POLITEKNIK BANTING SELANGOR

AEROLYTIX SMART DRONE FOR PRE FLIGH INSPECTION

NAME	MATRIC NO.
MUHAMMAD HARIS BIN SYFULL HAFEZ	24DAM23F1005
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DEPARTMENT OF AIRCRAFT MAINTENANCE

SESSION 1 2025/2026

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

SUPERVISOR:

MOHAMAD FAIZAL BIN DAUD

REPORT ENDORSEMENT

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

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Date : 12th DECEMBER 2025

CERTIFICATION OF PROJECT ORIGINALITY & OWNERSHIP

AEROLYTIX SMART DRONE FOR PRE FLIGHT INSPECTION

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"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.

Endorsed by,

SIGNATURE : WRITER 1

(SUPERVISOR SIGNITURE)

SIGNATURE : WRITER 2

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SIGNATURE : WRITER 3

SUPERVISOR 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.

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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

The rapid advancement of unmanned aerial vehicles (UAVs), commonly known as drones, has opened new possibilities in various industries, particularly in the field of aircraft inspection
and maintenance. Traditional inspection methods are often time-consuming, labor-intensive, and sometimes pose safety risks to personnel due to the need for manual checks in high or hard-to-reach areas. This project addresses these challenges by developing an integrated drone-based inspection system designed to enhance the efficiency, accuracy, and safety of aircraft inspections.

The primary objective of this project is to design and implement a stable and reliable drone system capable of performing precise aerial inspections while providing operators with an intuitive interface for real-time monitoring and control. The system consists of a custom-built quadcopter equipped with high-resolution cameras and sensors, with the control and monitoring software developed using **Python in Visual Studio Code (VSC)**. The software incorporates features such as live camera feed streaming, pre-flight checklists, and manual override controls using a joystick interface.

The methodology involves a comprehensive process of hardware design and integration, software development, and systematic testing. The flight control algorithms were implemented in Python to manage stable flight, maneuverability, and obstacle detection. Extensive experimental tests were conducted to evaluate the drone's performance under various operational conditions. The software interface was also assessed for usability, responsiveness, and reliability in transmitting real-time data from the drone to the operator.

The results demonstrate that the developed drone system achieves stable flight and precise control, while the Python-based interface provides seamless real-time monitoring and manual override capabilities. The integrated system effectively reduces inspection time, minimizes safety risks to personnel, and ensures accurate data collection for aircraft maintenance purposes.

In conclusion, this project validates the feasibility and effectiveness of using UAV technology combined with Python-based software solutions for aircraft inspection. The outcomes of this study provide a foundation for further research into autonomous inspection drones, potentially leading to fully automated and intelligent inspection systems in the aviation industry. The integration of hardware and software in this project highlights the significant potential of UAVs to transform conventional aircraft maintenance practices, enhancing both efficiency and operational safety.

TABLE OF CONTENT

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Drones, or Unmanned Aerial Vehicles (UAVs), are aircraft systems that operate without a human pilot onboard. These devices have evolved rapidly from military reconnaissance tools to versatile platforms used in numerous civil and industrial applications. Their capabilities include remote operation and autonomous flight, allowing them to perform tasks that are otherwise risky, timeconsuming, or physically challenging for humans.

Historically, drones were developed for military reconnaissance, target practice, and surveillance. With advances in electronics, computing, and battery technology, drones have transitioned into civilian and industrial sectors. Today, they are widely used in agriculture, photography, logistics, infrastructure inspection, search and rescue operations, and environmental monitoring. Their ability to access confined spaces or hazardous areas provides significant advantages in operational efficiency and safety.

In the context of aircraft maintenance and hangar security, drones present a promising alternative or complement to human personnel. Traditional inspections involve visual checks, physical assessments, and security patrols conducted by trained staff. While effective, these processes are often limited by fatigue, visibility, subjectivity, and restricted accessibility. Small defects, such as hairline cracks, hidden corrosion, or obstructed sensors like pitot covers, may go unnoticed during routine manual inspections.

The integration of drones into these workflows offers several advantages. UAVs equipped with high-resolution cameras, GPS, inertial measurement units (IMUs), and telemetry systems can perform scheduled patrols, capture consistent visual data, and provide a permanent record of inspections. By combining these drones with software developed in Python using Visual Studio Code and controlled via ArduPilot, operators can monitor the drone in real time, adjust flight paths, and perform manual overrides when necessary. This approach enhances efficiency, safety, and reliability while reducing human workload.

Additionally, the development of autonomous drones involves understanding principles of aerodynamics, propulsion, flight control algorithms, and sensor integration. It also requires proficiency in programming, system testing, and data analysis. These skills are essential for diploma-level students, bridging theory and practical applications in the field of UAV technology.

1.2 Problem Statements

Despite their potential, manual inspections and traditional security methods face several limitations:

1. Restricted Surveillance Coverage: Large hangars and clustered aircraft create blind spots where human guards may be unable to monitor effectively.
2. Human Fatigue: Continuous monitoring can lead to fatigue, reduced attention, and potential oversight.
3. Safety Risks: Personnel conducting inspections in elevated or confined spaces face hazards such as falls, collision with equipment, or exposure to chemicals.
4. Time and Cost: Maintaining human security and inspection teams for continuous coverage is expensive and time-consuming.
5. Inconsistent Data Recording: Manual logs and visual checks may miss critical details or lack proper documentation for future reference.

A real-world incident exemplifies the importance of addressing these issues. On July 18, 2018, a Malaysia Airlines Airbus A330-300 (Flight MH134) nearly took off with pitot tube covers still in place. Fortunately, the oversight was corrected before departure. Blocked pitot tubes can cause inaccurate airspeed readings, posing serious safety risks (ATSB, 2019). Such incidents highlight the potential consequences of human error and the need for reliable, automated inspection systems.

Thus, developing an autonomous drone system that can assist or replace manual inspection routines is essential. The drone should be capable of performing pre-programmed patrols, capturing high-quality imagery, providing telemetry data, and operating safely in hangar environments.

1.3 Project Objectives

1.3.1 General Objectives

- To design and implement an autonomous drone system capable of performing hangar security patrols and aircraft inspections.
- To demonstrate the use of Python-based software with ArduPilot for autonomous navigation, data collection, and live monitoring.
- To evaluate the system’s effectiveness in enhancing safety, efficiency, and reliability compared to traditional human inspections.

