survive impacts during the testing phase. It is also affordable and can be easily prepared into simple shapes in case the arms are damaged, or changes of dimensions are required. Its low density and comparable strength to laser cut or 3D printed plastics is a great advantage. The 4 motor mounts are planned to be made of resin through a 3D printed process. This process is chosen due to the mounts demand of complicated shapes, while sacrificing rigidity.

## Work Package 2: Unit Testing

### Deliverable 1: Design of a remote controller for the drone

Based on the design of the PS5 controller, the team will replicate a remote controller with similar functionality into the CAD model as mentioned above to test the quadcopter. Specifically, this controller consists of one dual axis X, Y joystick (control the pitch and roll rates), 2 buttons (control the yaw rate), one potentiometer (adjust the throttle input for thrusting) and one ESP32 (using ESP-NOW wireless communication protocol).



### Deliverable 2: Calibration and functioning of the driving unit

Each component needs to be tested and calibrated individually to make sure the components work as it attended. For ESC and MPU6050, this needs to be carefully checked before doing the assembly since it will have a direct impact on the drone performance. Without calibrating and checking the functionality of each component, not only will the drone not fly as attend but also creating an unsafe testing environment and might damage the components.

### Deliverable 3: Testing and validation of the sensor

#### IMU GY-87

**A diagram with icons on it

Description automatically generated**

Figure 4: Summarize the content of testing and validation of IMU GY-87.

IMU GY-87 sensor is being used. The Microprocessor Unit 6050 (MPU6050), the Barometric Pressure Sensor 180 (BMP180), and the Magnetoresistive Sensor (HMC5883L) comprise this integrated sensor. This model was selected due to its cost-effectiveness and widespread availability.

The application of the MPU6050 and BMP180 modules to the quadcopter is under consideration as part of this endeavor. Acceleration is measured in gravitational units (), while angular velocity () is expressed in degrees per second by the first sensor. The absolute pressure is detected by the second sensor.

This project uses MATLAB software to collect and display values from these sensors. Verification of the angle value is possible by angling the MPU in various angles. According to MPU6050 setup mentioned in section 3.1.3, rotating along Y and X-axis corresponds to adjusting pitch angle and roll angle, respectively. For instance, when the MPU is positioned on a relatively level surface, both angles are approximately equal to . Pitch and roll angle are approximately equal to in absolute value when it is positioned perpendicular to both the Y-axis, and X-axis. This sensor is susceptible to the small vibrations that often prevalent during a drone flight, angle values are affected by these vibrations. An algorithm, therefore, is required to mitigate the noisy angle values, enabling the use of stable data. The Kalman filter technique [] is very advantageous since it effectively mitigates the noisy data. This filter allows the user to balance between newly and previously gathered data, or so-called prediction, to output a more leveled stream of data.

#### GPS

Drones have become very popular in recent years with their extremely convenient features and ability to replace many internal components that were previously handled by humans. With this project, we want to bring a drone with a continuous location update feature so that users can continuously keep track of where their device is on the map.

## Work Package 3: Control and validation of the drone

### Deliverable 1: PID tunning of the roll and pitch (An)

For this project, PID cascade control will be used. The Outer loop of the PID will be designate for angle while the inner loop of the PID will be for velocity. The process as followed:

* + Test the code for PID to make sure it works as attended. In this phase propeller should not be attached to the motor for safety. Turn on the throttle then rotate the drone to see if there a change in motor RPM to make sure the PID is working well
  + After confirming that the code for PID works as attended, attach the drone to the test rig and propeller motor. All safety precaution must check be checked before increase the throttle and test the pitch and roll for the drone

### Deliverable 2: Safety implementation for the drone emergency stop

For safety implementation, these steps can be considered:

