**POLITEKNIK BANTING SELANGOR**

# AI DRONE SECURITY SYSTEM IN HANGAR


| NAME | MATRIC NO. |
|---|---|
| THANUS A/L MOGAN | 24DAM22F1006 |
| AMIR HAKIMI BIN ABDUL HALIM | 24DAM22F1047 |
| KU AHMAD MU’AZ BIN KU AMIZI | 24DAM22F1023 |
| KIREN A/L KALIMUTHU | 24DAM22F1041 |

**DEPARTMENT OF AIRCRAFT MAINTENANCE**


**SESSION 1 2024/2025**

**POLITEKNIK BANTING SELANGOR**

# AI DRONE SECURITY SYSTEM IN HANGAR


| NAME | MATRIC NO. |
|---|---|
| THANUS A/L MOGAN | 24DAM22F1006 |
| AMIR HAKIMI BIN ABDUL HALIM | 24DAM22F1047 |
| KU AHMAD MU’AZ BIN KU AMIZI | 24DAM22F1023 |
| KIREN A/L KALIMUTHU | 24DAM22F1041 |


**A REPORT SUBMITTED TO DEPARTMENT OF AIRCRAFT MAINTENANCE IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR A DIPLOMA ENGINEERING IN AIRCRAFT MAINTENANCE**


**SUPERVISOR:**

**PUAN ROSMAWAR BINTI HUSSIN**

REPORT ENDORSEMENT

This report is being submitted, reviewed, and endorsed to fulfil the conditions and requirements of report writing as specified.

**Checked by:**

Supervisor's Signature : ROSMAWAR

Supervisor's Stamp : ROSMAWAR BINTI HUSSIN
PENSYARAH
JABATAN PENYENGGARAAN
PESAWAT POLITEKNIK BANTING

Date : 26 NOVEMBER 2024

**Endorsed by:**

Project Coordinator's Signature :

Project Coordinator's Stamp : KHAIRUL IZWAN BIN ISMAIL
Pensyarah
Jabatan Penyenggaraan Pesawat
Politeknik Banting Selangor

Date : 3rd December 2024

CERTIFICATION OF PROJECT ORIGINALITY & OWNERSHIP

AI DRONE SECURITY SYSTEM IN HANGAR

SESSION: DECEMBER 2024

| NAME | MATRIC NO. |
|---|---|
| THANUS A/L MOGAN | 24DAM22F1006 |
| AMIR HAKIMI BIN ABDUL HALIM | 24DAM22F1047 |
| KU AHMAD MU'AZ BIN KU AMIZI | 24DAM22F1023 |
| KIREN A/L KALIMUTHU | 24DAM22F1041 |

"We hereby declare that this report is the result of our own work, except excerpts that we have outlined its sources and this project will be the ownership of polytechnic.

**SIGNATURE: WRITER 1**

**SIGNATURE: WRITER 2**

**SIGNATURE: WRITER 3**

**SIGNATURE: WRITER 4**

Endorsed by,

ROSMAWAR

**(SUPERVISOR'S SIGNATURE)**

ROSMAWAR BINTI HUSSIN
PENSYARAH
JABATAN PENYENGGARAAN
PESAWAT POLITEKNIK BANTING

**SUPERVISOR'S STAMP**

DATE: …………………………

# ACKNOWLEDGEMENT

We take this opportunity to express our heartfelt gratitude to all those who have contributed to the successful completion of this project.

First and foremost, we are deeply indebted to our project supervisor, Madam Rosmawar, for their invaluable guidance, constructive feedback, and constant encouragement throughout the course of this project. Their expertise and insights have been instrumental in shaping our ideas and overcoming challenges.

We are also extremely grateful to Politeknik Banting Selangor for providing us with the necessary resources, infrastructure, and a conducive environment to carry out our work. The support and facilities offered have significantly aided us in achieving our project goals.

Our sincere thanks also go to department lecturers, who were always available to address our queries and provide technical support whenever needed. Their patience and willingness to help us troubleshoot and refine our work were invaluable.

We extend our gratitude to our peers and colleagues, who provided constructive criticism and collaborated with us in brainstorming innovative ideas. The discussions and shared experiences helped us broaden our perspectives and explore creative solutions.

We would also like to acknowledge the unwavering support of our families and friends, who have been our pillars of strength throughout this journey. Their constant encouragement, understanding, and sacrifices have motivated us to persevere through challenging times.

Finally, we wish to thank anyone we may have inadvertently overlooked but whose contributions, no matter how small, have played a part in the successful completion of this project.

This project has been a rewarding and enriching experience, and we owe its success to all the people mentioned above. Thank you all for your support and belief in our abilities.

# ABSTRACT

Security is important to any organization who wants to protect their assets. Security checks are often carried out in aircraft hangars by the security personnel appointed by the company to go around the hangar periodically to check for any security hazards. Aircraft hangar is a very busy space where machines and aircraft move in and out so do people work around there. There is potential where intruders may enter the premises or safety hazard for the security personnel itself as there are many contributing factors which could cause an accident to the security staff. To battle these issues, our team has developed a drone with artificial intelligence built into it for assisting security staff in carrying out their periodic rounds. Our product major goal is to reduce the risk of security staff getting in accident and in the same time enhance the security system in the hangar area with the help of AI. The AI onboard the drone will allow the security staff to identify unwanted personnel in the premises by using facial recognition and also fly it far away from the job site which ensures the safety of the security staff. Real time recording is done by the drone so that every security check will have its evidence. The drone is built with open-source hardware and software which ensures the cost of operating and developing it is low. The drone is made out of ABS plastic which makes it durable and less likely to break if in collision. As a result, we will have a reliable piece of hardware which will aid in security sector of the aircraft hangar and in the same time minimize the risk of getting in a accident when working around the hangar.

# TABLE OF CONTENT

## LIST OF TABLES

## LIST OF FIGURES

# CHAPTER 1

# INTRODUCTION

## 1.1 BACKGROUND STUDY

Drones, also known as unmanned aerial vehicles (UAVs), have become a prominent feature in modern technology, blending innovation with many practical applications. These aerial devices are remotely operated or autonomously navigated, allowing them to perform a wide range of tasks with precision and efficiency.

The origins of drones can be traced back to the military, where they were initially used for reconnaissance and target practice. However, over the years, drones have transitioned into the civilian sector, revolutionizing industries such as agriculture, photography, logistics, and environmental monitoring. Their ability to reach areas that are otherwise difficult or dangerous for humans has opened new doors for exploration, data collection, and entertainment.

Drones vary in size and capability, from small consumer drones used by hobbyists and photographers to large industrial drones designed for complex tasks like infrastructure inspection and large-scale agriculture. With advances in technology, drones are becoming smarter and more autonomous, with sophisticated sensors, cameras, and artificial intelligence enabling them to perform complex tasks with minimal human intervention.

This rapid evolution of drone technology brings both opportunities and challenges. While drones offer significant benefits in terms of efficiency and safety, they also raise concerns about privacy, security, and airspace management. As a result, regulatory bodies worldwide are actively developing frameworks to ensure safe and responsible drone operation.

In the following sections, we will explore the diverse applications of drones, the technologies that drive their innovation, and the ethical considerations that come with their use. Join us as we dive into the world of drones, discovering how these remarkable devices are shaping the future across a wide range of industries.

On the other hand, Security guards in hangars play a pivotal role in maintaining a secure and orderly environment, ensuring the safety of aircraft, equipment, and personnel. These expansive structures, where aircraft are stored, maintained, and repaired, require constant vigilance to prevent unauthorized access and detect potential security threats.

One of the primary responsibilities of hangar security guards is controlling access. They monitor entry points, checking identification and badges to ensure that only authorized personnel are allowed inside. This access control is crucial in safeguarding sensitive areas and high-value assets within the hangar.

Beyond controlling access, security guards are responsible for ongoing surveillance and regular patrols throughout the hangar. They monitor the facility through a network of CCTV cameras and maintain a visible presence as they walk their assigned routes. These patrols help identify and address any unusual or suspicious activities, contributing to a safe environment.

In addition to surveillance, hangar security guards are trained to respond swiftly and effectively to security incidents and emergencies. This includes incidents like unauthorized entry, equipment tampering, fire outbreaks, or accidents within the hangar. Their emergency response training ensures they are prepared to take appropriate action, minimizing risks and coordinating with emergency services if needed.

Security guards also play a key role in maintaining safety compliance. They interact with hangar personnel and visitors, providing guidance on safety protocols and enforcing rules as needed. This might involve checking safety equipment, ensuring clear access to emergency exits, or reminding staff of proper safety procedures.

Overall, the presence of security guards in hangars helps deter theft, vandalism, and unauthorized access, while also promoting a culture of safety and compliance. By performing these critical duties, they contribute to the smooth operation of hangar activities and the safety of everyone within the facility.

Figure 1.1: Drone


Figure 1.2: Security Guard at Hangar Area

## 1.2 PROBLEM STATEMENTS

Traditional security measures, heavily reliant on human personnel, face several limitations that hinder their effectiveness and increase operational risks. These limitations include restricted surveillance coverage, exposure to hazardous environments, limited mobility and flexibility, and the high costs associated with maintaining a human security workforce.

Human-based security operations often struggle with fatigue, slow response times, and reduced visibility in challenging conditions such as low light or hard-to-reach areas. Furthermore, safety risks to security personnel when patrolling dangerous or high-risk locations are significant concerns. The increasing need for comprehensive, cost-effective, and adaptable security solutions has highlighted the shortcomings of traditional security methods.

This problem is particularly pronounced in large-scale environments like industrial sites, agricultural fields, and major events, where the ability to monitor vast areas quickly and efficiently is crucial. Additionally, the challenges in collecting and analysing real-time data for rapid decision-making further complicate effective security operations.

## 1.3 PROJECT OBJECTIVES

### 1.3.1 General Project Objectives

- To design a security system in the hangar using drones.
- To develop better surveillance and safe place around the hanger.
- To demonstrate a drone conducting the check-around.
- To evaluate the effectiveness of the security around the hangar area 24/7 despite the situation.

### 1.3.2 Specific Individual Project Objectives

#### 1.3.2.1 Product Structure

- To achieve the drone for monitoring room, it must look for the specific part of drone. The core will be a drone platform, like a manoeuvrable multi rotor or a fixed wing. Next is equipped with various sensors, the drone can gather detailed information about a room or the environment. For example, a high-resolution camera will capture visual data and else. A reliable GPS unit will provide precise location information within the space

#### 1.3.2.2 Product Mechanisms

- To build a drone with a better and smoother mechanism. A mechanism where it eases the process of flying the drone with minimal difficulties. This includes on better lift-drag ratio.
- To develop a better system on the propulsion system and flight controlling system. The components used needs to be suitable and well fit.

#### 1.3.2.3 Software / Programming

- To build a stable system to run an AI driven drone to ensure maximum security is achieved. Autonomous drones require stable system to operate so it will work effectively at any situation and prevent unwanted behaviours during operation. This reduces effort for monitoring the operation.
- To develop a stable software would allow the drone to achieve peak level of security by working without flaws. This will ensure the drone is optimized to adapt any situation at any given time. Software and the programming are the groundwork of this entire project. Failing this will eventually mean the project is a no go.

#### 1.3.2.4 Accessories & Finishing

- To make the drone more visible at night, it is recommended to install a lighting system. Additionally, a collision avoidance sensor can be added to enhance safety. A camera can also be installed for surveillance purposes. It is crucial to choose a bright colour for the drone to increase its visibility. Moreover, a propeller guard can be installed to prevent damage to the propellers and prevent any potential accidents caused by the spinning propellers

## 1.4 PURPOSE OF PRODUCT

### 1.4.1 SCOPE PROJECT

This AI drone is designed to ease the security checks conducted in the hangar area based on the schedule that has been determined. This will reduce the cost significantly and conduct the task in a shorter period compared to the security guards conducting it.

This also increases the hangar's safety and security system more robust. It can record and store the footage that can be excessed at any time for any enquiry purposes or back tracking purposes.

## 1.5 SCOPE OF PROJECT

### 1.5.1 Product Structure

This drone has installed a specific feature that can meet a requirement of our objective on this product. Like the drone uses a fixed wing that can coverup a larger space. To support the propeller, we use a 1000kv brushless motor each side. For the system component, we use GPS compass M8N module, GPS folding holder, limo voltage display and gimbal set.

### 1.5.2 Product Mechanisms

This drone has a better lift-drag ratio as all the calculations are made according to each component and design. It uses a high-powered DC motor which rotates the propellers of the drone at higher RPM and ensures the best flight experiences.

As for the systems, it is easy to be handles it requires just basic drone knowledge to operate it from a stationary point covering a large area of the hanger.

### 1.5.3 Software / Programming

- For this AI drone we will be using C++ as the base programming language. An intermediate software will be used to communicate with the drone and the ground station unit which is ArduPilot. ArduPilot is an open based software developed for autonomous UAV which is used to command the drone with the C++ program file.

- Secondly, we use QGroundControl and MissionPlanner to assign the location for the home point and route planning. This software will help to monitor the drone's status and live location of it. At the same time, this software could be used to record the route the drone had flew and plan timing for routine workspace inspection. Lastly, we incorporated MavLink system to monitor the status of the drone. It's a code run on Linux devices to monitor the live status of the drone like flying speed, battery percentage, GPS coordinate, etc.

### 1.5.4 Accessories & Finishing

It is crucial to install a lighting system on the drone, such as LED flashing lights, to make it visible at night during operation. To ensure the safety of the drone during flight, sensors such as Lidar and ultrasonic sensors should be installed to avoid collisions with the surrounding environment. Additionally, installing a camera serves multiple purposes, including monitoring the surrounding conditions during operation. It's important to choose bright colours such as white, yellow, or green to increase visibility and avoid using dark colours. Lastly, installing a propeller guard around the propeller can prevent potential damage and incidents.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 GENERAL LITERATURE REVIEW

### 2.1.1 Demand in Aviation

Aviation security encompasses a variety of measures and resources designed to safeguard civil aviation from unlawful interference, such as terrorism, sabotage, and threats to life and property. The aviation industry must ensure the safety and airworthiness of its aircraft to mitigate potential internal risks to airlines.

One potential risk is the threat of terrorism. Aviation has been a prime target for terrorist attacks due to the potential for massive casualties and widespread fear. Strict security measures help to prevent hijackings, bombings, and other forms of terrorism. (Britannica**,** n.d)

Furthermore, maintenance activities in hangar areas are crucial to prevent the loss of valuable airline assets. Security measures protect aircraft and infrastructure from theft, vandalism, sabotage, and other criminal activities.

Comprehensive security in aviation is essential for protecting lives, assets, and the integrity of the global air travel system. It includes preventive measures, compliance with regulations, and the capacity to respond to emerging threats effectively.

In order to prevent errors, risks, and accidents, the security systems need to be upgraded to keep pace with advancing technology such as artificial intelligence, machine learning, and biometrics, which offer new tools for enhancing security. Upgrading security systems to incorporate these technologies can improve threat detection and response times.

### 2.1.2 Type of Security System

#### 2.1.2.1 Security Guard Services

Security personnel are commonly employed globally to monitor and patrol areas in order to ensure adherence to safety standards. However, it's important to recognize that security personnel, like all individuals, have limitations and are susceptible to human error. One area of potential concern is the risk of complacency over time. If security personnel do not regularly encounter significant threats, there is a possibility that they may become less attentive to their duties. This could lead to reduced vigilance and a decreased ability to respond effectively to emergencies.

Additionally, while technology is an important asset in security, there is a possibility that security guards may become overly dependent on it. Relying too heavily on surveillance cameras or alarms may lead to a decreased awareness of their immediate surroundings, potentially allowing security breaches to go unnoticed. Lastly, it is important for security guards to meet specific physical requirements in order to effectively carry out their duties. Certain physical limitations, such as health issues or injuries, may impact their ability to patrol areas, respond to emergencies, or perform other physically demanding tasks.