1.3.2 Specific Objectives

1.3.2.1 Product Structure

- Develop a UAV platform (multi-rotor or small fixed-wing) equipped with high-resolution cameras, GPS, and inertial sensors.
- Ensure stability and maneuverability during autonomous and manual flight modes.
- Include gimbal mounting for cameras to maintain steady imaging.

1.3.2.2 Product Mechanisms

- Optimize aerodynamics (lift-drag ratio) to ensure efficient and stable flight.
- Select brushless motors and propellers suitable for the drone's weight and intended flight duration.
- Include safety mechanisms such as propeller guards, high-visibility coloring, and LED indicators.

1.3.2.3 Software / Programming

- Program autonomous flight routines in Python, integrated with ArduPilot firmware.
- Use MAVLink protocol for telemetry including GPS coordinates, battery level, speed, and altitude.
- Plan and monitor missions with QGroundControl or Mission Planner, enabling real-time adjustments.
- Implement basic collision avoidance using sensors such as LIDAR or ultrasonic modules. • Ensure software stability to allow continuous operation without failure or erratic behavior.

1.3.2.4 Accessories & Finishing

- Install bright LEDs for night visibility.
- Include cameras for surveillance and inspection purposes.
- Attach collision avoidance sensors to prevent accidents in tight or crowded areas. • Use propeller guards and bright colors to enhance safety and visibility.

1.4 Purpose of Product

The purpose of this project is to provide a practical and cost-effective solution to hangar security and aircraft inspection challenges. By automating routine inspections with UAVs, human personnel are freed from physically demanding tasks, reducing safety risks and operational fatigue. The drone system records visual and telemetry data, enabling review, audit, and traceability of inspections.

This project also serves as a learning platform for diploma-level students to gain practical experience in UAV design, flight control, programming, and system integration, bridging the gap between theoretical knowledge and real-world application.

1.5 Scope of Project

1.5.1 Product Structure

- UAV platform: Multi-rotor or small fixed-wing with sufficient endurance to cover a hangar area.
- Propulsion: Brushless motors, high-efficiency propellers.
- Sensors: GPS, IMU, camera gimbal, voltage monitoring.

1.5.2 Product Mechanisms

- Flight dynamics designed for stability and efficient maneuvering.
- Ease of operation with basic drone knowledge.
- Safety mechanisms: propeller guards, high-visibility LED lighting.

1.5.3 Software / Programming

- Python-based software controlling autonomous flight routines.
- Integration with ArduPilot and MAVLink for telemetry.
- Ground station software (QGroundControl / Mission Planner) for route planning, monitoring, and recording.
- Basic obstacle avoidance and automated logging of inspection data.

1.5.4 Accessories & Finishing

- LED lights for visibility during night operations.
- Collision sensors for safety.
- Camera for surveillance and inspection data recording. • High-visibility paint or decals for safety and easy identification.

CHAPTER 2

LITERATURE REVIEW

2.1 General Literature Review

2.1.1 Importance of Pre-Flight Inspection in Aviation

Pre-flight inspection is a critical procedure in aviation to ensure that an aircraft is safe and operational before takeoff. Every component of an aircraft, including fuselage, wings, engines, control surfaces, landing gear, and avionics, must be carefully inspected. The primary purpose is to detect mechanical defects, structural damage, or system failures that could jeopardize flight safety. By conducting these inspections, operators minimize the risk of in-flight malfunctions, safeguarding passengers, crew, and the aircraft.

Traditionally, inspections are performed manually by trained aviation technicians or pilots, requiring them to check both easily accessible and hard-to-reach areas. Manual inspections are time-consuming, physically demanding, and prone to human error, especially in large aircraft or under adverse weather and lighting conditions. Subtle defects can be missed, potentially leading to serious consequences. This has led the aviation industry to explore technological solutions, such as drone-assisted inspections, to improve efficiency, accuracy, and reliability [1].

2.1.2 Fundamentals of Aircraft Pre-Flight Procedures

Aircraft pre-flight procedures are standardized protocols guided by manufacturers and aviation authorities. These procedures ensure the aircraft's safety, functionality, and regulatory compliance. Key inspection areas include airframe, control surfaces, landing gear, fuel and hydraulic systems, avionics, and emergency equipment. Each inspection step ensures that the aircraft can perform its intended flight safely.

In addition to physical inspections, administrative tasks are performed, such as reviewing maintenance logs, verifying the presence of required equipment, and checking operational readiness. These steps help ensure compliance with aviation regulations and reduce the risk of accidents. However, pre-flight inspections are labor-intensive and susceptible to human error, especially when multiple aircraft are inspected consecutively. The integration of drones in preflight inspections can automate certain steps, reduce human workload, and improve inspection consistency [2].

2.1.3 Modern Approaches in Pre-Flight Inspection Using Drone Technology

Recent advancements in drone technology have transformed pre-flight inspections. Drones equipped with high-resolution cameras, thermal imaging, LiDAR, and 3D scanning can conduct comprehensive inspections with high precision. UAVs can fly around the aircraft to capture images and data from multiple angles and elevations, tasks that would otherwise be laborious or unsafe for manual inspectors.

These drones can be remotely controlled or programmed to follow automated flight paths, ensuring full coverage of critical inspection areas. AI and machine learning algorithms can automatically detect structural defects such as cracks, corrosion, oil leaks, and other anomalies. Historical inspection data can be used to compare and track recurring issues. Drones also operate effectively under challenging conditions, such as low-light environments, extreme weather, or areas difficult to access manually, providing flexible, efficient, and reliable inspections [3].

2.2 Specific Literature Review

2.2.1 Product Structure

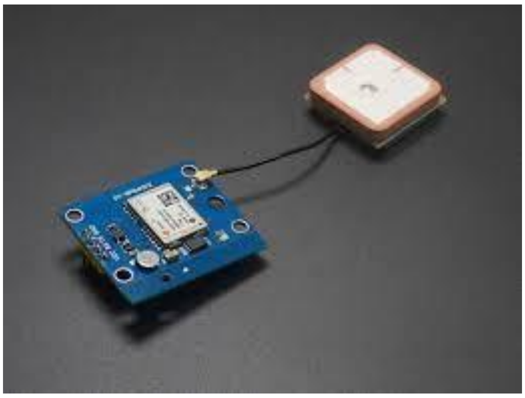
The design of a drone-based pre-flight inspection system integrates hardware, software, and operational protocols. Core hardware components include high-resolution cameras, GPS navigation, and stabilization systems, enabling precise flight around aircraft surfaces without risk of collision. Flight paths can be pre-programmed or manually controlled, allowing detailed capture of images for wings, engines, fuselage, and landing gear.