1. Prior to testing:

* PID controller must be tested first without propellers to ensure tester safety
* Limitation to the motors’ throttle must be applied to the microcontroller signals. Motors rotating at full speed is not allowed during the testing phase.
* A method of intervention to ESP-NOW can be considered in cases of faulty signals.
* A grounded manual kill switch must be implemented to turn off the drone when it receives faulty signal or lost connection.
* Double check the wiring for short circuits or loose signals
* Double check the motors and propellers before each test to make sure there is no error on the mechanical side, such as jammed motors or loose propellers
* Double check ESP-NOW and throttle values and make sure they are responding correctly.
* Always wear protection (helmets, gloves, visors, etc.) while standing near the testing area to prevent cuts from rotating propellers from out-of-control drone

1. During testing phase:

* The drone should be tested within closed walls to prevent it from flying rogue and harming passers-by.
* Testers must stay clear of the testing zone whenever the drone is powered on
* The kill switch must be handled at all time

1. Free flight:

* Drone flights must take place in vast empty areas where it is allowed in order to minimize harm to passers-by.
* Grounded manual kill switch cannot be used anymore. Instead, an on-board chain of commands to return drone to original position using GPS signals can be utilized.
* Remote pilots are advised to have a drone license to handle the drone in emergencies.

### Deliverable 3: Remote control of the drone

Thrust control: For the drone to fly, the propellers must be spun in a certain direction. Opposite motor positions must rotate in the same direction, and adjacent motor positions must rotate in the opposite direction. It must be noted that the propellers have different shapes fitting their specific rotation and must be assembled to the correct motor positions. The drone’s altitude, or thrust, can be adjusted by increasing or decreasing the motors’ throttle equally.

A close-up of a diagram

Description automatically generated

Figure 5: Sample throttle manipulation

Pitch & roll: Pitch and roll are used to move the drone forward, backward or to the right or left on the drone’s current horizontal plane. This movement can be created by tilting the drone by a certain angle, which can be done by differentiating the propellers’ speeds. The 2 propellers at the front of the desired direction must be smaller than the other 2. More speed difference means larger angle, which, then, means faster drone horizontal speed.

A diagram of a pitch and move back

Description automatically generated

Figure 6: Sample pitch manipulation.

A diagram of a game

Description automatically generated

Figure 7: Sample roll manipulation

Yaw control: Yaw motions are used to rotate the drone left or right along its vertical axis. This movement can be created by equally increasing the opposite motors’ throttle. The rotation of the drone is based on the rotation of the motors of which throttle is increased. For example, increasing clockwise motors rotates the whole drone clockwise. More speed difference means faster drone rotation.

A diagram of a game

Description automatically generated with medium confidence

Figure 8: Sample yaw manipulation

# Time management

* Time management: Recommended length: 4 pages (Tran and Truc)   
  The project must be covered in W12. The project time management should include a readable Gantt chart that show the allocated time and assignee for each task. The Gantt chart must be commented, especially for the allocated time for each task.

References usually seems unimportant for students. However, when you are creating a piece of art, drawing, or research contribution, it is important to be awarded and recognize for your work, which is why the reference section should be well-presented and completed. For instance, if you are interested in robotic research for human-robot interaction, there are fantastic resources given by the Disney research group on organic movement and animatronics [1].

Be careful that the reference section is updated and appear in the chronological order in appears in the report. It should NOT be alphabetical, or chronological in terms of year of publication. For instance, this is another in-line citation about robotic research on the Gough-Stewart platform, which is useful for flight simulator [2].

# Resources management

* Resources management: Recommended length: 5 pages (Long and Truc)   
  The project requires to buy and look for motors, sensors, and material. Some are provided by the University, but the proposal must list a **bill of material** required to successfully build the prototype.