#### 2.1.2.2 Closed Circuit Television (CCTV)

Closed-circuit television (CCTV) has become a common part of modern life. It is a network of cameras that send video signals to monitors in specific areas. CCTV enhances security by deterring potential criminals and providing valuable evidence for investigations. It is also used to monitor traffic flow, work areas, and wildlife behaviour without disturbing natural habitats.

CCTV plays a role in enhancing safety by identifying potential hazards and allowing for quicker intervention to prevent accidents or injuries. Additionally, it provides an extra layer of security by allowing authorized personnel to monitor real-time footage from anywhere. While CCTV is effective, it is not the only security solution available. Security guards, alarm systems, and access control systems also play important roles. Combining these methods provides the most effective security strategy.

## 2.2 SPECIFIC LITERATURE REVIEW

### 2.2.1 Product Structure

#### 2.2.1.1 Basic Design of Main Structure

The propeller framework is a critical component of a drone's design. The choice of propellers can significantly impact the drone's performance, including its speed, manoeuvrability, and noise levels. For example, the Octo XB propeller framework, or quadcopter, is designed to provide a high thrust-to-weight ratio, making it suitable for high-performance drones.

With its four propellers, the quadcopter design offers exceptional stability and control due to the balanced rotation of two clockwise and two counter clockwise propellers. This design is particularly beneficial for beginners and professionals, as it provides a simple and cost-effective solution with fewer mechanical parts, resulting in lower production and maintenance costs. The quadcopter's versatility allows it to be used in various applications, including recreational flying, photography, videography, agricultural monitoring, and delivery services. Additionally, the quadcopter's safety features, such as automatic return to home and obstacle avoidance, make it a safer option for users.

Figure 2.1: Example drone Quadcopter design

#### 2.2.1.2 Drone's Frame Cover

A drone's frame cover performs a job that goes beyond simple protection, significantlyaffecting the drone's overall effectiveness and performance. First of all, it provides protection from dust, moisture, collisions, and other environmental threats for sensitive electrical components including the GPS module, flight controller, and telemetry radio. This protection is essential to ensuring the drone's dependability and extending the life of its vital components.

In addition, the frame cover is crucial for improving the drone's aerodynamic efficiency. Properly crafted coverings reduce drag and turbulence, enhancing the drone's velocity, effectiveness, and stability. This is particularly crucial for high-performance drones used in aerial photography or racing. Moreover, an aerodynamic frame cover lowers drag overall, which is important for drones that run on batteries since it leads to longer flying durations and increased range. The drone can operate for longer periods of time because to its efficiency, which also translates to lower battery consumption.

Moreover, the longevity of the drone is greatly enhanced by the frame cover. Constructed with robust materials like as carbon fibre or high-impact polymers, it cushions impacts during collisions or forceful landings, protecting the drone's framework and averting expensive maintenance or replacements. Therefore, the frame cover is an essential component of contemporary drone design and operation as it not only increases aerodynamic performance and efficiency but also guarantees the drone's durability and lifetime.

Figure 2.2: Drone Frame High Strength 3D Printed

### 2.2.2 Product Mechanisms

#### 2.2.2.1 Type of Motors

2.2.2.1.1 Brushed D.C Motor

Most of the lightweight drone uses brushed motor. Brushed motor is internally commutated motor which uses direct current. Brushed motor is one of the longest motors used for about 10 decades. These motors are used for commercial and industrial buildings too. Brushed motor is simple and compact design which is easier to be maintained. The down sight of this motor is it’s noisy and consumes more power to run.

Figure 2.3: Brushed D.C Motor

2.2.2.1.2 Brushless D.C Motor

Brushless motor is widely used in drones for their high RPM and power efficiency. Brushless motor is electronically commutated motor. Brushless motor is more suitable for this AI Drone as it has longer lifespan and more energy efficient which allows it to consume less battery and fly for a longer period. Brushless motors are easier to replace and be calibrated.'

Figure 2.4: Brushless D.C Motor

### 2.2.2.2 Electronic

#### 2.2.2.1 Types of Flight Controllers

2.2.2.1.1 Regular Flight Controller/ESC Stack

This particular setup is a two-board stack consisting of flight controller and electronic speed controller (ESC) for the motors. This setup is used for smaller drones where space is limited and doesn't use high power motors which doesn't required high power ESC to run it. This compact setup reduce weight, but the drawback is it lacks on power.

Figure 2.5: Regular Flight Controller

2.2.2.1.2 AIO Flight Controller

This is just a single board flight controller which requires external ESC to be connected. This setup is done on larger drones where the motor requires dedicated ESC’s to run them. This is usually used on drones that are bigger then 470mm size.

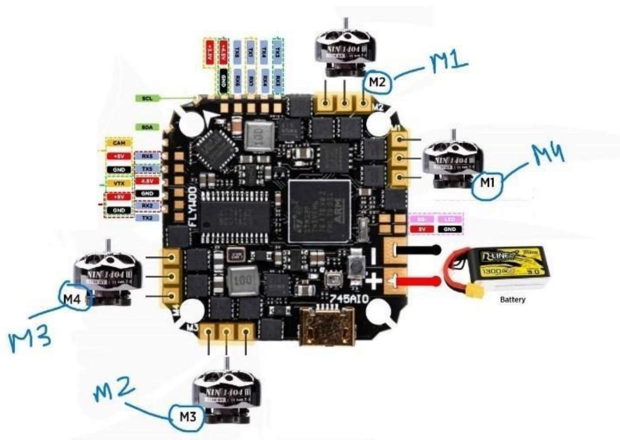



Figure 2.6: AIO Flight Controller

2.2.2.1.3 Ardupilot Mega (APM) Flight Controller

This flight controller is a professional quality Inertial Measurement Unit (IMU) autopilot that is based on Arduino Mega Platform. This allows the flight controller to be programmed and link it to software which allows it to fly autonomously. This will be the flight controller be used in our AI Drone Security System to control the drone autonomously with associated software and accompaniment computer.

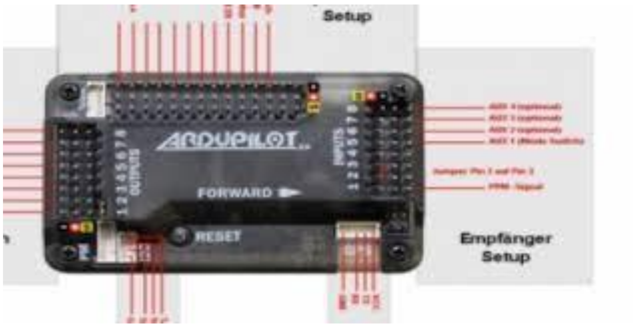



Figure 2.7: Ardupilot Mega Flight Controller

### 2.2.2.3 Propellers

2.2.2.3.1 Material of Propeller

The most common material available for propellers is ABS plastic, carbon fiber and wood. For this project we will be using ABS plastic propeller as it is cheap and widely available. Big drones use carbon fiber as they are lighter and more durable for heavy load usage but the down sight of it is it's very expensive and fragile. Lastly, wood propellers are rarely found, it's mostly used for drone conditions are heavy and sensitive to humidity and temperature changes. Wood propellers are more aerodynamic and quitter then the other options stated above but it requires special maintenance which is expensive and requires additional skills.

Figure 2.8: Types of Propellers

2.2.2.3.2 Size of Propellers

The size will depend on the size and the weight of the drone. Generally, bigger drones will use larger prop and smaller drones uses smaller prop. Bigger prop provides more thrust while consuming less power to lift heavy drones and vice versa for lighter drones. For our AI Drone we will be using 9045 propellers.

2.2.2.3.3 Number of Propeller Blades

There is various type of blades used in drones but widely used are two-blades, three-blades and four-blades. The number of blades depends on the size of the drone and movement it makes. More the number of the blades means more lift is provides and major movements can be done like in drone racings. We will be using a two-blade propeller as our drone is small and light.


Figure 2.9: Sizes of Propeller

### 2.2.2.4 Drone Frames

2.2.2.4.1 Ideal Frame

The frame which is ideal for this AI drone build would be Hybrid-X. This frame makes the design compact in the same time giving enough room to fit every electronic and AI hardware's. It is also made of abs plastic meaning it’s crash resistance and more robust. This also allows proper fitment for the camera position that is required to detect with AI.

2.2.2.4.2 Material of Frame

Widely used material is carbon fibre and ABS plastic. ABS plastic is cheaper and more impact resistance. Carbon fibre frames are lighter and more fragile. In the same time carbon fibre frame is more expensive. For this project, we will be using the ABS plastic frame as it is cheaper and easier to be modified for the use cases.

2.2.2.4.2 Drone Frame Configuration

There are many configurations of drone frames. The widely used drone frames are H-frame, True-X, Deadcat, Box Frame, Stretch-X, and many more. Every of this frame have their use cases. The use cases are defined by the weight of the drone, the manoeuvres it makes and center of gravity of drone.

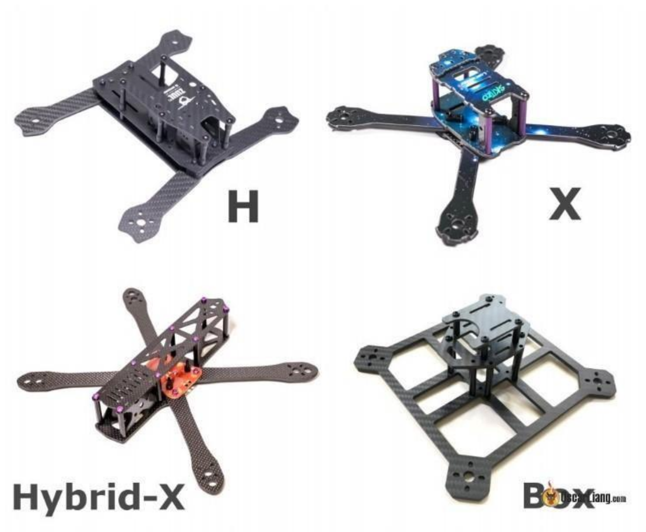



Figure 2.10: Drone frame Configuration

### 2.2.3 Software / Programming

#### 2.2.3.1 Types of Raspberry Pi

2.2.3.1.1 Model B

Linux operating system based mini computer. Uses SD card for internal storage and has 512mb of on-board RAM. It was released in April 2012. Uses ARM1176JZF-S 700MHz processor to run the entire system. It consist of Ethernet port, usb port, SD card slot HDMI output, audio jack , Wi-Fi and Bluetooth.

Figure 2.11: Raspberry Pi Model B

2.2.4.1.2 1 Model A+

Released on February 2013, a lower end version of Model B. It uses the same CPU as the Model B but with a lower on-board RAM 256mb.It has all the AIO ports except for Wi-Fi and Bluetooth.

Figure 2.12: Raspberry Pi Model A+

2.2.4.1.3 Model B+

Upgraded version of the Model B, released on July 2014. It is similar with Model B but doesn't support Wi-Fi and Bluetooth. This version of the Raspberry Pi board is still in the market.


Figure 2.13: Raspberry Pi Model B+

2.2.4.1.4 Zero Model

Zero model is a compact design version of the model’s above. It provides everything except large amount if AIO slots and doesn’t use the high-power version CPU which allows it to consume less power. It is more suitable for projects as it is small and lightweight design.

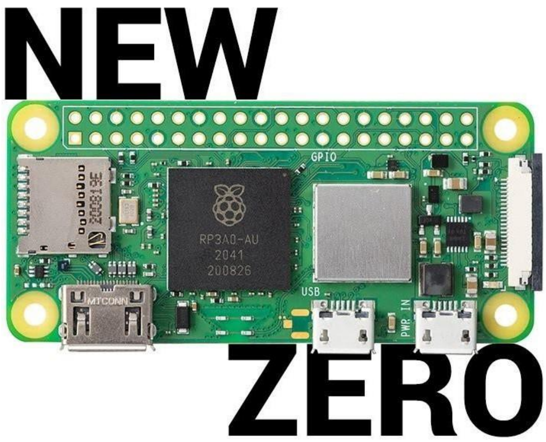



Figure 2.14: Raspberry Pi Zero Model

2.2.4.1.5 Model (2)

It is the upgraded and latest version of the raspberry board stated above. It comes equipped with higher end quad-core processor and larger amount of RAM for more smooth processing. At the same time it comes with latest Wi-Fi and Bluetooth version for easy workability.

Figure 2.15: Raspberry Pi Model (2)

## 2.2.4 Accessories & Finishing

### 2.2.4.1 Typical Accessories On Drone

2.2.4.1.1 LED Flashing Light

Mini LED flashing lights are commonly used in a variety of applications such as indicators and safety signals. They are compact, typically ranging in size from 1mm to 5mm in diameter, making them suitable for installation on drones. These LEDs are available in various colours including red, green, blue, yellow, white, and RGB (multi-colour), making them versatile for drone indication. They typically operate on low voltage, commonly between 1.8V to 3.3V for single LEDs, which results in low power consumption and helps to save battery life.

Figure 2.16: LED Light

2.2.4.1.2 Ultra Sonic Sensor

Ultrasonic sensors have a wide range of functions and applications. One of their functions is to accurately measure the distance to an object. Ultrasonic sensors are commonly used in automotive applications for parking assistance and collision avoidance, detecting when an object comes within a certain range. In addition, these sensors are suitable for installation on drones to prevent collisions with other objects, thus reducing the risk of incidents.


Figure 2.17: Ultrasonic sensor

2.2.4.1.3 Propeller guard

Human Protection and Propeller Protection are crucial features that we prioritize in our products. Our designs prevent accidental contact with spinning propellers, significantly reducing the risk of injury. Our propeller protection shields are engineered to withstand impacts, thus extending the lifespan of the propellers and decreasing maintenance costs. These features are essential for indoor drone operations, where space is confined, and the risk of collision with walls, furniture, or people is higher. We insist on using lightweight and easily installable materials to ensure maximum safety and efficiency.