Real-time data transmission allows ground technicians to monitor inspections live, while digital storage ensures access to historical inspection records. Advanced features such as AI-based defect detection flag potential issues automatically. This system structure reduces manual labor, improves accuracy, and increases inspection speed, transforming pre-flight checks from a time-consuming manual task into a streamlined automated process [4].

2.2.2 Hardware and Software Systems

Hardware Systems:

- Visual Cameras: Capture detailed images for visual inspection and analysis.



- GPS Navigation Modules: Enable accurate positioning and flight path control.

- Stabilization Technology: Maintain drone stability in wind or turbulence, ensuring precise data capture.

Software Systems:

- Flight Planning Software: Automates flight paths or allows manual adjustments for specific inspection needs.
- Image Processing Software: Detects defects in real-time, analyzes trends, and generates maintenance reports.
- Integration with Maintenance Management Systems: Enables automated documentation, issue tracking, and compliance reporting.

By combining reliable hardware with advanced software, drone-based inspection systems enhance inspection efficiency, accuracy, and repeatability [5].

2.2.3 Programming Integration

Programming integration enables automation of flight control, image capture, and defect detection. Popular programming languages include Python and Arduino, with Python preferred for its rich libraries supporting drone control and data analysis.

Automated flight routines ensure that drones capture specific components at precise angles, and periodic inspection routines allow monitoring of high-risk areas. AIbased image analysis identifies defects such as cracks, corrosion, or oil leaks, reducing the need for manual review. Cloud integration enables real-time feedback and report generation, providing immediate insights to technicians and allowing customization for different aircraft models [6].

2.3 Review of Recent Research / Related Products

2.3.1 Related Products

- AIRobot Inspection Drone: Uses high-resolution cameras, thermal imaging, and AIbased defect detection for autonomous inspections of aircraft wings, fuselage, and engines. Real-time analysis reduces human inspection effort [7].

- Airbus Hangar of the Future: Autonomous drones perform pre-flight checks, capture images, and track maintenance history, enabling monitoring of recurring defects and streamlining inspection workflows [7].

2.3.2 Recent Market Products

- DJI Matrice Series: Equipped with high-resolution imaging, payload capacity, and LiDAR sensors, suitable for inspections in complex or low-visibility conditions.

- Skydio Drones: Offer autonomous navigation, obstacle avoidance, and AI-assisted inspections, ideal for precise, repeatable, and safe pre-flight checks [8].

2.3.3 Review of Recent Research

- Journal of Aerospace Engineering (2022): Drones improve detection of structural issues, outperform manual inspections in accuracy, and reduce inspection time by up to 40%.
- International Journal of Aviation Technology (2023): AI-assisted drones enable real-time defect detection and predictive maintenance, emphasizing improved efficiency, reliability, and safety in pre-flight inspections [9].

2.4 Comparison of Drone-Based Systems vs Market Products

Aspect	Proposed Drone System	DJI Matrice Series	Skydio Drones
Flight Control	Manual + programmed paths	Manual + automated	Fully autonomous
Imaging	High-resolution, thermal, LiDAR	High-resolution, LiDAR	High-resolution, obstacle avoidance
Aspect	Proposed Drone System	DJI Matrice Series	Skydio Drones
AI Integration	Real-time defect detection	Limited AI features	AI-assisted navigation + detection
Data Management	Local based, historical tracking	Local + cloud	Cloud based
Ease of Use	Moderate, requires pilot	Moderate	High, moderate training
Inspection Speed	Faster than manual	Fast	Fast, autonomous
Environmental Conditions	All-weather, low-light	Moderate	Moderate, obstacle-prone areas

CHAPTER 3

RESEARCH METHODOLOGY

3.1 DESIGN ENGINEERING TOOLS

3.1.1 Design Requirement Analysis

To develop a drone system capable of performing efficient pre-flight inspections, we first conducted a Design Requirement Analysis to clearly define the objectives and features the system should have. This process was essential for ensuring the system met both technical and user-specific needs, providing clarity on the project's scope.

3.1.1.1 Questionnaire Survey

To make sure we weren't missing anything, we reached out to aviation maintenance professionals, the people who actually perform these inspections. We created a questionnaire survey to gather their insights on the current inspection process and what improvements they would like to see. Some of the key areas we focused on included:

- Current inspection methods: How inspections are typically carried out (manual walk arounds, visual checks, etc).
- Pain points: What problem do they face with the current methods? (For example, time consumption, difficulty accessing certain areas, etc.)
- Desired features: What do they think would make the inspection process more efficient and effective? (Features like drone automation, real-time data feedback)
- Technology preferences: What kinds of technology would they prefer in the system? (For instance, camera quality, the interface used to control the drone, and data storage options).

This survey gave us a lot of valuable feedback, helping us figure out what was most important to those using the system day-to-day.

3.1.1.2 Pareto Diagram

Once we had the survey results, we used a Pareto Diagram to help us prioritize what to focus on. The Pareto Principle, also known as the 80/20 rule, suggests that a small number of problems often account for the majority of the issues. Using this, we could focus our design efforts on the most impactful areas.

Here are the key insights from the Pareto analysis:

- Time efficiency: A lot of respondents highlighted that inspections are very time-consuming. Our drone's ability to quickly scan the aircraft was a big selling point.

- Accuracy and thoroughness: Many professionals pointed out that inspecting hard-to-reach areas is difficult manually, and drones could provide more consistent, detailed checks.

- Data management: Another issue raised was how difficult it is to handle and analyze inspection data. We decided to integrate cloud storage and data analytics to make this part smoother.

- This analysis really helped us focus on the right features and made sure we were designing something that would truly solve the biggest challenges.

3.1.2 Design Concept Generation

With a solid understanding of the requirements, we moved on to generating design ideas. The goal was to come up with several potential solutions that could meet our needs and improve the inspection process.

3.1.2.1 Function Tree

We created a Function Tree to break down the main tasks the system needed to perform. This helped us map out the key functions and how they would work together. For example:

- Navigation and mobility: How the drone moves and avoids obstacles while flying around the aircraft.
- Image capture and data collection: How the drone captures high-quality images and stores them.
- User control and feedback: How the operator interacts with the drone and monitors its progress.
- Data storage and reporting: How the data is stored and made accessible for analysis.