Table 1: A detailed Bill of Material for quadcopter and remote controller.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **BILL OF MATERIAL (BOM)** | | | | | |
| **Item no.** | **Component** | **Description** | **QTY** | **Unit Price (VND)** | **Total (VND)** |
| **Quadcopter** | | | | | | | |
| 1 | Wooden plate | - 15 x 15 x 0.5 cm | 2 | 10,000 | | | 20,000 |
| 2 | Wooden stick | - 1.5 x 1.5 x 18 cm | 4 | 5,000 | | | 20,000 |
| 3 | Force distributor plate | - 4.2 x 1.6 x 0.5 cm  - Acrylic | 4 | 4,000 | | | 16,000 |
| 4 | Motor support | - 5.65 x 3.3 x 1.8 cm  - 3D-printed  - Rigid Resin | 4 | 40,000 | | | 160,000 |
| 5 | Shock proof | - 30 x 50 x 4 cm  - Styrofoam | 2 | 19,000 | | | 38,000 |
| 6 | Mini Breadboard | - 3.5 x 4.6 x 0.8 cm  - 170 points | 2 | 5,000 | | | 10,000 |
| 7 | Full size breadboard | - 16 x 7 x 2 cm  - 630 points | 2 | 20,000 | | | 40,000 |
| 8 | Connector wire | - 10 cm F – M  - 10 cm M – M  - 10 cm F – F | 30 | 500 | | | 15,000 |
| 9 | Microcontroller | - 5.2 x 2.9 x 1.3cm  - ESP32 WROOM CH340 | 1 | 75,000 | 75,000 |
| 10 | BLDC Motor | - 1000kV  - FEICHAO | 4 | 100,000 | 400,000 |
| 11 | Power Distribution Board | - 5 x 3.6 x 0.4 cm  - PDB – XT60 | 1 | 70,000 | 70,000 |
| 12 | Li-Po battery | - 4 cells  - 1550 mAh  - 14.8V | 1 | 473,000 | | | 473,000 |
| 13 | Sensor | - 2.2 x 1.7 cm  - IMU GY-87 | 1 | 130,000 | | | 130,000 |
| 14 | XT60 connector |  | 3 | 7,500 | | | 22,500 |
| 15 | USB cable | - UGREEN USB-A 2.0 to USB-C Cable  - 100 cm (Black) | 1 | 50,000 | | | 50,000 |
| 16 | Electric Speed Controller (ESC) | - 30A | | 4 | 100,000 | | 400,000 |
| **Total** | | | | | | | **1,939,500** |
| **Remote Controller** | | | | | | | |
| 17 | Top cover | - 16 x 10.8 x 2.8 cm  - Acrylic | 1 | ???? | | | ???? |
| 18 | Middle cover | 1 | ???? | ???? |
| 19 | Bottom cover | 1 | ???? | | | ???? |
| 20 | ON and OFF switch | - 3 pins flip switch  - MTS-102 | 1 | 4,000 | | | 4,000 |
| 21 | Microcontroller | - 5.2 x 2.9 x 1.3cm  - ESP32 WROOM CH340 | 1 | 75,000 | | | 75,000 |
| 22 | Joystick | - Dual Axial X, Y PS2 Joystick | 1 | 10,000 | | | 10,000 |
| 23 | Potentiometer | - B5K model  - 5K ohm | 1 | 13,000 | | | 13,000 |
| 24 | Tactile button | - 2.6 x 1.2 x 1.4 cm | 3 | 5,000 | | | 15,000 |
| 25 | Mini OLED I2C screen | - SSD1306  - 128 x 64 px  - 0.96 inches | 1 | 73,000 | | | 73,000 |
| 26 | Li-Po battery | - 2 cells  - 2000mAh  - 7.4 V | 1 | 100,000 | | | 100,000 |
| **Total** | | | | | | |  |

# Organization and Partners presentation

* Organization and Partners presentation: Recommended length: 2 pages (Long and Thuy)   
  Even though the project is a prototype, the group should introduce potential stakeholders or company that could be interested in such project. Domain can be applied in the military, education, entertainment, or services.