## 2.3 REVIEW OF RECENT RESEARCH / RELATED PRODUCTS

### 2.3.1 Related Patented Products

#### 2.3.1.1 Patent A

**Table 2.1: Drone Security System for Protecting Privacy and Method for Controlling the Same**

| No. | Patented Product | Patent Summary |
|---|---|---|
| 1. |  | **Patent Title:** Drone Security System for Protecting Privacy and Method for Controlling the Same<br><br>**Patent No:** KR101779938B1<br>**Published Date:** 2017-09-19<br>**Patent Office Country:** Korea<br>**Inventors:** Kim Tae-woo<br>**Abstract:** The present invention relates to a drones security device and a control method thereof for protecting privacy by enhancing security by guiding landing and forced landing by GPS control and jamming when a drone penetrates into a privacy protection area, A security management server for detecting occurrence of GPS and disturbance propagation for determining whether the penetrator is authorized or not and analysing images taken by a security drone, And a security drone that acquires an image and generates GPS disturbance and jamming to control the penetration drones. |

#### 2.3.1.2 Patent B

**Table 2.2: Autonomous Security Drone (Sunflower Lab)**

| No. | Patented Product | Patent Summary |
|---|---|---|
| **1.** |  | **Patent Title :** Autonomous Security Drone<br>**Release Date :** 14 JANUARY 2020<br>**Patent Developer :** Sunflower Lab<br>**Patent Home Country :** United States of America<br>**Abstract :** World's first fully autonomous residential security drone system. It has always-on motion and vibration sensor with artificial intelligence which provides increased security for homeowners. It uses a Beehive system which is a powerful drone-in-box system which integrates with existing security camera and sensor fitted in buildings. It has rapid deployment which allows the drone to take off in under 5 seconds and could cover 4 acre of land in under 30 seconds. It has real-time object tracking and identification which gives clear visual through a high quality live video stream even in low light conditions. |

#### 2.3.1.3 Patent C

**Table 2.3: JOUAV VTOL Fixed Wing Surveillance Drone**

| No. | Patented Product | Patent Summary |
|---|---|---|
| 1. | <br><br> | **Patent Title :** VTOL Fixed Wing Surveillance Drone<br>**Patent Developer :** JOUAV<br>**Patent Home Country :** Chengdu City, China<br><br>**Abstract :** Uses Vertical Take-off and Landing (VTOL) fixed wing drone. This drone have rapid response time for emergencies responses. It can perform perimeter patrols 20 times faster than a manned patrol. It has improved visual capacities from a high altitude which offers wide aerial point of view. It uses high-quality sensor and HD cameras for improved accuracy. It also reduces the risk to security staff as pilots will be safe distance away from the event. Lastly, this drone is designed to save cost andincrease the return of investment of aorganisation. Initial investment of drone tech will be expensive but in a longer term the cost will reduce. |

#### 2.3.1.4 Patent D

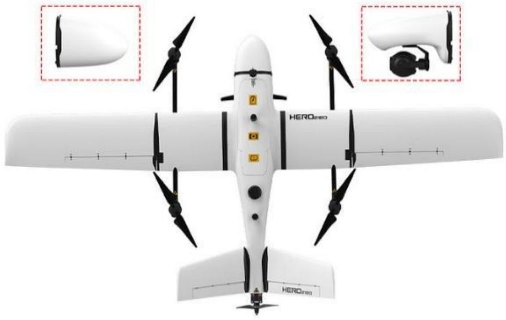
**Table 2.4: Unmanned Aerial Vehicle (UAV) Drone**

| No. | Patented Product | Patent Summary |
|---|---|---|
| 1. | <br> | **Patent Title:** Unmanned Aerial Vehicle (UAV) Drone<br>**Published Date:** September 16 2021<br>**Patent Office Country:** Malaysia<br>**Abstract:** The Royal Malaysian Police (PDRM) has expanded the use of drones throughout peninsular Malaysia to 10 units to further strengthen the country's border control through artificial intelligence (AI) technology in an effort to curb cross-border criminal activities. The use of drones in controlled monitoring can last for 30 minutes to an hour and can be flown in a radius of five to eight kilometers. |

### 2.3.2 Recent Market Products

#### 2.3.2.1 Product A

**Table 2.5: Hero VTOL Fix-wing aircraft**

| | | |
|---|---|---|
| **1.** | <br> | **Product Name:** Hero VTOL Fix-wing aircraft<br>**Published Date:** 11 October 2022<br>**Product Office Country:** China<br>**Inventors:** Makeflyeasy (MFE)<br>**Abstract:** The Hero VTOL is a multi-purpose vertical take-off and landing fixed wing. The unique design of the UAV nose can be replaced, which can be equipped with an orthophoto camera or a tilt camera when used in the field of surveying and mapping and can be equipped with an optoelectronic pod in the field of monitoring. The multi-purpose design expands the range of applications and reduces the cost of flight. |

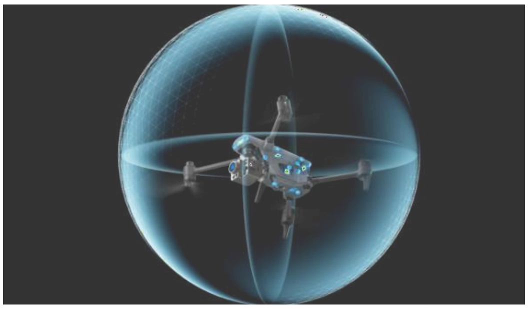
#### 2.3.2.2 Product B

**Table 2.6: DJI Inspire 3**

| **No.** | **Marketed Product** | **Product Summary** |
|---|---|---|
| **1.** |   | **Product Name :** DJI Inspire 3<br>**Publish Date :** April 2023<br>**Product Home Country :** Shenzen, China<br>**Developer :** SZ DJI Technology Co Ltd<br>**Abstract :** Professional camera drone with a dive speed of 9 m/s It's new design provides powerful manoeuvrability which provides accurate controls and extended flight time of 28 minutes. It has Centimeter-level accuracy with RTK positioning which makes flight-route planning more accurate. It also has customizable obstacle avoidance which can be customized to preferred range or completely turned off. At the same time, has 8K full-frame imaging system which records at high quality images. It also has 2 battery system which increases the battery life in the drone. |

#### 2.3.2.3 Product C

**Table 2.7: Autel Alpha**

| No. | Marketed Product | Product Summary |
|---|---|---|
| **1.** |   | **Product Name :** Autel Alpha<br>**Publish Date :** February 2024<br>**Product Home Country :** China<br>**Developer :** Autel Robotics<br>**Abstract :** Autel Alpha is an intelligent industrial drone for multi-purpose use cases. Boasting significant enhancements in autonomous flight capabilities, anti-interference capabilities, obstacle avoidance capabilities, video transmission technology and battery systems which injects robust performance into the flight platform. It has a foldable design and IP55-rating level which tackles most of the challenging environments. It has built-in RTK dual-antenna system which ensures precise control within millimetres when carrying out a mission. |

#### 2.3.2.4 Product D

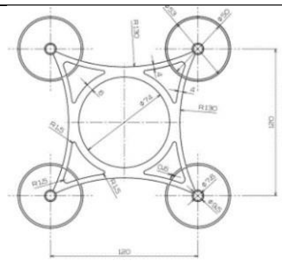
**Table 2.8: DJI Mini 4 Pro**

| **No.** | **Marketed Product** | **Product Summary** |
|---|---|---|
| **1.** |   | **Product Name:** DJI Mini 4 Pro<br>**Published Date:** 25 September 2023<br>**Product Office Country:** China<br>**Inventors:** SZ DJI Technology Co., Ltd.<br>**Abstract:** The drone boasts an impressive 34 minutes of flying time when fully charged. It is equipped with an advanced sensing system, including an omnidirectional binocular vision system and a 3D infrared sensor at the bottom of the aircraft. These sensors enable the drone to effectively navigate around obstacles, particularly when utilizing its ActiveTrack 360 system, which operates an autopilot. Advanced Pilot Assistance Systems (APAS) ensures additional safety by enabling automatic braking and bypassing during flight. |

## 2.4 COMPARISON BETWEEN RECENT RESEARCH AND CURRENT PROJECT

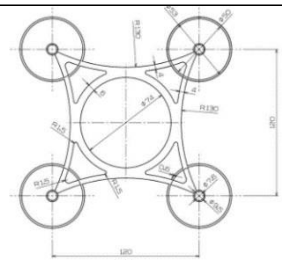
### 2.4.1 Comparison Hero VTOL Fixed Wing Aircraft vs. Drone Security Device vs. AI Drone Security System

**Table 2.9: Hero VTOL Fixed Wing Aircraft vs. Drone Security Device vs. AI Drone Security System**

| PRODUCT | Hero VTOL Fixed wing Aircraft | Drone Security Device | AI Drone (Current Project) |
|---|---|---|---|
| **DESIGN** |  |  |  |
| **SYSTEM** | Artificial Intelligence (AI) and manual remote control | Manual Remote Control | Artificial Intelligence (AI) |
| **BATTERY** | 125 – 136 minutes | 30 Minutes | 30 Minutes |
| **FLYING RADIUS** | 126 – 144 km | 30 – 40 km | 10 – 15 km |
| **SENSING TYPE** | Inertial Measurement Unit (IMU) | A GPS Controller | LiDAR sensor |

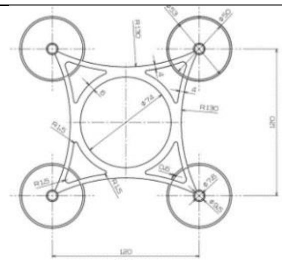
### 2.4.2 Comparison of Autonomous Drone Security (Sunflower Lab) vs DJI Inspire 3 vs Ai Drone Security System

**Table 2.10: Autonomous Drone Security (Sunflower Lab) vs DJI Inspire 3 vs Ai Drone Security System**

| | | | |
|---|---|---|---|
| **DESIGN** |  |  |  |
| **SYSTEM** | Artificial Intelligence (AI) Controlled and Integration with home security system | Manual Remote Control | Artificial Intelligence (AI) |
| **BATTERY** | 15 Minutes | 26 - 28 Minutes | 30 Minutes |
| **FLYING RADIUS** | 600 Meters | 12 -15 Kilometres | 10 – 15 Kilometres |
| **SENSING TYPE** | N/A | Visual Sensors and Dual and Positioning Antennas | LiDAR sensor |

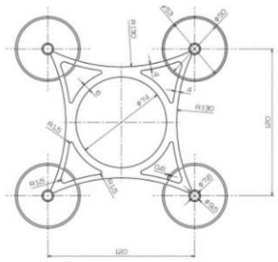
### 2.4.3 Comparison of JOUAV VTOL Fixed Wing Surveillance Drone vs Autel Alpha vs Ai Drone Security System

**Table 2.11: JOUAV** VTOL Fixed Wing Surveillance Drone vs Autel Alpha vs Ai Drone Security System

| | | | |
|---|---|---|---|
| **DESIGN** |  |  |  |
| **SYSTEM** | Autonomous Control | Manual Remote Control | Artificial Intelligence (AI) |
| **BATTERY** | 180 Minutes | 40 Minutes | 30 Minutes |
| **FLYING RADIUS** | 6.5 Kilometres | 30  Kilometres | 10 – 15 Kilometres |
| **SENSING TYPE** | LiDAR sensor | Omnidirectional sensing system | LiDAR sensor |

### 2.4.4 Comparison Unmanned Aerial Vehicle (UAV) Drone vs. DJI Mini 4 Pro vs. AI Drone Security System

**Table 2.12: Unmanned Aerial Vehicle (UAV) Drone vs. DJI Mini 4 Pro vs. AI Drone Security System**

| PRODUCT | Unmanned Aerial Vehicle (UAV) Drone | DJI Mini 4 Pro | AI Drone (Current Project) |
|---|---|---|---|
| **DESIGN** |  |  |  |
| **SYSTEM** | Artificial Intelligence (AI) and manual remote control | Manual Remote Control | Artificial Intelligence (AI) |
| **BATTERY** | 30 – 60 Minutes | 30 Minutes | 30 Minutes |
| **FLYING RADIUS** | 5 – 8 Kilometers | 18 – 25 Kilometers | 10 – 15 Kilometers |
| **SENSING TYPE** | N/A | Omnidirectional binocular vision system | LiDAR sensor |

# CHAPTER 3

# RESEARCH METHODOLOGY

## 3.1 PROJECT BRIEFING & RISK ASSESSMENT

### 3.1.1 Utilisation Of Polytechnic's Facilities

Using the soldering facility to build your drone at polytechnic allows for precise and durable connections essential for reliable flight. Soldering enables secure joins between critical components, like ESCs, motors, and the flight controller, which are vital for stability and performance. With access to specialized equipment, like temperature-controlled irons and desoldering tools, you can customize and repair connections as needed, ensuring robustness against vibrations and movement in flight. Plus, working in a supervised environment provides access to mentors who can offer valuable guidance, enhancing your technical skills for a successful drone build.

## 3.2 OVERALL PROJECT GANTT CHART

| PROJECT ACTIVITIES | | W1 | W2 | W3 | W4 | W5 | W6 | W7 | W8 | W9 | W10 | W11 | W12 | W13 | W14 | W15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROGRAMMING<br>• ROS 2<br>• ARDUPILOT<br>• OPENCV<br>• MAVLINK<br>• C++ | P | ■ | ■ | ■ | ■ | | | | | | | | | | | |
| | E | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | |
| MATERIAL ACQUISITION<br>• DRONE FRAME<br>• BRUSHLESS MOTOR<br>• LI-PO BATTERY<br>• FLIGHT CONTROLLER | P | | | | ■ | ■ | ■ | ■ | | | | | | | | |
| | E | | | | | ■ | ■ | ■ | | | | | | | | |
| PRODUCT ASSEMBLY<br>• STRUCTURE INSTALLATION<br>• ELECTRICAL AND ELECTRONIC ASSEMBLY | P | | | | | | ■ | ■ | ■ | | | | | | | |
| | E | | | | | | | ■ | ■ | | | | | | | |
| FINISHING<br>• WIRE ARRANGEMENT<br>• PERFORM SAFETY INSPECTION | P | | | | | | | | ■ | ■ | | | | | | |
| | E | | | | | | | | ■ | ■ | | | | | | |
| TESTING AND CALIBRATION<br>• FLIGHT TEST<br>• MAPPING<br>• FACE RECOGNITION<br>• TESTING SOFTWARE AND TROUBLESHOOTING | P | | | | | | | | | ■ | ■ | ■ | ■ | ■ | | |
| | E | | | | | | | | | ■ | ■ | ■ | ■ | | | |
| POST-PROJECT REVIEW<br>• COMPLETING THESIS | P | | | | | | | | | | | | ■ | ■ | ■ | ■ |
| | E | | | | | | | | | | | | | | | |