This function tree gave us a clear roadmap of what the system needed to do and how everything would come together.

3.1.2.2 Morphological Matrix

Next, we used a Morphological Matrix to explore different ways we could approach each of these functions. This tool helped us generate different options for the drone's design. For example:

Drone type: Should we go with an HD camera, 4K, or infrared for nighttime or thermal inspections?

- Control interface: How should operators control the drone via a smartphone app, a remote control, or a more custom-built interface?
- Data storage: Should we store the data on a cloud platform or an SD card?

Using this matrix, we evaluated the strengths and weaknesses of each option and started narrowing down the features we wanted to include.

3.1.2.3 Proposed Design Concepts

Concept 1 (MUHAMMAD HARIS BIN SYFULL HAFEZ)

This was our simplest design, a quadcopter drone with an HD camera that's controlled manually with a remote. It stores footage on an SD card for easy access.

Concept 2 (ZULHAFIZ RAFIQUE BIN ZULFADHIL**)**

This concept involved an advanced quadcopter with a 4K camera, obstacle avoidance sensors, and the ability to stream live data to a smartphone app via WiFi.

Concept 3 (NUR AMALINA BINTI MOHD ADIB)

Our most advanced concept is a hybrid drone with both standard and infrared cameras, AI-powered image analysis, and cloud storage for real-time data processing and sharing.

3.1.2.4 Accepted Vs Discarded Solution

After discussing each concept, we decided that Concept 3 was the most promising. It offered the most advanced features, like AI-based image analysis and cloud storage, which we believed would make the system not only more efficient but also much more versatile for different inspection needs.

3.1.3 Evaluation & Selection of Conceptual Design

3.1.3.1 Pugh Matrix

To formally select the best design, we used a Pugh Matrix to compare all three concepts based on specific criteria like:

- Cost
- Camera quality
- Drone mobility
  Ease of use
- Data management capabilities

Concept 3 scored the highest in all of these categories, so we chose it as our final design. This matrix really helped us ensure that our decision was objective and backed by clear data.

3.1.4 Conceptual Design of the Proposed Product

With Concept 3 chosen, we moved on to refining the conceptual design. The final design integrates all the key features:

- A hybrid drone for maximum flexibility
- Dual cameras (HD + infrared) for comprehensive inspection coverage
- Cloud-based storage for easy access and sharing of data
- A mobile app for easy control and real-time monitoring

This design forms the foundation for the development phase, where we'll build and refine the actual product.

3.2 PRODUCT SKETCHES / WIRING DIAGRAM / INTERFACE LAYOUTS

Once we had the conceptual design in place, it was time to bring our ideas to life visually. This section covers the detailed sketches of the drone system, the interface layouts, and any relevant wiring diagrams. Visual representations are essential to help the team and others understand how the final product will look and work.

3.2.1 General Product Sketching / General Interface Layout*

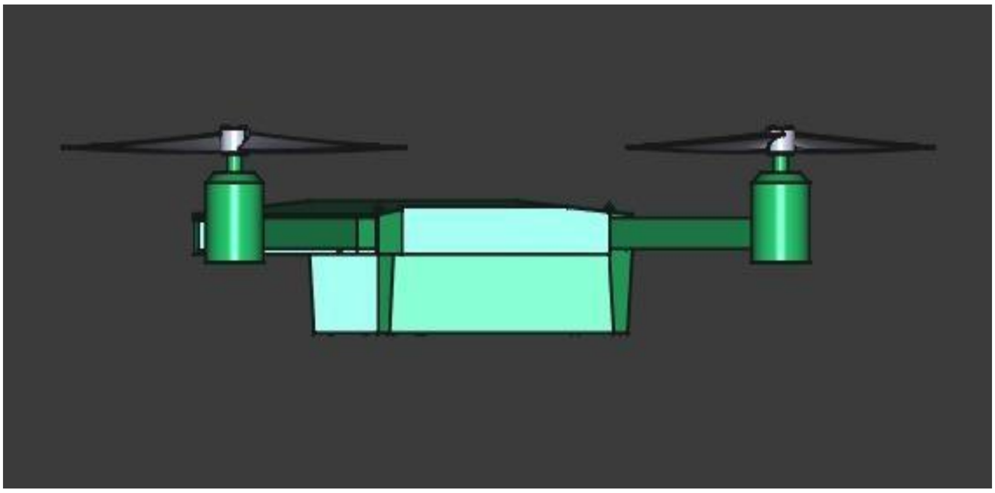
We started by sketching the overall design of the drone and its components. This includes both orthographic and isometric views to give a full picture of how the drone will be built. The sketches also show the layout of the onboard camera system, obstacle avoidance sensors, and the battery compartments.

These sketches help ensure that all components fit together properly and that the drone's design remains practical and efficient. Additionally, we have included the design of the control surface, which will allow users to operate the drone with ease through either a mobile app or a remote control.

The goal here was to make sure that every part of the drone was thought through in terms of both functionality and how it would be used by operators during inspections.

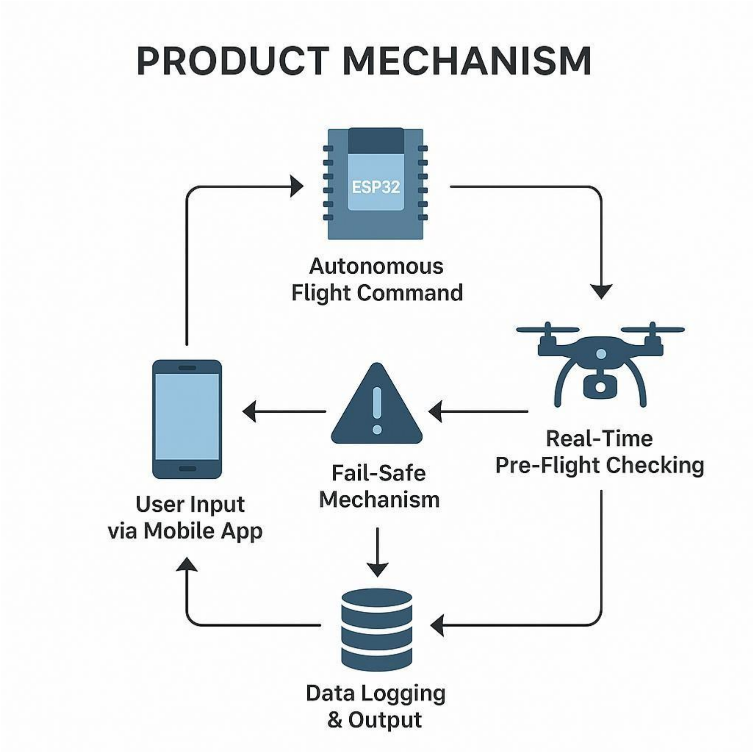
3.2.2 Specific Part Sketching / Specific Interface Layout