# Risk Analysis

|  |  |  |  |
| --- | --- | --- | --- |
| **RISK ANALYSIS TABLE** | | | |
| **Risk description** | **Risk probability (%)** | **Risk impact (%)** | **Overall score (%)** |
| **Team risk** | | | |
| Members can hinder the project progress due to bad time management in doing tasks. | 65 | 85 | 75 |
| Members do not cooperate with others during project. | 50 | 80 | 65 |
| Members can easily be unmotivated while doing project. | 75 | 75 | 75 |
| Conflicts between members. | 30 | 40 | 35 |
| Project Manager do not have enough experience to lead the team. | 15 | 95 | 55 |
| **Project risk** | | | |
| Scope Creep: Lost track in developing the project. | 70 | 80 | 75 |
| Unpredicted behaviour of the drone while testing. | 40 | 90 | 65 |
| Overheating components during testing. | 70 | 80 | 75 |
| Does not have spare parts. | 60 | 60 | 60 |
| Incorrect module assembly or bad electrical wiring leads to malfunctions. | 60 | 80 | 70 |
| Weak wireless signal penetration of ESP-NOW causing lagging in controlling the drone. | 70 | 80 | 75 |
| Misread datasheet leading to wrong wiring connection. | 60 | 80 | 70 |
| Bad connection to the battery making it short circuit. | 30 | 90 | 60 |
| Causing mix signal with battery reverse current while flashing the microcontroller. | 70 | 80 | 75 |
| Bad soldering technique. | 40 | 40 | 40 |
| Wrong coding logic for the microcontroller. | 80 | 20 | 50 |
| Unorganized jumpers wiring causing confusion to detect appropriate connection. | 80 | 60 | 70 |
| Using wrong components. | 40 | 70 | 55 |
| Ignore safety guidelines. | 70 | 90 | 80 |
| Electric shock. | 90 | 80 | 85 |

Note:

* The ‘Risk Probability’ column is scored in the scale from ‘0’ to ‘100’ in the unit of percentage.
* The ‘Risk Impact’ column is scored in the scale from ‘0’ to ‘100’ in the unit of percentage.
* The ‘Total’ column will take the average from ‘Risk Probability’ and ‘Risk Impact’ number.
* High-risk

# Team introduction and team contract

* Team introduction and team contract: Recommended length: 5 pages (everyone)   
  Each team member must include a short resume with picture (half a page for each member), stating their program, their strength, and weakness.   
  A team contract should be signed by all the members and should include specific rules that each member must follow to ensure integrity within the group.

## Team Introduction

**A young person in a white shirt

Description automatically generatedTEAM MEMBER 1 - NGUYEN LE CONG HIEU**: I am currently a junior student pursuing Bachelor degree of Engineering (Electronic and Computer Systems Engineering) at Royal Melbourne Institute of Technology University Vietnam (RMIT University Vietnam). I have studied and experienced fundamental knowledge about electronics soldering, embedded systems (such as working with ARDUINO and ESP-WROOM-32 using C coding language), communication protocols (Bluetooth, Wi-Fi, ESP-NOW and UART) between hardware devices. Those are the necessary skills and foundations required for the Quadcopter project. Moreover, writing professional reports and managing time efficiently while doing tasks assigned in the team are my strengths. I am also an enthusiastic and energetic person, so most of the time I can bring comfortable and fun times to help my team deal with stressful deadlines. One important thing is that I am eager to learn new things and perspectives from my other teammates to improve my presentation skill and develop my confidence even more.

**TEAM MEMBER 2 - NGUYEN LE QUOC AN**: I am currently a third-year student Bachelor degree of Engineering (Mechatronics and Robotic Engineering) at RMIT University Vietnam. I have studied and experienced the fundamentals of control systems, embedded systems, and material. I have a good understanding of C, C++, Arduino IDE and PlatformIO. I have been working in a startup environment for more than 1 year as a technical lead (BlockgenAI) and team lead (The Great Escape). My strength is to maximize the finite amount time for my team to have the highest productivity. Since quadcopter is one of the future technologies, I am eager to participate in this project to create a well-rounded Quadcopter for the future. I am willing to learn new things not only from research and documentation, but also from my colleagues.