**Table 3.1: Gantt Chart**

## 3.3 PROJECT FLOW CHART

### 3.3.1 Overall Project Flow Chart


Figure 3.1: Overall Project Flow Chart

### 3.3.2 Specific Project Design Flow / Framework

#### 3.3.2.1 Product Structure

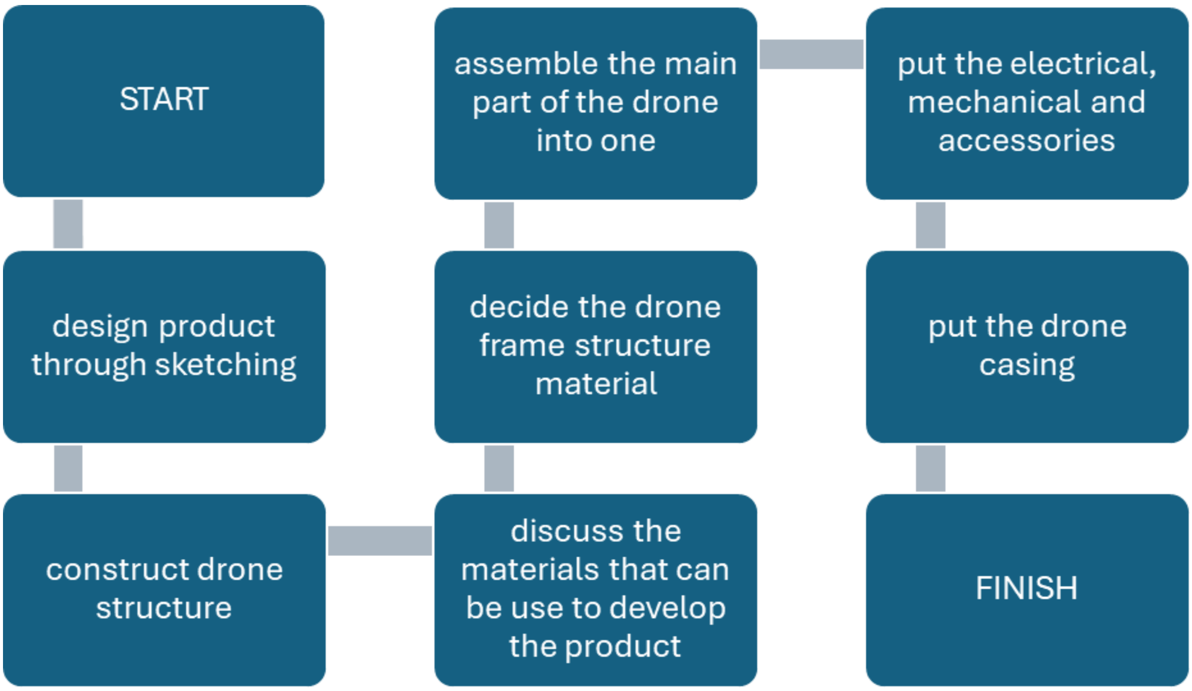



Figure 3.2 Product Structure Design Flow

#### 3.3.2.2 Product Mechanisms

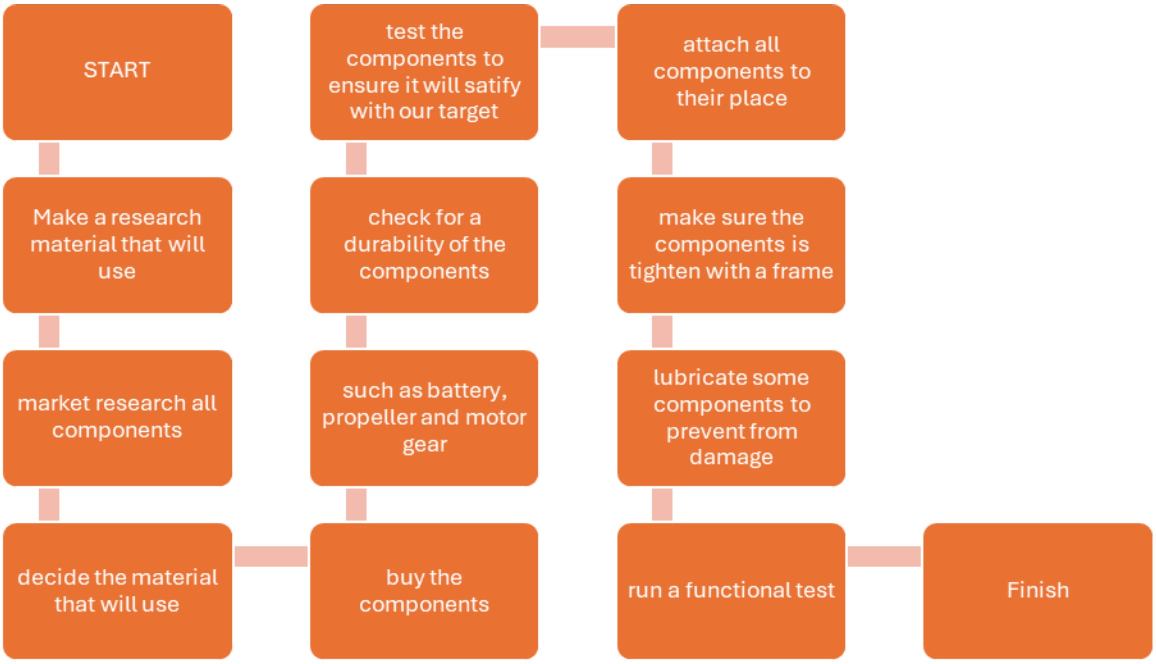



**Figure 3.3 Product Mechanisms Design Flow**

#### 3.3.2.3 Software / Programming

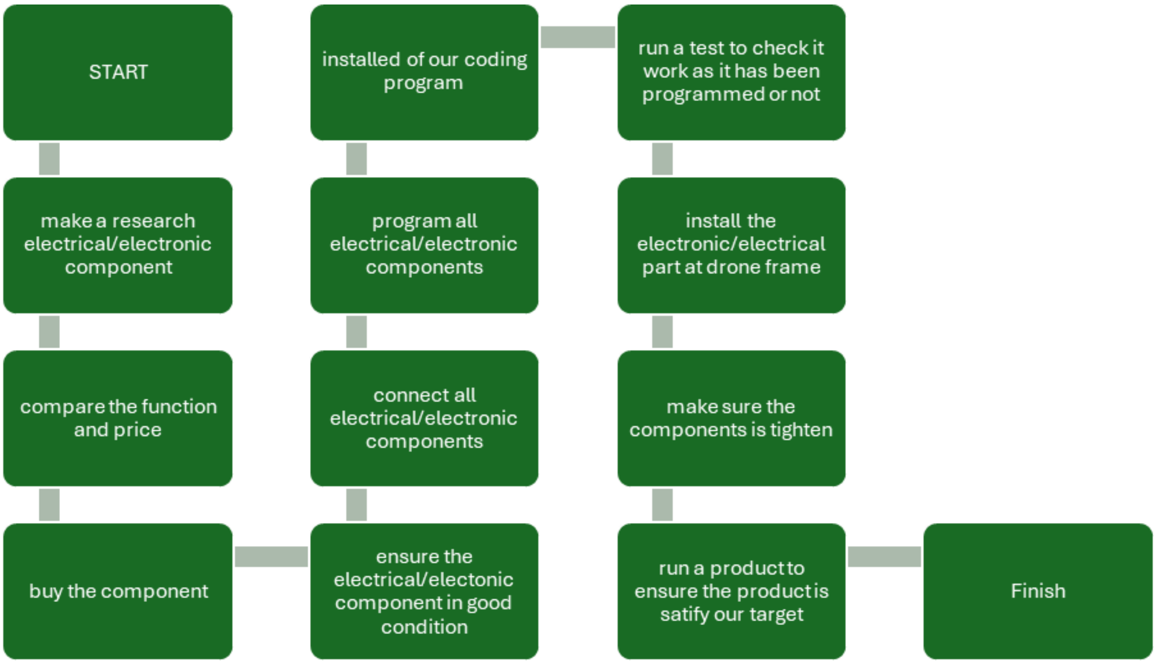



**Figure 3.4 Software/Programming Design Flow**

### 3.3.2.4 Accessories & Finishing

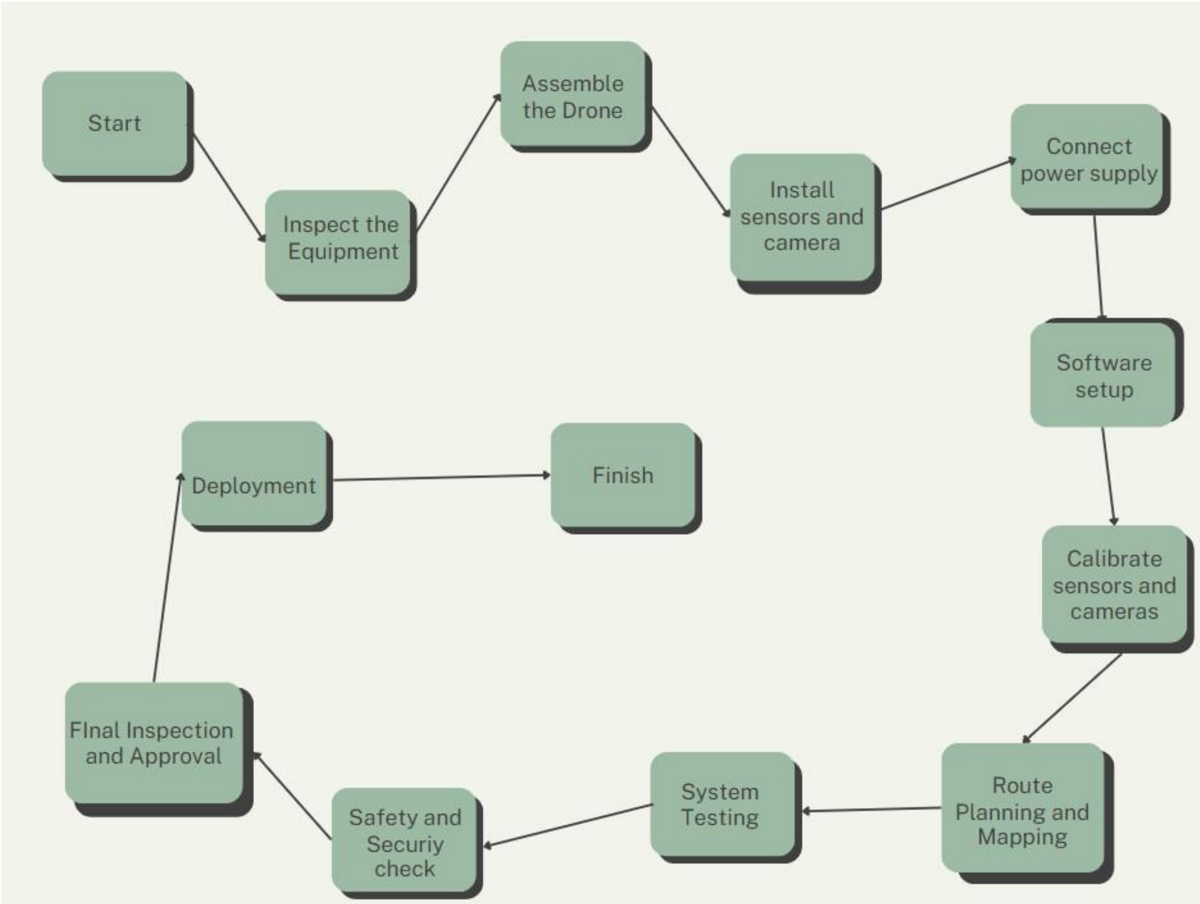
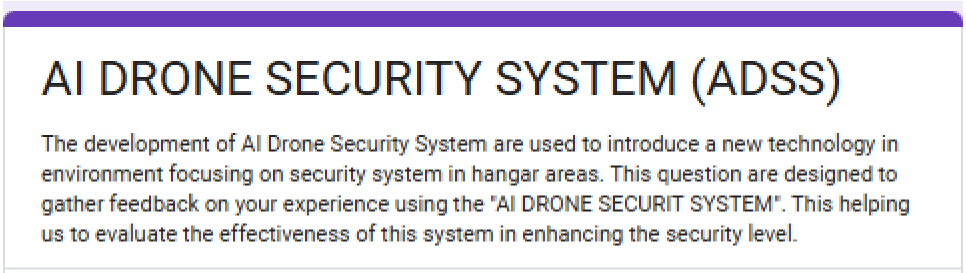



**FIgure 3.5 Product Accessories and Finishing Design Flow**

## 3.4 DESIGN ENGINEERING TOOLS

### 3.4.1 Design Requirement Analysis

#### 3.4.1.1 Questionnaire survey


AI DRONE SECURITY SYSTEM (ADSS)

The development of AI Drone Security System are used to introduce a new technology in environment focusing on security system in hangar areas. This question are designed to gather feedback on your experience using the "AI DRONE SECURIT SYSTEM". This helping us to evaluate the effectiveness of this system in enhancing the security level.

**Figure 3.6: Questionnaire Survey through Google Form**

We have conducted a survey using google form to get our customers feedback as well as the hangar users of Politeknik Banting,Selangor. This form has 2 parts.

Part A: Personal Information

Part B: Questions regarding A.I Security Drone

#### 3.4.1.2 Pareto diagram

| Features | Frequency | Cumulative | Total percentage | Cumulative Percentage | Pareto Baseline |
|---|---|---|---|---|---|
| security | 44 | 44 | 32.35% | 32.35% | 80% |
| safety | 35 | 79 | 25.74% | 58.09% | 80% |
| effectiveness | 35 | 114 | 25.74% | 83.82% | 80% |
| cost | 22 | 136 | 16.18% | 100.00% | 80% |
| GRAND TOTAL | 136 | | | | 80% |

Table 3.2: Pareto Diagram

From the table above, we can understand that enhancement, understanding and acceptable plays a vital role in this project. These three key elements should be focused to ensure it meets the consumer needs. This table is shown in a Pareto Chart Diagram below.

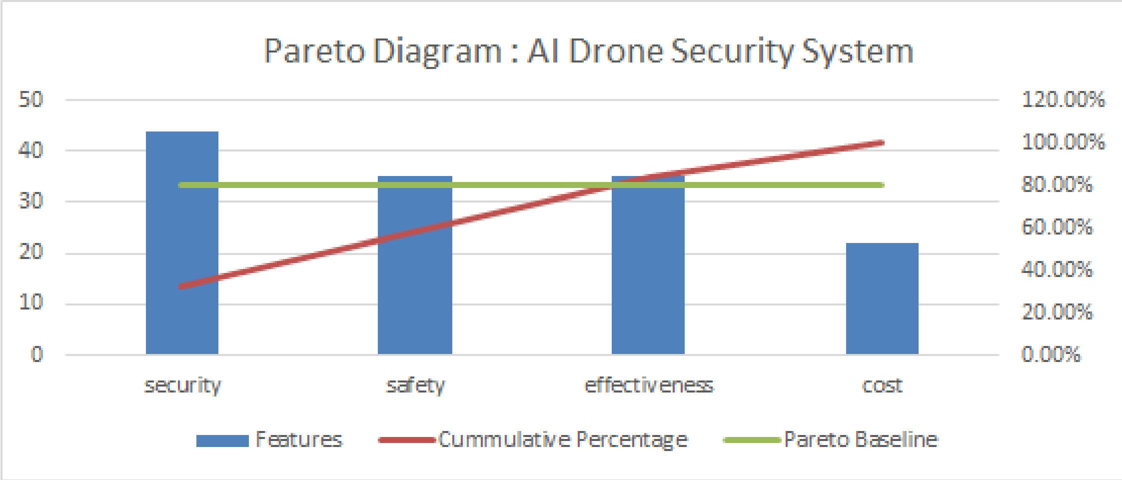



**Figure 3.7: Pareto Chart Diagram**

### 3.4.2 Design Concept Generation

#### 3.4.2.1 Proposed Design Concept 1

| Function | Idea 1 |
|---|---|
| Cost | RM 1000.00 |
| Safety | Error Warning System |
| Security | Hacking Detection |
| Effectiveness | 30 minutes of monitoring connection |

**Table 3.3: Proposed Design Concept 1**

#### 3.4.2.2 Proposed Design Concept 2

| Function | Idea 2 |
|---|---|
| Cost | RM 700.00 |
| Safety | 360° camera |
| Security | Motion Detector |
| Effectiveness | Patrols 1 hour fully charged |

**Table 3.4: Proposed Design Concept 2**

#### 3.4.2.3 Proposed Design Concept 3

| Function | Idea 3 |
|---|---|
| Cost | RM 600.00 |
| Safety | A.I camera |
| Security | Ultrasonic sensor |
| Effectiveness | 30 minutes of monitoring connection |

**Table 3.5: Proposed Design Concept 3**

#### 3.4.2.4 Proposed Design Concept 4

| Function | Idea 4 |
|---|---|
| Cost | RM 800.00 |
| Safety | Auto Landing system |
| Security | Reaches up to 15m height |
| Effectiveness | 45 minutes of battery life upon full charge |

**Table 3.6: Proposed Design Concept 4**

#### 3.4.2.5 Accepted Vs Discarded Solution

| Function | Idea 1 | Idea 2 | Idea 3 | Idea 4 |
|---|---|---|---|---|
| Cost | RM 1000.00 | RM 700.00 | RM 600.00 | RM 800.00 |
| Safety | Error Warning System | 360° camera | A.I camera | Auto Landing system |
| Security | Hacking Detection | Motion Detector | Ultrasonic sensor | Reaches up to 15m height |
| Effectiveness | 30 minutes of monitoring connection | Patrols 1 hour fully charged | 30 minutes of monitoring connection | 45 minutes of battery life upon full charge |

**Table 3.7: accepted vs discard ideas**

Idea 1 was accepted, and the rest of the other ideas were rejected as based on the comparison, idea 1 is has the best design concept for this project.

### 3.4.3 Evaluation & Selection of Conceptual Design

#### 3.4.3.1 Pugh Matrix

| CRITERIA | FACTOR | IDEA 1 | IDEA 2 | IDEA 3 | IDEA 4 | DJI MINI DRONE 4 PRO |
|---|---|---|---|---|---|---|
| COST (RM) | 0.16 | 3 | 3 | 3 | 3 | D A T U M |
| SAFETY | 0.27 | 2 | 2 | 3 | 2 | |
| SECURITY | 0.3 | 1 | 3 | 3 | 1 | |
| EFFECTIVENESS | 0.27 | 2 | 3 | 3 | 2 | |
| TOTAL SCORE | 1.0 | 1.86 | 2.73 | 3 | 1.86 | |
| RANKING | | 3 | 2 | 1 | 4 | |

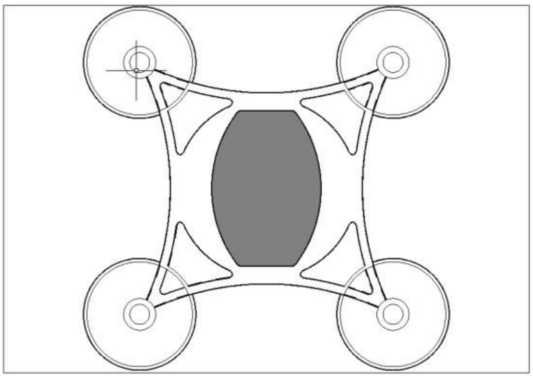
**Table 3.8: Pugh Matrix**

Based on the table above, those are the criteria that play a vital role in completing our product making it different and unique from other products on the market. Concept 3 is our desired project as it has the most positive feedback upon comparing and it’s the most suitable concept.