3.2.2.1 Product Structure



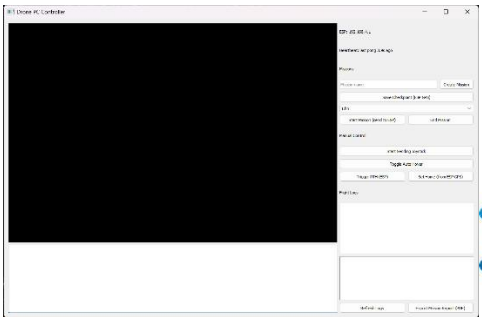
Using the drone body as an integrated structural frame and 3D printing it with PETG is a practical and cost-effective solution for student-level projects. PETG provides a good balance between strength, flexibility, and ease of printing, making it suitable for lightweight drone builds like yours that follow a DJI Mini design. It's stronger than PLA and less brittle, with moderate resistance to heat and UV, which is sufficient for short to medium-duration flights. However, PETG is heavier than some advanced filaments like Nylon, so optimizing the design with proper infill (40–60%), wall thickness (2–3mm), and ventilation paths is important to maintain stability and performance. Integrating compartments inside the body for components such as the flight controller, ESP32, GPS, and battery allows for a cleaner build and better space management. Overall, your approach is solid for your project, as long as the internal payload remains light and the structure is reinforced at key stress points like motor mounts and arm joints.

3.2.2.2 Product Mechanisms



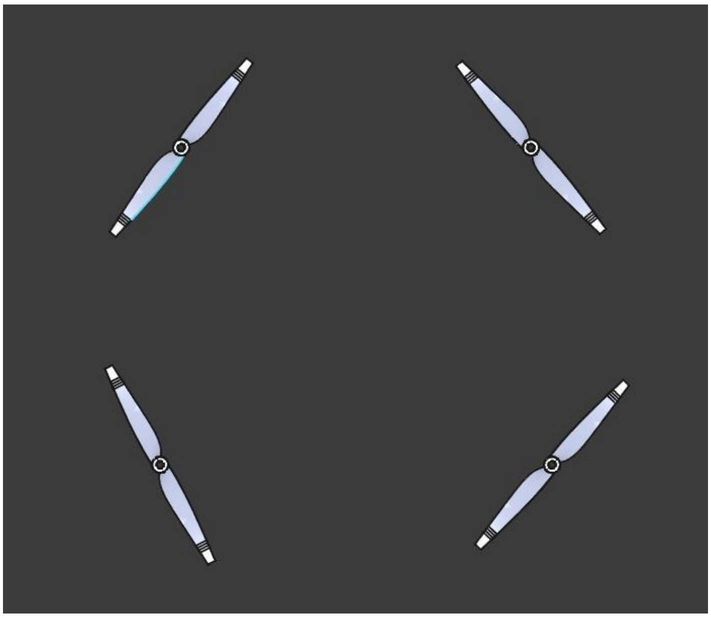
The mechanism of this product begins when the user selects the type of aircraft using app. This command is sent to the ESP32 microcontroller via Wi-Fi. The ESP32 processes the input and triggers a pre-set autonomous flight path based on the selected aircraft. It then communicates with the flight controller to control the drone's movement. As the drone flies along the inspection route, the onboard camera captures live footage and performs visual analysis to detect any anomalies on the aircraft's surface. All flight data and images are transmitted to the app for real-time monitoring and stored for later review. If any system errors occur, the user can manually override the drone using the app. In case no action is taken, the drone's built-in fail-safe mechanism will automatically return it to its starting point. This ensures a balance between autonomy, safety, and user control.

3.2.2.3 Software / Programming



For the software and programming part of this project, the system is built using multiple platforms that work together to ensure seamless operation. The mobile application is developed using Visual Code Studio, which serves as the main command center where the user selects the type of aircraft and monitors real-time footage. The app sends commands to the ESP32 microcontroller over a Wi-Fi connection. The ESP32 is programmed using Arduino IDE or PlatformIO with Python and Qtpyie to process commands, run visual detection, and communicate with the flight controller. The flight controller Davedrone operates on Betaflight firmware, which controls drone movement based on inputs from the ESP32. Visual detection algorithms are implemented on the ESP32 using lightweight image processing libraries and trained models optimized for embedded systems. The software workflow ensures that user commands, autonomous path execution, image analysis, and emergency handling are all handled efficiently in real-time, while also logging flight data and images back to the application for post-flight review.

3.2.2.4 Accessories & Finishing



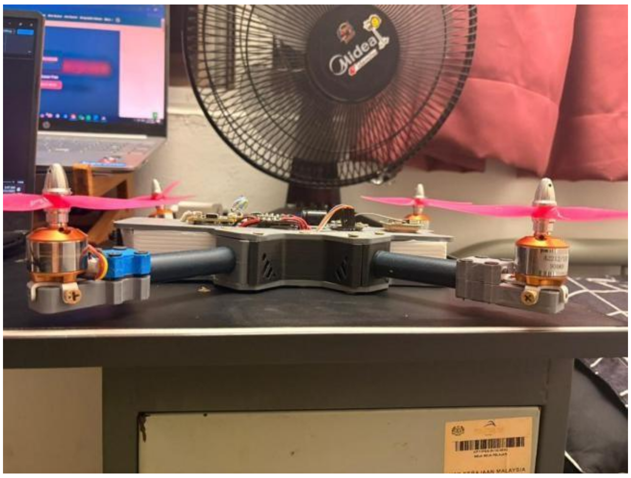
The drone incorporates essential accessories such as the propeller and camera to ensure stable flight and accurate inspection performance. The propellers are responsible for generating lift and enabling precise maneuverability during autonomous operations. For this project, 4 to 5-inch propellers with moderate pitch are ideal to match the compact size of the drone body, similar to the DJI Mini. These can be 3D printed using PETG filament, which offers a good balance of strength and flexibility while remaining cost-effective. However, for better durability and performance, carbon fiber or reinforced plastic propellers are recommended. The drone is also equipped with an HD camera module, which serves as the visual system for real-time monitoring and AI-based inspection. This camera streams live footage to the mobile application and captures images for analysis. Mounted securely with anti-vibration support, it provides clear visuals from various angles around the aircraft. The camera's data is used by the ESP32 to perform image processing and detect any surface anomalies during the pre-flight check, making it a vital component in the success of the autonomous inspection system.