**TEAM MEMBER 3 - DO BAO LONG**:

I am now a third-year student pursuing a bachelor’s degree in engineering, specializing in Mechatronics and Robotic Engineering, at RMIT University Vietnam. My GPA is 3.7 on a 4-point scale. Specifically, I obtained the SOLIDWORKS Professional in Mechanical Design (CSWP) certification. In addition, I possess a high level of proficiency in using many software applications, including SOLIDWORKS, Visual Studio Code, NI Multisim, Capture CIS, PCB Editor, and Adobe Illustrator. In addition, I have extensive knowledge in many coding languages, including C, C++, MATLAB, Python, and System Verilog HDL. In addition, I have held the position of Marketing Manager for roughly two years. This role provided me with non-technical abilities in addition to my engineering degrees such as project management, team, and people management. I am appreciative of the quadcopter project because it allows me to utilize all of my abilities, skills, and hobbies to ensure its successful completion, and it also provides me with the opportunity to learn additional concepts, including hardware designs, programming for MPU6050, BMP280m and self-balancing.

**TEAM MEMBER 4 - TRAN QUANG TUAN**: I am currently a third-year Bachelor student majoring in Engineering (Mechatronics and Robotics Engineering) at RMIT University Vietnam. During my time in college, I have acquired fundamental Mechanical and Electronics Engineering knowledge. Combining those with hands-on experience in soldering and drilling, I can be helpful with the assembly process for the project. In addition, I have basic exposure to C++ and MATLAB, and can contribute to calculations and embedded problems. Such insights are beneficial not only for this particular project, but also for prospective ones later in my career. As I am eager to learn new things from practice, this is an exciting chance to explore and acquire new experiences and perspectives from my teammates.

**TEAM MEMBER 5 - MAI CHIEU THUY**: Presently, I am in the culminating phase of my academic pursuit as a final-year student, specializing in Software Engineering. Throughout my academic tenure, I have acquired comprehensive proficiency in various programming languages, including Python, C++, Java, HTML, CSS, and JavaScript. Additionally, I have garnered adeptness in utilizing the Arduino Integrated Development Environment (IDE). Complementing my academic endeavors, I am actively engaged in a professional capacity within the corporate sphere, contributing to the dynamic landscape of Intel Product Company. As part of this esteemed organization, renowned for its prowess in chip manufacturing for laptops and PCs, I assume a pivotal role as the primary custodian of the MAE Chatbot project, thereby fortifying my practical experience in software engineering and project management.

Team introduction and team contract: Recommended length: 5 pages (everyone)   
Each team member must include a short resume with picture (half a page for each member), stating their program, their strength, and weakness.   
A team contract should be signed by all the members and should include specific rules that each member must follow to ensure integrity within the group.

**TEAM MEMBER 6 - LUU NGUYEN BAO TRAN**: Currently a 3rd year Robotics and Mechatronics Engineering student studying at Royale Melbourne Institute of Technology, my specialty includes Computer Aided Design (CAD) in Solidworks, along with fundamental knowledge in C, C++ and MATLAB.

**TEAM MEMBER 7 - TRINH THANH THANH TRUC**: I am currently a junior student pursuing Bachelor degree of Engineering (Mechatronics and Robotics Engineering) at RMIT University Vietnam. I have studied and experienced fundamental knowledge including CAD in SolidWorks, Electronics, Control Systems and coding languages such as C, C++ and MATLAB. I have hands-on experience in soldering and hand drilling. Such abilities are required for not only the quadcopter but also future projects. Moreover, as a learning-oriented person, I am excited to have a chance to explore new knowledge and perspectives from all of my team members and my colleagues, to develop my thinking and skill set for the future.