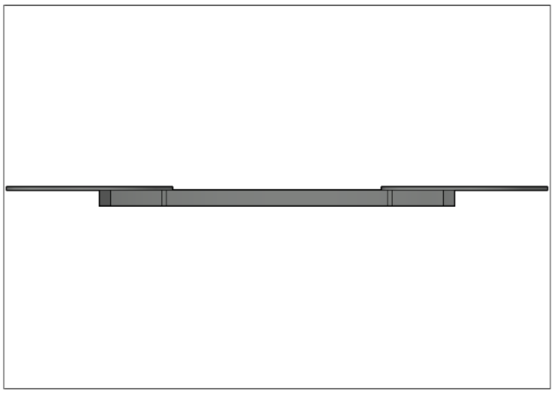
As the products are compared with a product in the market, it is found that concept 3 has all 4 positive feedback which is the most suitable way to make this product.

## 3.5 PRODUCT DRAWING / SCHEMATIC DIAGRAM

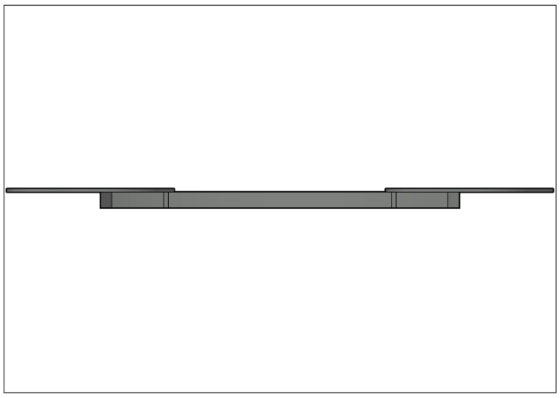
### 3.5.1 General Product Drawing



Plane view



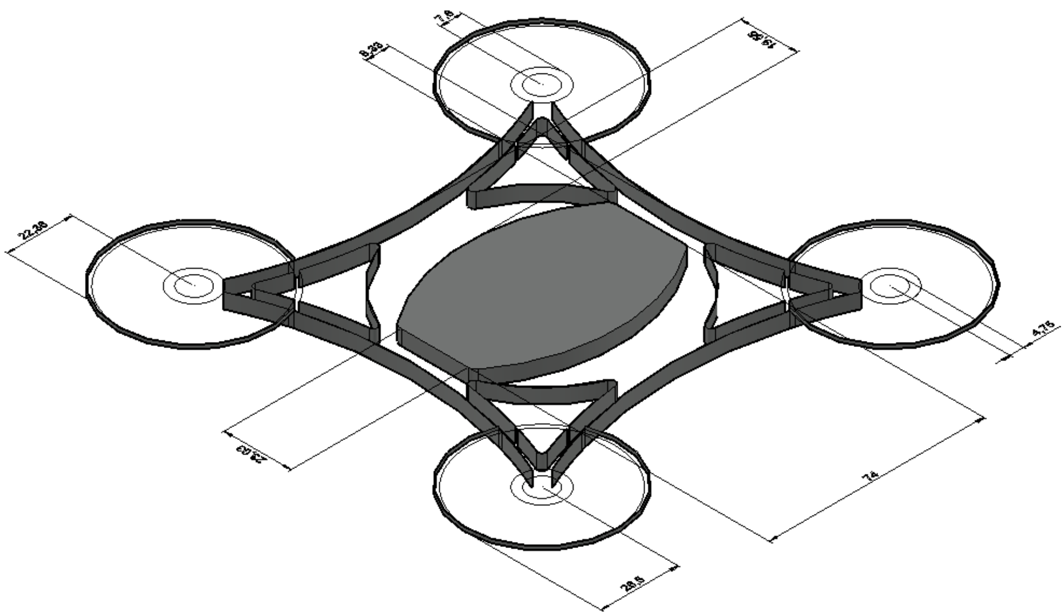
Side view



Front view

| | |
|---|---|
| Name: Politeknik Banting, Selangor | Orthographic view |
| Title: AI Security Drone | Class: DAM 4C |
| Scale: 1:1 | Unit: Millimetres |

Figure 3.8: Product drawing in Orthographic View



| | |
|---|---|
| Name: Politeknik Banting, Selangor | Orthographic view |
| Title: AI Security Drone | Class: DAM 4C |
| Scale: 1:1 | Unit: Millimetres |

Figure 3.9: Product sketch with dimension

### 3.5.2 Specific Part Drawing / Diagram

#### 3.5.2.1 Product Structure

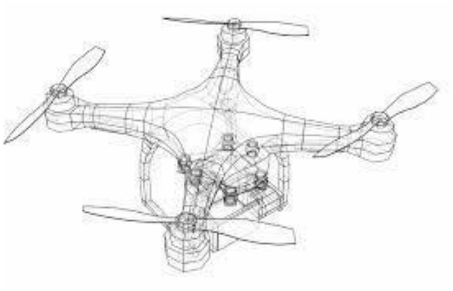


Figure 3.10: Quadcopter Drone Sketch

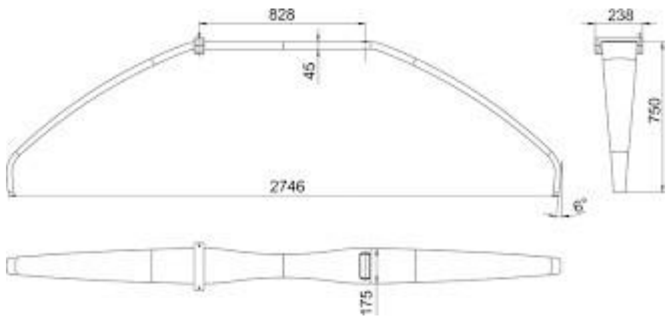



Figure 3.11: Main Landing Gear of Drone

#### 3.5.2.2 Product Mechanisms

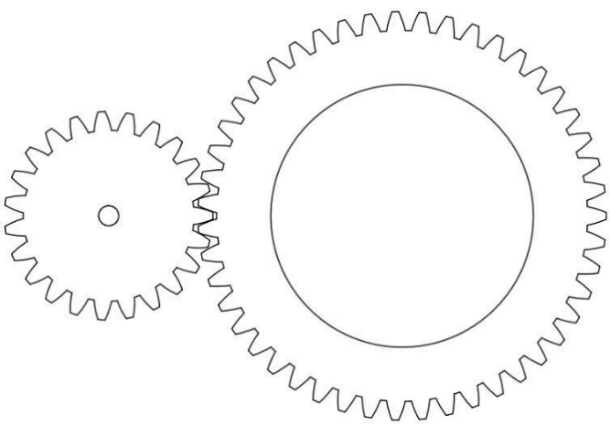


Figure 3.12: Spurs Gear

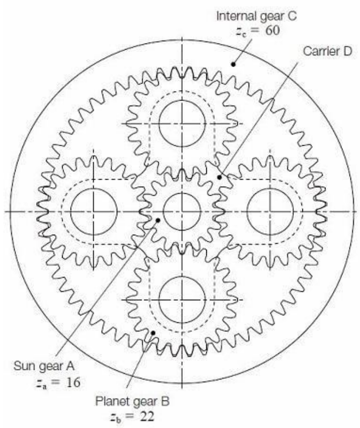



Figure 3.13: Planetary Gear

#### 3.5.2.3 Software / Programming

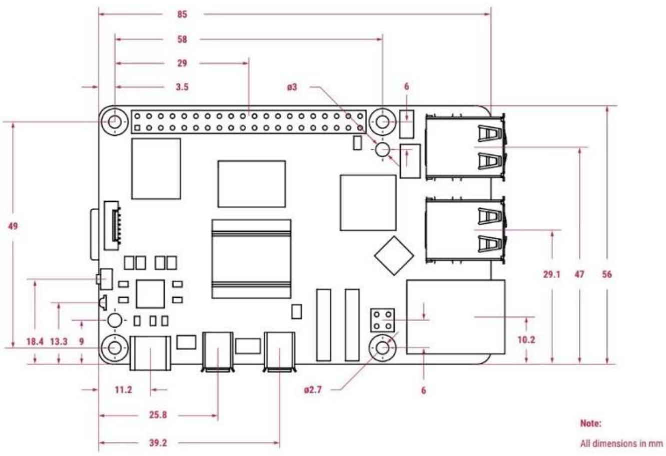



Figure 3.14: Raspberry Pi 5

#### 3.5.2.4 Accessories & Finishing

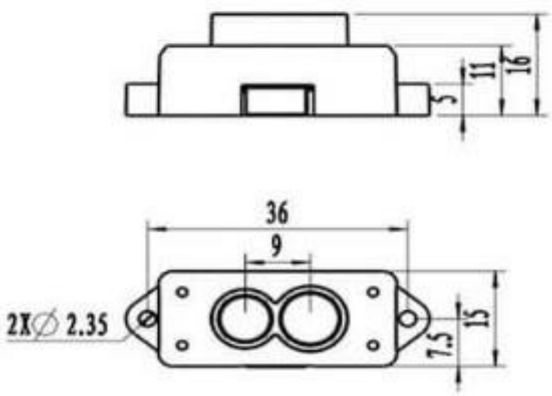



Figure 3.15: Mini Micro LiDAR Sensor

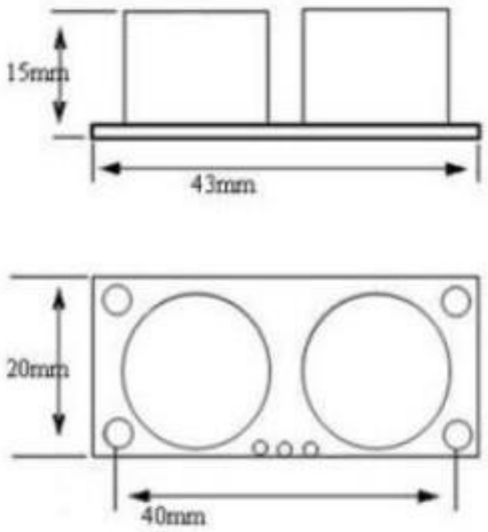



Figure 3.16: Ultrasonic Sensor

## 3.6 DEVELOPMENT OF PRODUCT

### 3.6.1 Material Acquisition

Materials were bought from a dealer on the online store. We bought a drone set that cost RM500.00 that includes the drone frame, motors, propellers, bolts and screws, drone leg, flight controller APM 2.8, and battery connectors.

Materials such as batteries and battery voltage detector, were recycled from older projects from out team members.

### 3.6.2 Machines and Tools

The only machines that we used was the soldering iron as it was used to solder the wires together to ensure it is held strongly. Tools such as tiny screw drivers were used to install the propellers and drones' legs.

### 3.6.3 Specific Project Fabrication

#### 3.6.3.1 Phase 1

Basic hardware was installed, and the functionality was tested.

#### 3.6.3.2 Phase 2

Set up the Flight Controller APM 2.8, connecting to mission planner in the laptop. The flight controller was programmed and stability of the drone.

#### 3.6.3.3 Phase 3

The Raspberry PI was programmed for facial recognition, auto landing and take-off, and slam.

#### 3.6.3.4 Phase 4

All the hardware and software were compiled together which makes up A.I Drone Security.

## 3.7 PRODUCT TESTING / FUNCTIONALITY TESTS

### 3.7.1 Flow Diagram

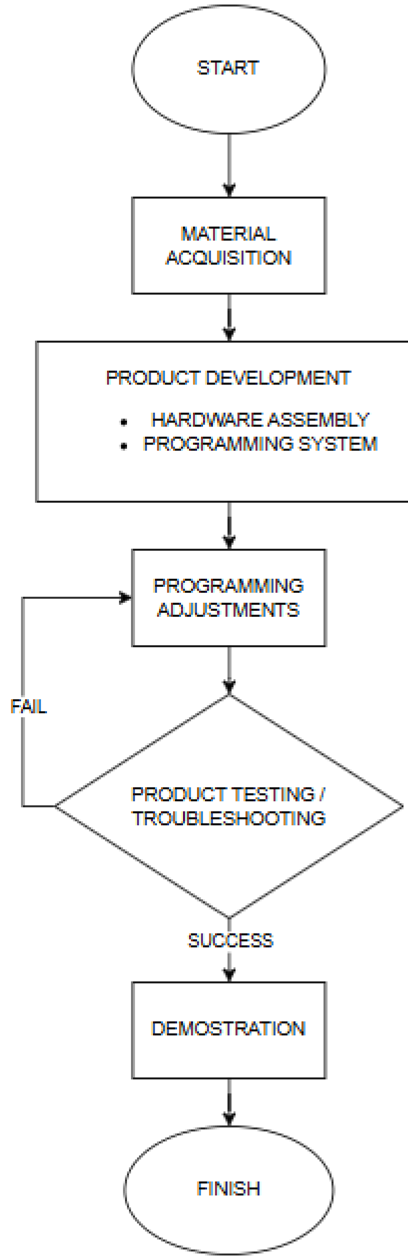



Figure 3.17: Project Flow Diagram

## 3.8 LIST OF MATERIALS & EXPENDITURES

| No | Items | Unit | Price/Unit | Total (RM) |
|---|---|---|---|---|
| **3.9.1 Product Structure** | | | | |
| **No** | **Items** | **Unit** | **Price/Unit** | **Total (RM)** |
| 1 | F330 MultiCopter Frame Airframe Flame Wheel | 1 | RM135.35 | RM135.35 |
| 2 | Landing Gear for Multirotor Quadcopter F330 | 1 | RM35.50 | RM35.50 |
| 3 | Body Shell Top Cover Assembly Drone Replacement | 1 | RM50.35 | RM50.35 |
| **3.9.2 Mechanical Mechanism** | | | | |
| **No** | **Items** | **Unit** | **Price/Unit** | **Total (RM)** |
| 1 | CCW brushless motor | 1 | RM100.00 | RM100.00 |
| 2 | 8 pcs drone propeller blade wing | 1 | RM62.00 | RM62.00 |
| 3 | Mexcel D4000H non-standard battery | 4 | RM20.00 | RM80.00 |
| **3.9.3 Electrical Mechanism** | | | | |
| **No** | **Items** | **Unit** | **Price/Unit** | **Total (RM)** |
| 1 | Ardupilot APM 2.8 Flight Controller | 1 | RM109.50 | RM109.50 |
| 2 | Raspberry Pi 3 Model B+ | 1 | RM186.70 | RM186.70 |
| **3.9.4 accessories and finishing** | | | | |
| **No** | **Items** | **Unit** | **Price/Unit** | **Total (RM)** |
| 1 | Ultrasonic Range Sensor | 1 | RM4.40 | RM4.40 |
| 2 | LED Light | 10 | RM1.00 | RM10.00 |
| 3 | TX06 FPV Camera system | 1 | RM79.09 | RM79.09 |

| | | | | |
|---|---|---|---|---|
| **4** | **Drone Propeller Guard** | **1** | **RM11.99** | **RM11.99** |
| **5** | **TF Lunar LiDAR Range Sensor** | **1** | **RM139.98** | **RM139.98** |
| **GRAND TOTAL** | **RM1004.86** | | | |

**Table 3.9: LIST OF MATERIALS & EXPENDITURES**

# CHAPTER 4

# RESULT & DISCUSSION

## 4.1 PRODUCT DESCRIPTION

### 4.1.1 General Product Features & Functionalities

Developing an AI drone security system requires the integration of advanced technologies in AI and security to minimize incidents in the hangar area due to potential errors. Some essential features and functionalities to consider include autonomous navigation and surveillance for the drone, with features such as real-time path tracking. The AI-powered analytics should include object detection and recognition, facial recognition, and behaviour analysis. Advanced sensors and data collection should involve multi-sensor integration, environmental sensors, and high-resolution cameras to monitor activities in the area.