3.2.3 Overall Dimension of the Product

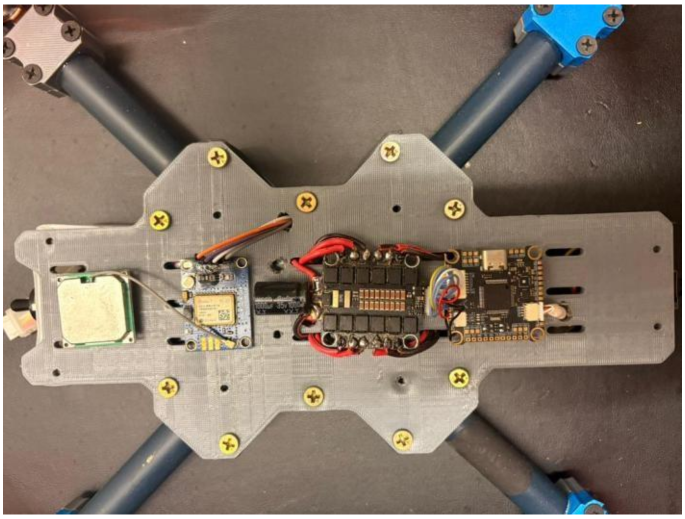
The overall product design of the drone is inspired by the compact and aerodynamic structure of the DJI Mini series, making it ideal for lightweight and efficient autonomous flight operations. The dimensions closely follow those of the DJI Mini, measuring approximately 245 mm in diagonal length (motor to motor) and weighing under 250 grams excluding the battery, which aligns with most regulatory weight limits for small drones. The body is designed with a streamlined profile to reduce air resistance and enhance stability during flight. Constructed using PETG material through 3D printing, the frame maintains a strong yet flexible structure capable of withstanding minor impacts and environmental stress. Internally, the drone is compartmentalized to house essential components such as the flight controller, power distribution board, GPS module, and ESP32 unit. An additional dedicated space is reserved for the camera module at the front and the AI detection system integrated with the ESP32. The design ensures that all components are securely positioned to avoid vibration and maintain balance. The arms are foldable or fixed depending on the build, with enough clearance for 4inch propellers to operate without obstruction. This compact yet functional design allows the drone to navigate tight inspection zones around aircraft while maintaining reliable flight performance and structural integrity.