## Team Contract

The contracted team is expected to work together in order to enhance performance towards a set goal. It is there to keep things clear, fair and straightforward among all team participants.

**Roles and Responsibilities:**

* **Leader/Coordinator:** [Nguyen Le Quoc An] will oversee the coordination of tasks, facilitate communication, and ensure the team stays on track.
* **Researcher:** [All team members] will be responsible for gathering relevant information, data, or resources needed for the project.
* **Presenter/Communicator:** [Luu Nguyen Bao Tran, Trinh Thanh Thanh Truc] will oversee organizing presentations, drafting reports, and communicating progress to stakeholders.
* **Quality Assurance:** [Nguyen Le Quoc An] will review and ensure the quality of work delivered by the team.
* **Deadline Manager:** [Nguyen Le Quoc An, Trinh Thanh Thanh Truc] will track deadlines, distribute tasks, and ensure timely completion of objectives.

**Communication:**

* **Channels:** The team will primarily communicate through: Face to face, Messenger, Discord.
* **Frequency:** Regular updates will be shared during the meeting
* **Response Time:** All team members agree to respond to messages or requests within 24 hours during weekdays.

**Decision-Making:**

**Consensus:** Major decisions will be made through a consensus among team members.

**Voting:** In case of deadlock, a democratic vote will be conducted with a simple majority rule

**Conflict Resolution:**

* **Open Dialogue:** Team members agree to address conflicts openly and respectfully.
* **Mediation:** If needed, a neutral third party will mediate conflicts to find a resolution.
* **Escalation:** Unresolved conflicts will be escalated to Dr. Vu Dinh Son for further action.

**Contribution and Accountability:**

* **Commitment:** Each team member commits to fulfilling their assigned tasks promptly and effectively.
* **Accountability:** Failure to meet deadlines or fulfill responsibilities will be addressed through overtime work.

**Ethical Guidelines:**

* **Plagiarism:** All work must be original or properly cited following the agreed-upon referencing style.
* **Respect:** Team members will maintain respect for diverse opinions, backgrounds, and ideas.
* **Confidentiality:** Any sensitive information shared within the team remains confidential unless specified otherwise.

By signing below, team members acknowledge their understanding and acceptance of the terms outlined in this contract.

Team member 1’s signature: \_\_\_\_\_\_\_\_\_\_\_\_\_­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: 20/11/2023

Team member 2’s signature: \_\_\_\_\_\_\_\_\_\_\_\_\_­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: 20/11/2023

Team member 3’s signature: \_\_\_\_\_\_\_\_\_\_\_\_\_­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: 20/11/2023

Team member 4’s signature: \_\_\_\_\_\_\_\_\_\_\_\_\_­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: 20/11/2023

Team member 5’s signature: \_\_\_\_\_\_\_\_\_\_\_\_\_­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: 20/11/2023

Team member 6’s signature: \_\_\_\_\_\_\_\_\_\_\_\_\_­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: 20/11/2023

Team member 7’s signature: \_\_\_\_\_\_\_\_\_\_\_\_\_­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: 20/11/2023

# Conclusion

* Conclusion: Recommended length: 1 page (Thuy)  
  The conclusion should summarize the project proposal and introduce future works.

# References

* References: Recommended length: n/a  
  The preferred format is IEEE.

|  |  |
| --- | --- |
| [1] | S. Coros, B. Thomaszewski, G. Noris, S. Sueda, M. Forberg, R. W. Summer, W. Matusik and B. Bickel, "Computational design of mechanical characters," *ACM Transactions on Graphics,* vol. 32, no. 4, pp. 1-12, 2013. |
| [2] | K. Wen and C. M. Gosselin, "Forward Kinematic Analysis of Kinematically Redundant Hybrid Parallel Robots," *Journal of Mechanisms and Robotics,* vol. 12, no. 6, 2020. |

# Appendix

A screenshot of a web page

Description automatically generated

A screenshot of a diagram

Description automatically generated