Communication and networking features should include secure communication channels, real-time data streaming, and mesh networking. Safety and compliance functionalities should cover fail-safe mechanisms, regulatory compliance, and collision avoidance to mitigate damage to the drone and reduce maintenance costs. Other functionalities to consider are surveillance and monitoring, intrusion detection and response, data analysis and reporting, user interface and control, energy management, and integration and expandability features such as modular design, interoperability, and scalability. The AI drone security system can provide comprehensive, efficient, and adaptable security solutions for various applications.

### 4.1.2 Specific Part Feature

#### 4.1.2.1 Product Structure

The product structure didnt have propeller guards as version of the structure didn't have it when bought. Due to this, it wasn’t safe to fly around areas that has high risk of damaging things or causing harms to students or staffs.

**Figure 4.1: Drone frame installation**

#### 4.1.2.2 Product Mechanisms

The motor rotates up 20,000 rpm, and allows the drone to have a stable flight during its flight time. Two motors rotate clockwise and the other two rotate counter clockwise, which is diagonal.

**Figure 4.2: Brushless motor**

#### 4.1.2.3 Software / Programming

Raspberry PI 4 is used in this drone. Programming such as face detection, auto take-off and landing were successfully programmed. Unfortunately, slam programming to map the entire hangar for autonomous flight wasn't successful as the flight controller was too old.


**Figure 4.3: Ardupilot Flight Controller**

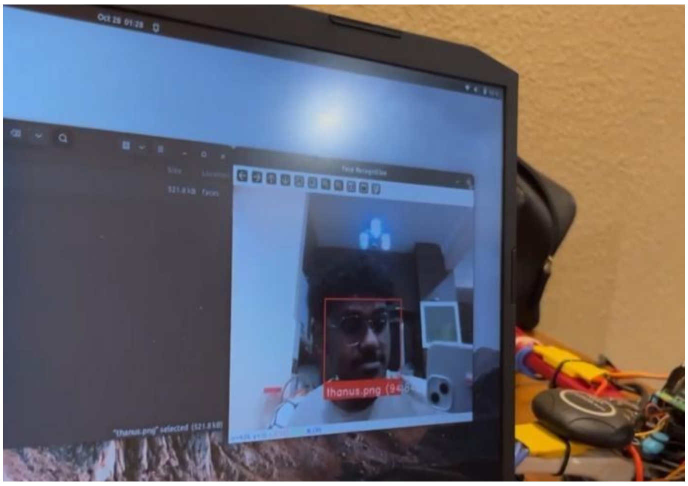


**Figure 4.4: Facial recognition**

#### 4.1.2.4 Accessories & Finishing

Unfortunately, the camera did not have high-definition resolution. Installing powerful cameras requires some more money. Face recognition is a feature of the camera's technology that is displayed on the monitor. The name was there if the camera picked up on the staff, and the unknown was there if the other person was picked up. The integration process takes into account the weight and balance of the drone to ensure that the drone can handle the camera’s weight without compromising flight stability and performance.

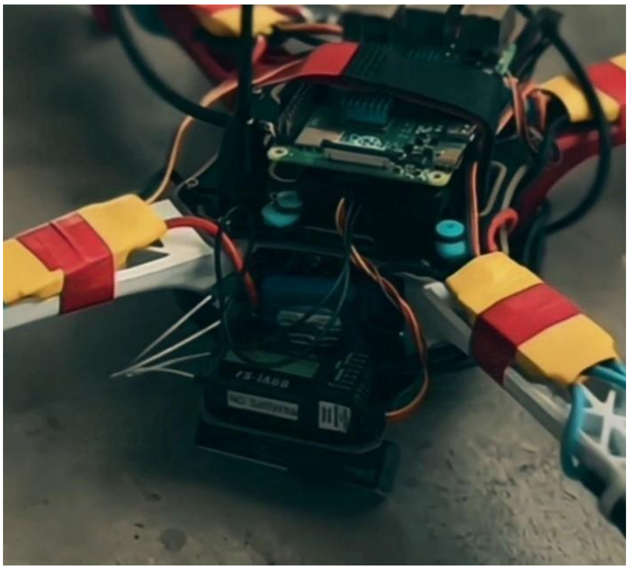


**Figure 4.5: Camera positioned 45°**

### 4.1.3 General Operation of the Product

Pre-operation setup for the product operation comprised a site survey and mapping to provide a comprehensive 3D map of the location. This involved pinpointing crucial locations for monitoring, like perimeters, high-risk regions, and entry/exit points. Based on site requirements, the drones were outfitted with the proper cameras, which should include behavior analysis and facial recognition. The operational workflow comprised incident response with an alarm system to alert security personnel, real-time surveillance using live feed video from the drone, and safe storage of gathered data for later use and analysis. Reporting on patrol actions must be done on a regular basis. If a technical malfunction or low battery occurs during an emergency, the drones are configured to make a safe emergency landing. Regular maintenance checks for the drone, including the propellers and battery performance, are also necessary.

### 4.1.4 Operation of the Specific Part of the Product

#### 4.1.4.1 Product Structure

The **structure** of a drone, often referred to as the **frame**, is the backbone that supports all the key components. It is made of plastic. Frame is the main body or skeleton of the drone. It is typically lightweight but rigid enough to hold all the drone's components securely. Arms are extensions from the central body that hold the motors and propellers. Landing gear is the support structures that allow the drone to land without damaging sensitive components. Central hub is the middle part of the drone where electronics like the flight controller, battery, and communication systems are located.

**Figure 4.6: Drone Frame**

#### 4.1.4.2 Product Mechanisms

The motors rotate at maximum 20,000 rpm which makes the drone to fly with maximum stability and achieve heights. The Li-Po battery which power ups the motor, and the flight controller, which is calibrated in the mission planner app, which ensures the direction of the flight and ensures all motors rotate at the same speed.

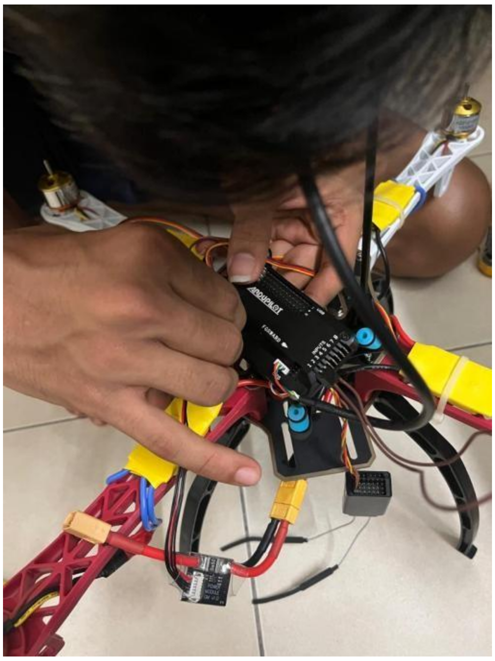


**Figure 4.7: Connecting flight controller to the motors**

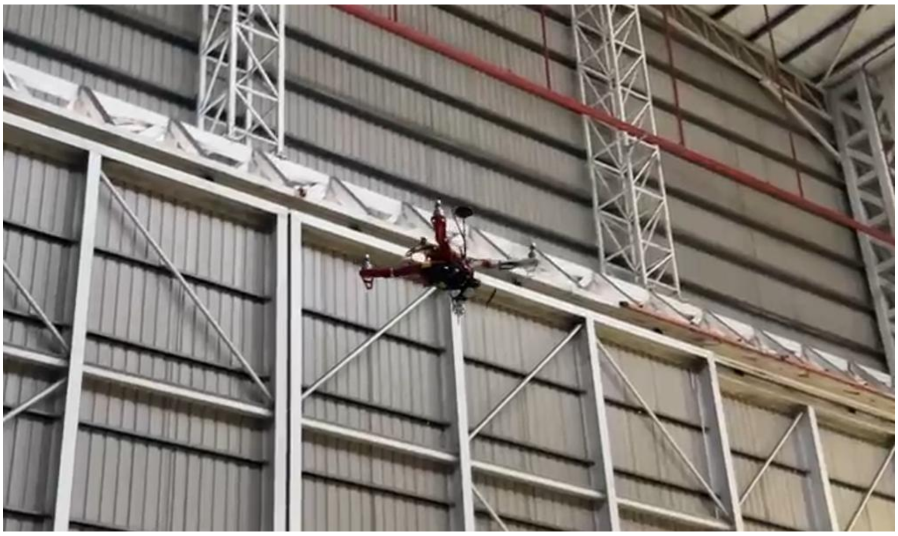


**Figure 4.8: Drone on flight**

### 4.1.4.3 Software / Programming

Facial recognition can be done on flight, which is from the Raspberry PI, that has been programmed this feature. The other features such as auto landing and take-off and slam, couldn’t be achieved successfully as the flight controller was an old one which couldn’t be connected to the current generation of the Raspberry PI. This didn’t give us a chance to use our auto landing and take-off programming that has been completed in the raspberry pi and the slam as well.

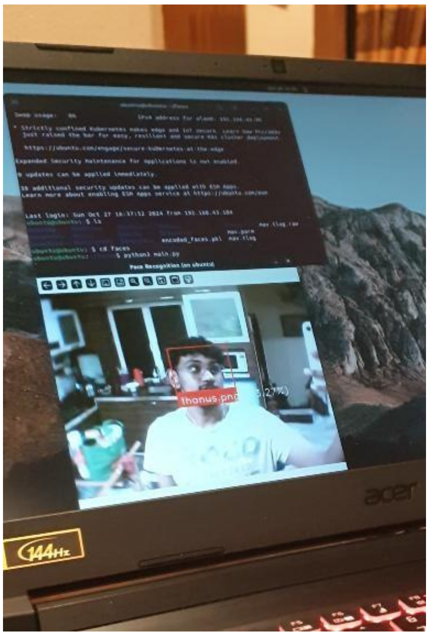


**Figure 4.9: Facial recognition from the drone**

#### 4.1.4.4 Accessories & Finishing

Camera that has been used on this drone is the old camera that is not a 360° camera which has been recycled from previous project. Due to low quality recording, facial recognition can be done at a very near distance.

**Figure 4.10: Drone with camera below the structure**

## 4.2 PRODUCT OUTPUT

Firstly, the purpose of project is to monitor and secure surrounding in hangar area because there are issues tell about the disadvantage of traditional security system that currently has been use in any place. Therefore, our team come out with idea which is AI Drone Security System to overcome the problem that occur and can assist the traditional system by a little. Next purpose is to enhance drones that can be used as an access remote to dark areas and during emergency situation. The impact of our project, issues of the problem in traditional security system can be reduced and can make the hangar area be more secure by using our project because it can assist and provide more features to the security system in the future. Due to increase the safety in hangar also can reduce the possibility of incident happen in that hangar.

## 4.3 ANALYSIS OF PROBLEM ENCOUNTERED & SOLUTIONS

### 4.3.1 Product Structure

The legs of the drone were broken during out first flight test from the impact it had taken. It fell from 5m height which absorbed all the impact and broke the leg. This resulted in no legs for the drone. As to overcome this, we ordered a new pair of legs to attach it to the drone.

### 4.3.2 Product Mechanisms

The motor which is powered by the Li-Po battery can only ensure the drone to fly for 5 minutes maximum as the battery was a recycled battery and an old one too. Due to high cost we remain to use the same battery as it is enough to show the functions of the drone.

### 4.3.3 Software / Programming

Although all programming has been successfully done, due to an old version of the flight controller, it shows unsupported when connected to the raspberry pi. This gave us a major problem as this limits the ability of the drone to achieve its its ultimate capabilities and our goals. As to overcome this, we have planned to buy a better version of the flight controller to ensure it can be connected.

### 4.3.4 Accessories & Finishing

The camera used right now, is a low-quality camera which makes facial recognition hard to be done from far range. It can only be done if the camera is 10-15m away from a person, which is close. A better camera will be replaced soon as higher quality camera will solve this issue.

# CHAPTER 5

# CONCLUSION & RECOMMENDATION

## 5.1 ACHIEVEMENT OF AIM & OBJECTIVES OF THE RESEARCH

### 5.1.1 General Achievements of the Project

The AI Drone Security System is designed to enhance surveillance and threat detection through a variety of advanced features that align with our objectives. The system includes strategically placed smart cameras that effectively monitor blind spots, entry points, and key areas such as aircraft storage and maintenance zones. Leveraging AI-powered video analytics, the system aims to identify unauthorized access and detect suspicious activities.

Additionally, the integration of drones with real-time video streaming enables aerial monitoring of large hangar spaces and facilitates quick inspections in areas with limited fixed camera coverage. A sophisticated Drone Management Algorithm optimizes the drones' flight paths for efficient patrolling and ensures a prompt response to alerts generated by the smart cameras.

The system utilizes a decentralized processing architecture, allowing its components to operate independently. This design feature is crucial for maintaining operational capability during any potential loss of connection to the control room, which is essential for remote or high-security locations. Moreover, the system continuously monitors environmental factors and employs motion detection in critical zones, ensuring a thorough approach to safety and security while minimizing network congestion by transmitting only essential alerts.

### 5.1.2 Specific Achievement of Project Objectives

#### 5.1.2.1 Product Structure

The primary objective is to design a safe flight drone that adheres to precise drawing and sizing specifications, specifically tailored for surveillance tasks in both hangar and narrow areas. This drone features a robust frame made from strong plastic materials, ensuring durability and resilience during operation.

At its core, the design incorporates a quadcopter configuration with four propellers. This innovative design provides exceptional stability and control, thanks to the balanced rotation of two clockwise and two counterclockwise propellers. This unique feature makes the drone an ideal choice for both beginners and seasoned professionals, offering a straightforward and cost-efficient solution. With fewer mechanical parts involved, it not only streamlines production costs but also simplifies maintenance.

The drone's aerodynamic efficiency is significantly enhanced by its meticulously crafted frame cover. This essential component reduces both drag and turbulence, leading to improved velocity, operational effectiveness, and overall stability in flight

#### 5.1.2.2 Product Mechanisms

We are excited to introduce our advanced drone, which is equipped with a brushless motor, an advanced ArduPilot flight controller, and durable propellers designed with a wide pitch ratio. However, we do have some concerns regarding the product's mechanism, specifically due to the outdated flight controller model that cannot effectively pair with the software programming.

Furthermore, utilized brushed motors, known for their internal commutation and direct current operation are working effectively with the speed and power. These motors have a long-standing presence in various commercial and industrial applications, attributed to their simple and compact design. However, they do present some challenges, including higher noise levels and increased power consumption.

In contrast, the brushless motor integrated into our drone offers electronically commutated operation, providing a longer lifespan and enhanced energy efficiency. This efficiency contributes to reduced battery usage, thereby prolonging flight times without compromising performance.

This design is particularly advantageous for smaller drones, where space can be limited. By employing this efficient configuration, we aim to minimize weight while balancing power capacity.

For our propellers, we have opted for ABS plastic, recognized for its cost-effectiveness and wide availability, making it a practical choice for our project. The thoughtful integration of these components positions us to create a drone that not only meets our performance and efficiency goals but also remains practical and easy to maintain.

#### 5.1.2.3 Software / Programming

We appreciate the progress made in the software programming, which has successfully addressed many of our requirements. The facial recognition functionality operates effectively onboard the flight, utilizing the Raspberry Pi that has been specifically programmed for this purpose. However, we faced challenges with implementing additional features such as auto landing, take-off, and SLAM due to the limitations of our current flight controller, which is an older model incompatible with the latest Raspberry Pi. While the programming for auto landing and take-off, as well as SLAM, has been completed, the connection issue with the outdated flight controller has hindered our ability to fully realize these capabilities. To enhance the performance of our drone and better align with our objectives, we are considering upgrading to a more advanced flight controller that will be compatible with the Raspberry Pi.

#### 5.1.2.4 Accessories & Finishing

The objectives pertaining to accessories and finishing have not been fully met due to budget constraints, which have limited our ability to procure higher-quality components. Currently, the camera installed on the drone is an older model that lacks advanced features, notably the capacity for 360° recording. This camera has been repurposed from a previous project and, as a result, suffers from low recording quality.