3.2.4 Detailed dimension on the Product Parts

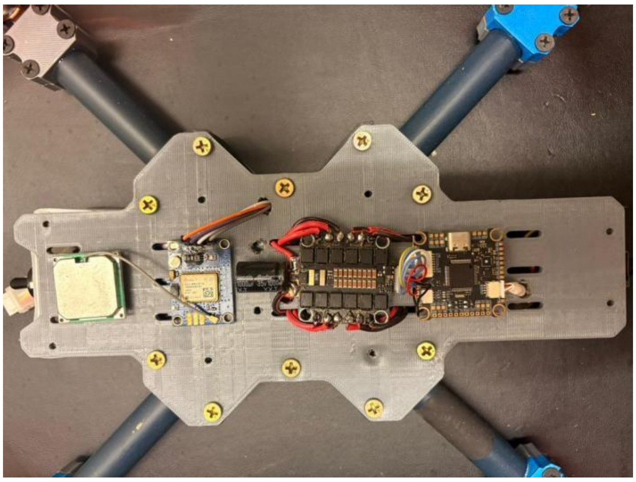
3.2.4.1 Base / Main Structure

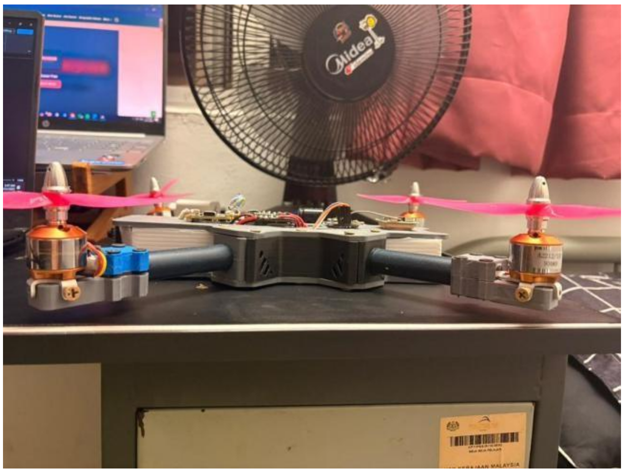


3.2.4.2 Inner Section / Compartment

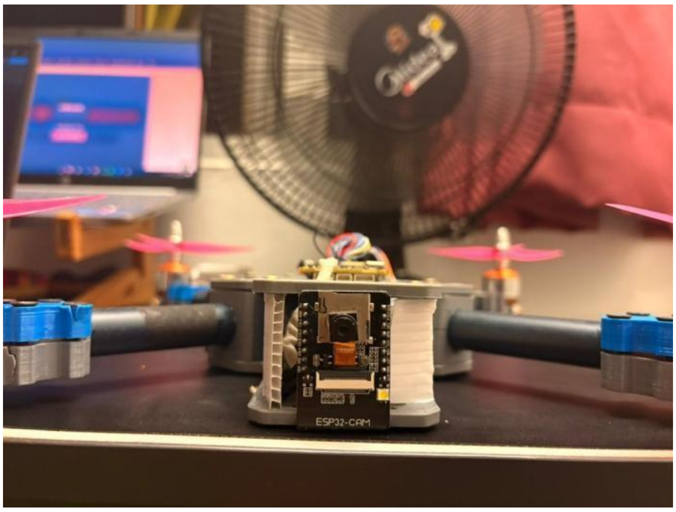


3.2.4.3 Top / Front / Side Section





3.2.4.4 Accessories / Outer Section



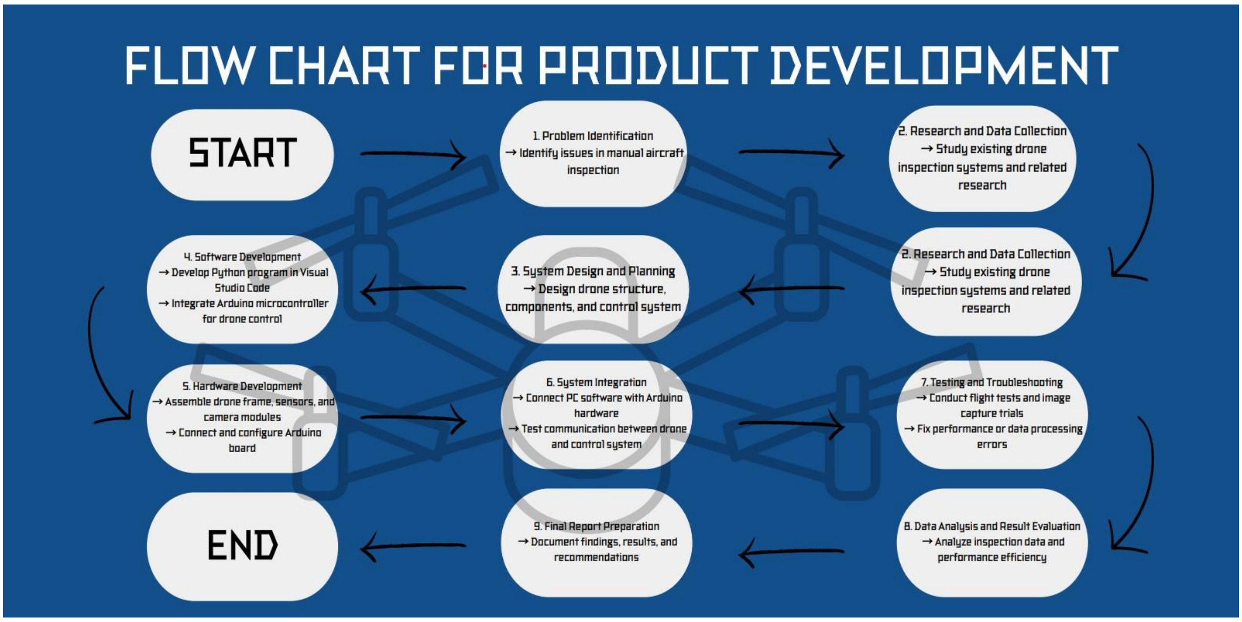
3.3 PROJECT FLOW CHART

Now that the design is taking shape, it's time to map out how the project will unfold. The project Flow Chart is our guide for the steps we take in order to complete the drone system on time.

3.3.1 Overall Project Flow Chart

1. Planning and Research: This is where we define the project's objective and gather the necessary research, like the survey and Pareto analysis, to understand what the drone needs to accomplish.
2. Design Phase: Once we had the requirements, we moved into the design phase, where we brainstormed concepts, created sketches, and finalized the specifications.
3. Development and Testing: This is where the real work begins. We'll start building the prototype, integrate all the components, and test the systems to see how it performs in real-life conditions.
4. Evaluation and Refinement: After the testing phase, we'll evaluate the drone's performance and make any necessary adjustments to ensure it works as expected.

5. Final Report and Presentation: Finally, we'll compile everything into a final report, including the development process, results from testing, and recommendations for future improvements.



This chart gives us a clear path to follow, so we stay on track and don't miss any critical steps along the way.

3.3.2 Specific Project Design Flow / Framework

While the overall project flow gives a high-level view, the specific design flow breaks down the process into more detailed steps for each part of the drone.

3.3.2.1 Product Structure

We started with the product structure because it's the foundation of the entire system. This includes deciding how the drone frame will be built and assembled.

The design flow for the structure involves:

- Selecting lightweight materials like petg for drone frame and aluminum for the motor rod.
- Ensuring the frame is strong enough to hold all the components, yet light enough not to compromise the drone's battery life or maneuverability.
- Designing modular parts that are easy to replace or repair in case of damage.

3.3.2.2 Product Mechanisms

The next step in the design flow is focusing on the mechanisms of the drone, things like the motors, propellers, and sensor systems. We're focusing on:

- High-efficiency motors to ensure long flight times (motor a2202)
- Obstacle avoidance sensors that will help the drone fly safely around the aircraft during inspections.
- Flight control systems that integrate all of these components into a smooth, easy-to-operate experience.

3.3.2.3 Software / Programming

The software and programming side of the project is where we make the drone smarter. This includes:

- Designing the user interface for the control system which is the application • Programming the drone's flight path and obstacle avoidance system to ensure it operates autonomously or with minimal manual input.
- Ensuring real-time data from the drone's sensors, like images and flight metrics, is displayed clearly for operator.

3.3.2.4 Accessories & Finishing

The final step in the design flow involves the accessories and finishing touches.

This includes:

- Selecting the camera types (OV2460 was choosen).
- Adding extra components like GPS for navigation, battery packs and camera.
- Finalizing the external design to ensure the drone is both functional

  and aesthetically appealing.

3.4 PRODUCT DESCRIPTION

Now that we have a clear plan for the design, it’s time to describe the final product and its features. This section breaks down how everything works together to provide a smooth and efficient aircraft inspection process.

3.4.1 General Product Features & Functionalities

The drone system is designed to perform through, efficient, and safe pre-flight inspections.

Here’s how it works:

- Drone Operation; The drone flies around the aircraft either autonomously or with some manual control, depending on the inspection area. It captures high-definition video and images of critical components like the wings, fuselage, and control surfaces.
- Camera System: Equipped with cameras, the drone can perform visual inspections during the day and in low-visibility conditions.
- Data Collection & storage: As the drone performs the inspection, it collects data in real-time, storing it either on an local storage for easy access and analysis.
- User Interface: A application as a remote controller allows the operator to control the drone and view live footage from the inspection. The interface is designed to be intuitive, providing clear instructions and real-time feedback

3.4.2 Specific Part Features

Each component of the drone is designed to work seamlessly within the overall system.