Consequently, the ability to perform facial recognition is severely restricted; it can only be effectively executed when the subject is located within a very short range, approximately 10 to 15 meters. This distance is considerably too close for

## 5.2 CONTRIBUTION OR IMPACT OF THE PROJECT

Incorporating enhanced security measures serves to effectively discourage unauthorized access to aircraft, tools, and sensitive equipment while also providing valuable documentation for post-incident assessments through high-definition video recordings. The use of UAVs allows for a more efficient response to potential threats, facilitating timely interventions in expansive areas and automating the identification of unusual activities, which can help lessen dependence on human oversight. Moreover, we prioritize operational safety by incorporating environmental monitoring systems that ensure adherence to safety standards and mitigate risks linked to hazardous conditions. Additionally, the implementation of these measures is both practical and economical, as it reduces the necessity for extensive manual patrolling and static security installations.

## 5.3 IMPROVEMENT & SUGGESTIONS FOR THE FUTURE RESEARCH

The system demonstrates considerable potential in enhancing the security of infrastructure and facilities by harnessing emerging technologies through several notable features. Its scalability allows for effective expansion in large-scale deployments, while sensor integration significantly enriches functionality by incorporating additional sensors. Emphasis on energy efficiency ensures that UAVs and IoT devices operate sustainably, optimizing energy use. The system also thoughtfully addresses privacy concerns, safeguarding user data, while redundancy measures are in place to maintain continuous operation through backup systems. Collaborative networks foster dynamic information sharing among components, and compliance with regulatory standards guarantees adherence to legal and safety requirements for UAVs and IoT systems. Improvements in the user interface (UI) prioritize creating a more accessible experience for operators and administrators. Furthermore, innovative features, such as automatic aircraft tracking utilizing AI for monitoring movement within the hangar and RFID integration for tool tracking to mitigate misplacement or theft, enhance the system's overall effectiveness. The introduction of an intuitive dashboard for real-time monitoring and control of hangar surveillance systems exemplifies a forward-thinking approach, positioning this solution as a compelling option for contemporary security needs. challenges. Future enhancements could solidify its application in real-world environments while maintaining efficient resource utilization and adaptability.

### 5.3.1 Product Structure

Upgrade frame material for example transitioning from traditional plastic to advanced lightweight composites, such as carbon fiber or fiberglass. These materials offer enhanced durability and significant weight reduction, which are essential for optimizing flight performance over extended periods.

Heat-Resistant Coating may be beneficial to implement a heat-resistant coating on the frame. This enhancement would improve the drone’s resilience during prolonged operations or in high-temperature settings, such as hangars.

Propeller Guards are crucial to improve safety while allowing for greater adaptability in confined spaces, all without compromising aerodynamic efficiency.

Additionally, exploring options to reduce propeller noise could be valuable for stealth operations, particularly in sensitive environments or during night surveillance activities.

### 5.3.2 Product Mechanisms

To enhance the performance of our drones, we propose the utilization of high-energy density batteries, specifically lithium-polymer or solid-state options, to achieve longer flight times and faster charging capabilities.

We also advocate for the implementation of energy recovery systems, such as regenerative braking for propellers during descents, which would enable the conversion of kinetic energy back into battery power.

In addition, we encourage the exploration of alternative energy sources, including solar-powered surfaces or hydrogen fuel cells, to support prolonged mission durations.

Finally, integrating 5G technology can greatly improve low-latency data transmission, allowing for real-time video feeds and effective remote control over extended distances.

### 5.3.3 Software / Programming

To enhance future iterations of the software, we propose the integration of advanced AI algorithms aimed at improving autonomous navigation and decision-making capabilities. This initiative would encompass the development of robust path-planning and obstacle-avoidance systems specifically designed for confined environments such ashangars. Furthermore, we recommend the implementation of efficient data processing algorithms to facilitate real-time data transmission for video feeds and environmental information. By doing so, we can ensure a seamless integration with IoT systems, ultimately enhancing situational awareness for operators.

### 5.3.4 Accessories & Finishing

We acknowledge the necessity for an upgrade, and we are excited to announce that plans are in motion to replace our existing camera with a state-of-the-art model that offers superior quality. This upgrade is anticipated to greatly enhance the drone's recording capabilities, allowing for clearer images and more detailed visuals, particularly in terms of facial recognition from increased distances. This improvement aims to overcome the current limitations we face.

In addition to the advanced camera, we will feature a 360-Degree Camera Gimbal, which will allow for a fully rotatable camera. This means we can achieve comprehensive monitoring without the need to reposition the drone itself, offering greater flexibility in capturing diverse angles and perspectives.

Furthermore, the integration of Thermal Imaging technology will enable the drone to detect heat signatures. This feature will be particularly advantageous for conducting operations at night or for inspecting equipment, where visibility may be compromised. Together, these enhancements will significantly bolster our drone's functionality and efficacy in various operational scenarios.

## LIST OF REFERENCES


1. **#1 Raspberry Pi Course-7 Different Types-Models**, 27 Dec. 2021. [Online]. Available: https://embeddedschool.in/different-types-of-raspberry-pi-board-model/. [Accessed: 27-May-2024].
2. agencywebdev, "Drone Batteries: Everything You Need to Know," *Coastal Drone*, 6 Dec. 2023. [Online]. Available: https://coastaldrone.co/drone-batteries-everything-you-need-to-know/. [Accessed: 27-May-2024].
3. "Archived: APM 2.5 and 2.6 Overview — Copter Documentation," *Ardupilot.org*. [Online]. Available: https://ardupilot.org/copter/docs/common-apm25-and-26-overview.html. [Accessed: 27-May-2024].
4. "DJI Avata," *Drones Kaki | DJI Enterprise Authorized Store*. [Online]. Available: https://www.droneskaki.com/collections/feature-on-homepage/products/dji-avata. [Accessed: 26-May-2024].
5. "Drone Camera Buying Guide to Identify the Best Drone Cameras in 2023," *English Jagran*. [Online]. Available: https://english.jagran.com/top-deals/electronics/camera/drone-camera-buying-guide-to-identify-the-best-drone-cameras-10072387. [Accessed: 27-May-2024].
6. "Drone Motor – Where to Begin?," *Robocraze*, 27 May 2024. [Online]. Available: https://robocraze.com/blogs/post/how-to-choose-drone-motors. [Accessed: 27-May-2024].
7. M. A. R. Estrada and A. Ndoma, "The Uses of Unmanned Aerial Vehicles –UAV's- (or Drones) in Social Logistic: Natural Disasters Response and Humanitarian Relief Aid," *Procedia Computer Science*, vol. 149, pp. 375–383, 2019. doi: https://doi.org/10.1016/j.procs.2019.01.151.
8. "Hero VTOL 4+1 Fixed Wing," *ArduPilot Discourse*, 11 Oct. 2022. [Online]. Available: https://discuss.ardupilot.org/t/hero-vtol-4-1-fixed-wing/91786.
9. "How Can You Choose the Best Materials for Your Drone's Frame and Propellers?," *LinkedIn*. [Online]. Available: https://www.linkedin.com/advice/3/how-can-you-choose-best-materials-your-drones-frame-propellers. [Accessed: 27-May-2024].
10. N. S. Labib et al., "The Rise of Drones in Internet of Things: A Survey on the Evolution, Prospects and Challenges of Unmanned Aerial Vehicles," *IEEE Access*, vol. 9, pp. 115466–115487, 2021. doi: https://doi.org/10.1109/access.2021.3104963.

11. “Mission Planner Home — Mission Planner Documentation,” *Ardupilot.org*. [Online]. Available: https://ardupilot.org/planner/. [Accessed: 27-May-2024].
12. Oscar, “A Comprehensive Guide to FPV Drone Frames,” *Oscar Liang*, 28 Apr. 2023. [Online]. Available: https://oscarliang.com/fpv-drone-frames/.
13. Oscar, “Best ESC for FPV Drones: Comprehensive Electronic Speed Controller Buyer’s Guide,” *Oscar Liang*, 29 Mar. 2023. [Online]. Available: https://oscarliang.com/esc/.
14. Oscar, “Flight Controller Explained: How to Choose the Best FC for FPV Drone,” *Oscar Liang*, 30 Apr. 2024. [Online]. Available: https://oscarliang.com/flight-controller/.
15. M. S. Varalakshmi, “Evolution and Significance of Drones in Modern Technology,” unpublished.
16. ImetomiVisit My Site!More, “Ultimate Intelligent Fully Automatic Drone Robot (W/ RPi, Arduino),” *Instructables*. [Online]. Available: https://www.instructables.com/Ultimate-Intelligent-Fully-Automatic-Drone-Robot-w/.
17. “Use-Cases and Applications — Copter Documentation,” *Ardupilot.org*. [Online]. Available: https://ardupilot.org/copter/docs/common-use-cases-and-applications.html. [Accessed: 27-May-2024].
18. “Using C++ to Control a Drone,” *Robotics Stack Exchange*. [Online]. Available: https://robotics.stackexchange.com/questions/12793/using-c-to-control-a-drone. [Accessed: 27-May-2024].
19. “Wireless Telemetry Systems | FPV Telemetry for Drones, UAV, USV, UGV,” *Unmanned Systems Technology*. [Online]. Available: https://www.unmannedsystemstechnology.com/expo/wireless-telemetry/. [Accessed: 27-May-2024].
20. M. L. B. M. Yaacob et al., “Bridge Pillar Inspection Using Thermography and Multispectral Images,” *Journal of Advanced Geospatial Science & Technology*, vol. 2, no. 2, pp. 72–89, 30 Aug. 2022. [Online]. Available: https://jagst.utm.my/index.php/jagst/article/view/45. [Accessed: 26-May-2024].
21. “You’re Planning a Drone Mapping Project. How Can You Choose the Best GPS Tools?,” *LinkedIn*. [Online]. Available: https://www.linkedin.com/advice/0/youre-planning-drone-mapping-project-how-can-you-choose-bsgoc. [Accessed: 27-May-2024]

**APPENDIX A: DECLARATION OF TASK SEGREGATION**

| **AMIR HAKIMI BIN ABDUL HALIM** | |
|---|---|
| **SUBCHAPTER** | **DESCRIPTION** |
| **1.3.2.4** | **Project Objective: Accessories and Finishing** |
| **1.5.2.4** | **Specific Individual Scope: Accessories and Finishing** |
| **2.1.1** | **Demand in Aviation** |
| **2.1.2.1** | **Type of Security System: Security Guard Services** |
| **2.2.4** | **Accessories and Finishing** |
| **2.3.1.4** | **Review of recent product / related product: Patented Product D** |
| **2.3.2.4** | **Recent Market Product: Marketed Product D** |
| **2.4.4** | **Comparison between recent research and current product: Unmanned Aerial Vehicle (UAV) Drone vs. DJI Mini 4 Pro vs. AI Drone Security System** |
| **3.2.2.4** | **Specific Project Design Flow / Framework: Accessories & Finishing** |
| **3.4.1.1** | **Questionnaire survey** |
| **3.4.2.4** | **Design Concept Generation: Propose Design Concept 4** |
| **3.4.3** | **Evaluation & Selection of Conceptual Design: Pugh Matrix** |
| **3.5.4.4** | **Specific Part Drawing / Diagram: Accessories And Finishing** |
| **3.6.2.4** | **Specific Project Fabrication: Phase 4** |
| **4.1.1** | **General Product Features & Functionalities** |
| **4.1.2.4** | **Specific Part Feature: Accessories and finishing** |
| **4.1.4.4** | **Operation of the Specific Part of the Product: Accessories & Finishing** |
| **4.3.4** | **Analysis Of Problem Encountered & Solutions: Accessories & Finishing** |

| | |
|---|---|
| **5.1.2.4** | **Specific Achievement of Project Objectives: Accessories & Finishing** |
| **5.2** | **Contribution Or Impact Of The Project** |
| **5.3.4** | **Improvement & Suggestions for The Future Research: Accessories & Finishing** |
| **KU AHMAD MU'AZ BIN KU AMIZI** | |
| **SUBCHAPTER** | **DESCRIPTION** |
| **1.3.2.1** | **Project Objective: Product Structure** |
| **1.4.2.1** | **Specific Individual Scope: Product Structure** |
| **2.1.2.2** | **Type Of Security System: Closed Circuit Television (CCTV)** |
| **2.2.1** | **Specific Literature Review: Product Structure** |
| **2.3.1.1** | **Review Of Recent Product / Related Product: Patented Product A** |
| **2.3.2.1** | **Recent Market Product: Marketed Product A** |
| **2.4.1** | **Comparison Between Recent Research and Current Product: Hero VTOL Fixed Wing Aircraft vs. Drone Security Device vs. AI Drone Security System** |
| **3.1.1** | **Utilisation of Polytechnic's Facilities** |
| **3.3.2.1** | **Specific Project Design Flow / Framework: Product Structure** |
| **3.4.2.1** | **Design Concept Generation: Propose Design Concept 1** |
| **3.5.2.1** | **Specific Part Drawing / Diagram: Product Structure** |
| **3.6.1** | **Material Acquisition** |
| **3.6.3.1** | **Specific Project Fabrication: Phase 1** |
| **3.7.1** | **Flow Diagram** |
| **3.8** | **List of Materials & Expenditures** |

| | |
|---|---|
| 4.1.2.1 | Specific Part Feature: Product Structure |
| 4.1.4.1 | Operation of the Specific Part of the Product: Product Structure |
| 4.3.1 | Analysis Of Problem Encountered & Solutions: Product Structure |
| 5.1.1 | General Achievements of the Project |
| 5.1.2.1 | Specific Achievement of Project Objectives: Product Structure |
| 5.3.1 | Improvement & Suggestions for The Future Research: Product Structure |

| THANUS A/L MOGAN | |
|---|---|
| SUBCHAPTER | DESCRIPTION |
| 1.3.2.3 | Project Objective: Software / Programming |
| 1.4.1 | Scope Project |
| 1.4.2.3 | Specific Individual Scope: Software / Programming |
| 2.2.2.2 | Specific Literature Review: Electronics |
| 2.2.3 | Specific Literature Review: Software & Programming |
| 2.3.1.3 | Review Of Recent Product / Related Product: Patented Product C |
| 2.3.2.3 | Recent Market Product: Marketed Product C |
| 2.4.3 | Comparison Between Recent Research and Current Product: JOUAV VTOL Fixed Wing Surveillance Drone vs Autel Alpha vs Ai Drone Security System |
| 3.2.2.3 | Specific Project Design Flow / Framework: Software / Programming |
| 3.3.1 | Overall Project Flow Chart |
| 3.4.1.2 | Pareto Diagram |
| 3.4.2.3 | Design Concept Generation: Propose Design Concept 3 |

| | |
|---|---|
| 3.5.4.3 | Specific Part Drawing / Diagram: Software / Programming |
| 3.6.3.3 | Specific Project Fabrication: Phase 3 |
| 4.1.2.3 | Specific Part Feature: Software/Programming |
| 4.1.4.3 | Operation of the Specific Part of the Product: Software / Programming |
| 4.2 | Product output |
| 4.3.3 | Analysis Of Problem Encountered & Solutions: Software / Programming |
| 5.1.2.3 | Specific Achievement of Project Objectives: Software / Programming |
| 5.3.3 | Improvement & Suggestions For The Future Research: Software / Programming |
| **KIREN A/L KALIMUTHU** | |
| **SUBCHAPTER** | **DESCRIPTION** |
| 1.1 | Background Study |
| 1.2 | Problem Statement |
| 1.3.1 | General Project Objectives |
| 1.3.2.2 | Specific Individual Product Objectives: Product Mechanism |
| 1.5.2 | Specific Individual Scope: Product Mechanism |
| 2.2.2 | Specific Literature Review: Product Mechanism |
| 2.3.1.2 | Review Of Recent Product / Related Product: Patented Product B |
| 2.3.2.2 | Recent Market Product: Marketed Product B |
| 2.4.2 | Comparison Between Recent Research and Current Product: Autonomous Drone Security (Sunflower Lab) vs DJI Inspire 3 vs Ai Drone Security System |
| 3.3.2.2 | Specific Project Design Flow / Framework: Product Mechanisms |
| 3.4.2.2 | Design Concept Generation: Propose Design Concept 2 |

| | |
|---|---|
| **3.5.1** | **General Product Drawing** |
| **3.5.2.2** | **Specific Part Drawing / Diagram: Product Mechanisms** |
| **3.6.2** | **Machines and Tools** |
| **3.6.3.2** | **Specific Project Fabrication: Phase 2** |
| **4.1.2.2** | **Specific Part Feature: Product Mechanisms** |
| **4.1.3** | **General Operation of the Product** |
| **4.1.4.2** | **Operation of the Specific Part of the Product: Product Mechanisms** |
| **4.3.2** | **Analysis Of Problem Encountered & Solutions: Product Mechanism** |
| **5.1.2.2** | **Specific Achievement of Project Objectives: Product Mechanisms** |
| **5.3.2** | **Improvement & Suggestions For The Future Research: Product Mechanisms** |

**APPENDIX B: TURNITIN SIMILARITY REPORT**

# THESES_AI_DRONE_SECURITY

*by* KIREN KALIMUTHU

---

**Submission date:** 22-Nov-2024 09:19AM (UTC+0800)
**Submission ID:** 2528038621
**File name:** THESIS_AI_DRONE_SECURITY_SYSTEM_1_.docx (6.9M)
**Word count:** 12421
**Character count:** 71817

THESES_AI_DRONE_SECURITY

ORIGINALITY REPORT

| 12% | 6% | 2% | 9% |
| --- | --- | --- | --- |
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
| --- | --- | --- |
| 1 | Submitted to Jabatan Pendidikan Politeknik Dan Kolej Komuniti<br>Student Paper | 5% |
| 2 | medium.com<br>Internet Source | <1% |
| 3 | store.ired.co.uk<br>Internet Source | <1% |
| 4 | Submitted to University of Hull<br>Student Paper | <1% |
| 5 | Halima Housny, El Ayachi Chater, Hassan El Fadil. "Observer-Based Enhanced ANFIS Control for a Quadrotor UAV", International Review on Modelling and Simulations (IREMOS), 2021<br>Publication | <1% |
| 6 | jagst.utm.my<br>Internet Source | <1% |
| 7 | Submitted to Ngee Ann Polytechnic<br>Student Paper | <1% |

| | | |
|---|---|---|
| 8 | themall.aucklandairport.co.nz<br>Internet Source | <1% |
| 9 | english.jagran.com<br>Internet Source | <1% |
| 10 | www.ecmjohnson.com<br>Internet Source | <1% |
| 11 | Submitted to Swinburne University of Technology<br>Student Paper | <1% |
| 12 | Submitted to University of Sydney<br>Student Paper | <1% |
| 13 | Submitted to University of Western Australia<br>Student Paper | <1% |
| 14 | Submitted to Mentone Grammar School<br>Student Paper | <1% |
| 15 | Submitted to University of Central Lancashire<br>Student Paper | <1% |
| 16 | Submitted to University of Queensland<br>Student Paper | <1% |
| 17 | Submitted to University of South Australia<br>Student Paper | <1% |
| 18 | thewikipoint.com<br>Internet Source | <1% |

| | | |
|---|---|---|
| 19 | Submitted to University of Maryland, Global Campus<br>Student Paper | <1% |
| 20 | Submitted to Georgia Virtual School<br>Student Paper | <1% |
| 21 | Submitted to University of Newcastle upon Tyne<br>Student Paper | <1% |
| 22 | www.slideshare.net<br>Internet Source | <1% |
| 23 | Sungjae Lee, Yosoon Choi. "Topographic Survey at Small-scale Open-pit Mines using a Popular Rotary-wing Unmanned Aerial Vehicle (Drone)", Journal of Korean Society For Rock Mechanics, 2015<br>Publication | <1% |
| 24 | Submitted to RMIT University<br>Student Paper | <1% |
| 25 | www.bazl.admin.ch<br>Internet Source | <1% |
| 26 | Submitted to International Islamic University Malaysia<br>Student Paper | <1% |
| 27 | Submitted to University of Salford<br>Student Paper | <1% |

| | | |
|---|---|---|
| 28 | Submitted to Liverpool John Moores University<br>Student Paper | <1% |
| 29 | metapress.com<br>Internet Source | <1% |
| 30 | www.etas.com<br>Internet Source | <1% |
| 31 | www.mdpi.com<br>Internet Source | <1% |
| 32 | Submitted to Chulalongkorn University<br>Student Paper | <1% |
| 33 | Submitted to Republic of the Maldives<br>Student Paper | <1% |
| 34 | Submitted to University of Northumbria at Newcastle<br>Student Paper | <1% |
| 35 | Submitted to Universiti Teknologi MARA<br>Student Paper | <1% |
| 36 | Amit Tiwary, Bhuvan Unhelkar. "Outcome-Driven Business Architecture - Synergizing Strategies and Intelligence with Architecture", CRC Press, 2018<br>Publication | <1% |
| 37 | Submitted to Universiti Teknikal Malaysia Melaka<br>Student Paper | <1% |

| | | |
|---|---|---|
| 38 | umpir.ump.edu.my<br>Internet Source | <1% |
| 39 | vdocuments.net<br>Internet Source | <1% |
| 40 | etd.aau.edu.et<br>Internet Source | <1% |
| 41 | krishikosh.egranth.ac.in<br>Internet Source | <1% |
| 42 | sainshumanika.utm.my<br>Internet Source | <1% |
| 43 | www.coursehero.com<br>Internet Source | <1% |
| 44 | www.uniselinus.education<br>Internet Source | <1% |
| 45 | Jinxia Zhang, Zhenjia Chang, Fusheng Niu, Yuying Chen, Jiahui Wu, Hongmei Zhang. "Simulation and Validation of Discrete Element Parameter Calibration for Fine-Grained Iron Tailings", Minerals, 2022<br>Publication | <1% |
| 46 | John Meneely. "3D Imaging of the Environment - Mapping and Monitoring", CRC Press, 2023<br>Publication | <1% |
| 47 | Submitted to University of Kent at Canterbury | |

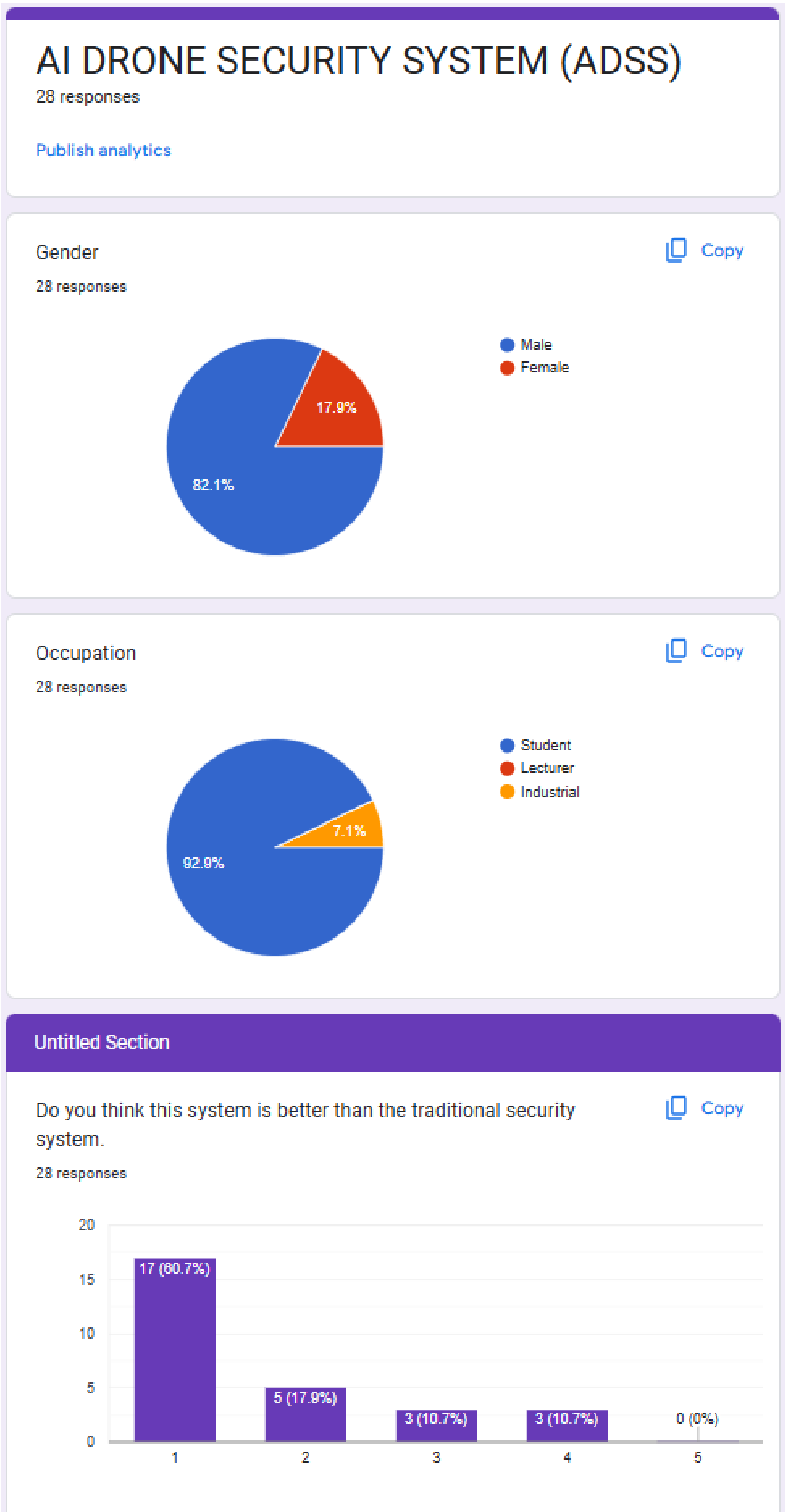
Student Paper

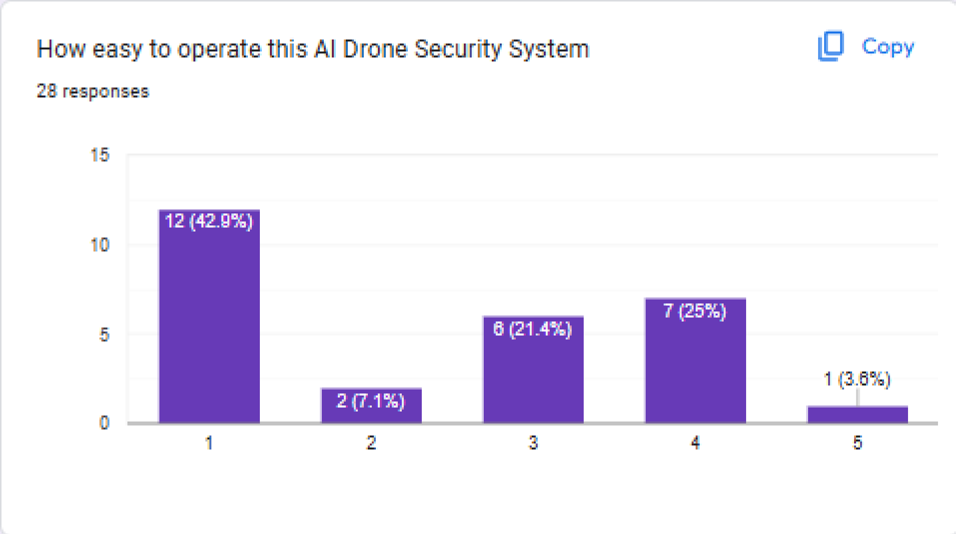
<1%

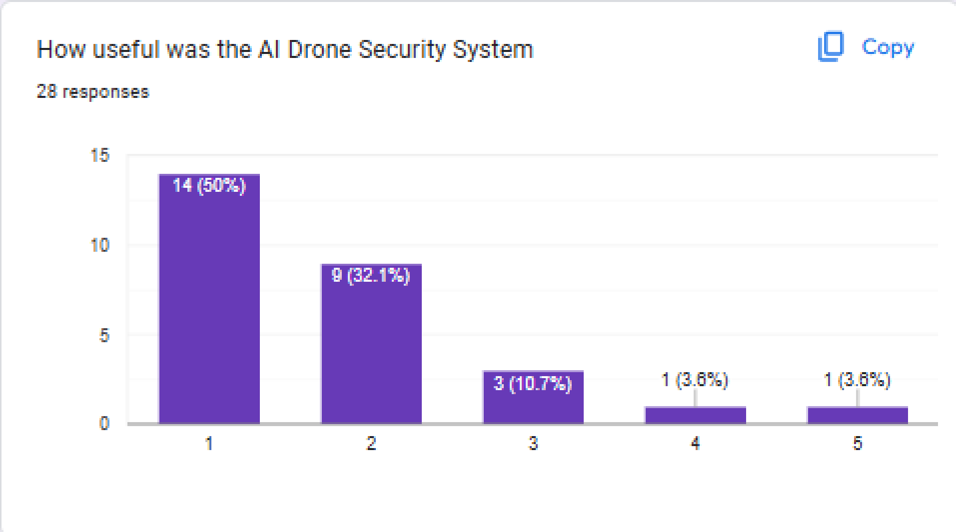
| | | | |
|---|---|---|---|
| 48 | www.findtheneedle.co.uk<br>Internet Source | <1% |
| 49 | Abdul Razzak Rumane. "Risk Management Applications Used to Sustain Quality in Projects - A Practical Guide", CRC Press, 2022<br>Publication | <1% |

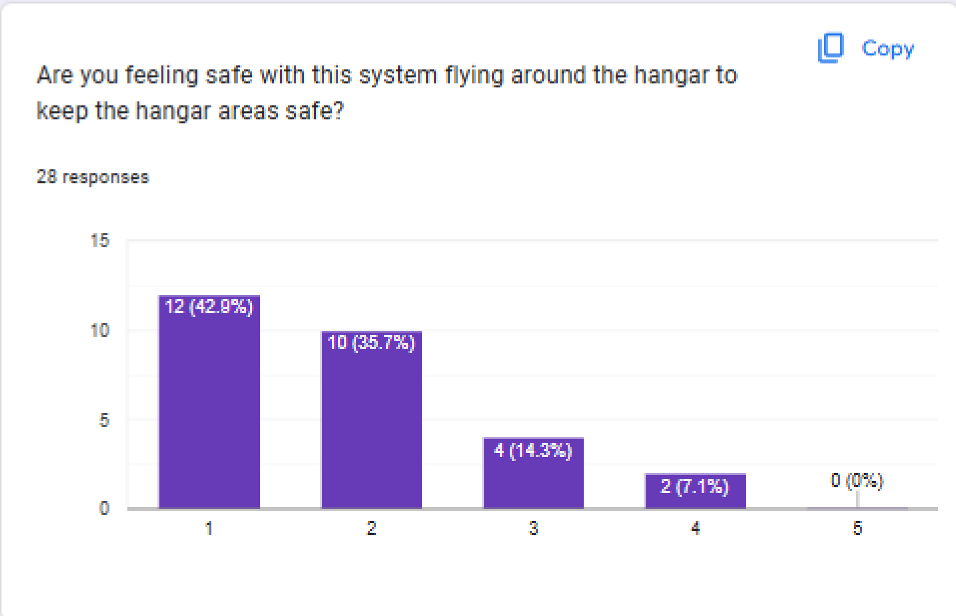
Exclude quotes Off
Exclude bibliography Off
Exclude matches Off

**APPENDIX C: DATA FROM SURVEY**




How easy to operate this AI Drone Security System
Copy
28 responses
15
10
5
0
12 (42.9%)
2 (7.1%)
6 (21.4%)
7 (25%)
1 (3.6%)
1
2
3
4
5


How useful was the AI Drone Security System
Copy
28 responses
15
10
5
0
14 (50%)
9 (32.1%)
3 (10.7%)
1 (3.6%)
1 (3.6%)
1
2
3
4
5


Are you feeling safe with this system flying around the hangar to keep the hangar areas safe?
Copy
28 responses
15
10
5
0
12 (42.9%)
10 (35.7%)
4 (14.3%)
2 (7.1%)
0 (0%)
1
2
3
4
5