Here's a breakdown of some key parts:

- Frame: The petg frame is both lightweight and durable, making it the prefect base for the drone's components.
- Motors: High-performance brushless motors provide smooth and efficient flight, ensuring the drone can operate for extended periods.
- Sensors: The drone is equipped with gps module as a navigation module.
- Cameras: The HD camera provides clear visual inspections.

3.4.3 General Operation of the Product

The operation of the drone system is designed to be as simple and user-friendly as possible, ensuring that maintenance professionals can use it with minimal training.

1. **Start-up & Initialization:**
   The process begins by launching the drone, either autonomously or manually. The operator can either let the drone follow a pre-set flight path or control it remotely for specific areas of the aircraft inspection.
2. **Flight Path and Navigation:**
   Using GPS the drone navigates around the aircraft, covering all the critical areas that need inspection. It uses obstacle avoidance technology to fly safely even in tight spaces or around obstacles, ensuring it doesn't crash into the aircraft or nearby objects.
3. **Data Collection & Real-Time Analysis:**
   As the drone flies, it captures high-definition video. The camera systems capture detailed footage of the aircraft's surfaces, including hard-to-reach areas. If there are any issues (like dendts, crack, or other anomalies), the data is automatically tagged and stored for easy access.
4. **Data Storage and Retrieval:**
   All the collected data, whether visual footage or thermal reading is stored on the local storage. This ensures that the data can be reviewed later, and the inspection history is kept secure.
5. **Data Analysis & Reporting:**

After the inspection is complete, the data can be analyzed for any potential problems. The drone system can also be programmed to automatically generate reports based on the images or video, making it easier for maintenance teams to assess the condition of the aircraft. These reports can be shared with relevant stakeholders immediately, ensuring faster decision-making and quicker resolutions.

3.4.4 Operation of the Specific Part of the Product

Each part of the drone system plays a critical role in the success of the inspection. Here's how some of the individual components work to make the whole system function smoothly:

3.4.4.1 Product Structure (Frame)

The drone frame is the backbone of the entire system, It holds everything together and needs to be both lightweight and durable. We chose a petg frame because it's strong yet lightweight, allowing the drone to fly for extended periods without compromising battery life. The design also ensures easy modularity, which means individual parts like the motors, camera system, and battery can be easily replaced or upgraded if necessary.

3.4.4.2 Product Mechanisms (Motors & Propellers)

The motors used in our drone are brushless motors, know for their efficiency, smoothness, and long lifespan. These motors drive the propellers, which are optimized for stability and smooth control during flight. The choice of motors and propellers ensures that the drone can handle different inspection scenarios, whether it's hovering in one spot to capture detailed images or flying along a preset path around the aircraft.

3.4.4.3 Software / Programming (Control System)

The software and programming behind the drone's operations are designed to make the entire process as efficient as possible. The control system allows the operator to either guide the drone manually or let it fly autonomously. The drone's path is planned using waypoints, and it automatically adjusts to avoid obstacles.

Additionally, the software processes the images captured by the drone in real-time, helping operator identify potential right after the inspections are completed.

3.4.4.4 Accessories & Finishing (Cameras, Sensors, and Extras)

In addition to the core components, the drone system comes equipped with several accessories and extra features that enhance its functionality:

- Cameras: The drone is equipped with both HD cameras for standard visual inspections and infrared cameras for thermal imaging allowing the drone capture detailed footage in all conditions.
- GPS system: This ensures the drone can navigate autonomously, following precise flight path and positioning itself correctly for each inspection area
- Battery: The drone is powered by a high-capacity lithium-polymer battery, designed to last for long inspection sessions without needing to recharge frequently.

3.5 LIST OF MATERIALS & EXPENDITURES

The next step in the project is to outline the materials needed to build the drone and the cost associated with each component. Below is the overall cost:

3.5.1 Product Structure

No	Items	Details	Unit Price (MYR)	Total (MYR)
1	**Petg Frame**	**Drone Frame**	**70**	**70**
2	**Aluminium Rod**	**Motor Rod**	**5**	**20**

3.5.2 Product Mechanisms

No	Items	Details	Unit Price (MYR)	Total (MYR)
1	Brushless Motor	Motor	25 (4 Unit)	100
2	Flight Controller	Drone Main controller	1	100
3	Battery	5000 mah	98	98
4	Gps Module	Navigation	25	25
5	Propeller	Provide Thrust	5 (4 Unit)	20
6	Electronic Speed Controller	50 Amp for each motor	50	50

3.5.3 Software / Programming

No	Items	Details	Unit Price (MYR)	Total (MYR)
1	Visual Studio Code	Programming	0	0

3.5.4 Accessories & Finishing

No	Items	Details	Unit Price (MYR)	Total (MYR)
1	Esp 32	Machine Learning	30	30
2	Camera	AI detection	20	20

GRAND TOTAL = RM533.00

3.6 OVERALL PROJECT GANT CHART

With the project plan in place, we can now see the timeline of the project's development. The Gantt Chart below outlines the key stages and when they're expected to take place. It ensures we stay on track and meet important deadlines.

Week	**W 1**	**W 2**	**W 3**	**W 4**	**W 5**	**W 6**	**W 7**	**W 8**	**W 9**	**W1 0**	**W1 1**	**W1 2**	**W1 3**	**W1 4**	**W1 5**
Briefing and Research	✓	✓	✓												
Design and Component Selection		✓	✓	✓		✓	✓								

Week	**W 1**	**W 2**	**W 3**	**W 4**	**W 5**	**W 6**	**W 7**	**W 8**	**W 9**	**W1 0**	**W1 1**	**W1 2**	**W1 3**	**W1 4**	**W1 5**
Prototype Development and Testing			✓	✓	✓			✓	✓						
Evaluation and Refinement				✓	✓	✓				✓	✓				
Final Report and Presentation					✓	✓						✓	✓	✓	

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.

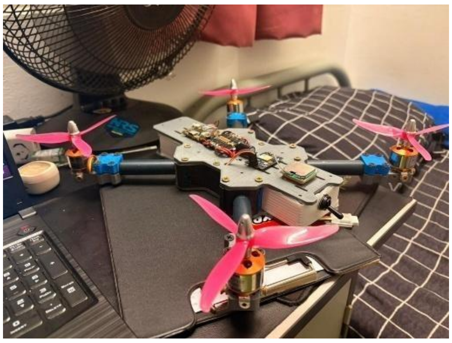


Figure 4.1: Drone frame installation

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

Esp32 is used in this drone. Programming such as machine learning, 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: Flight Controller

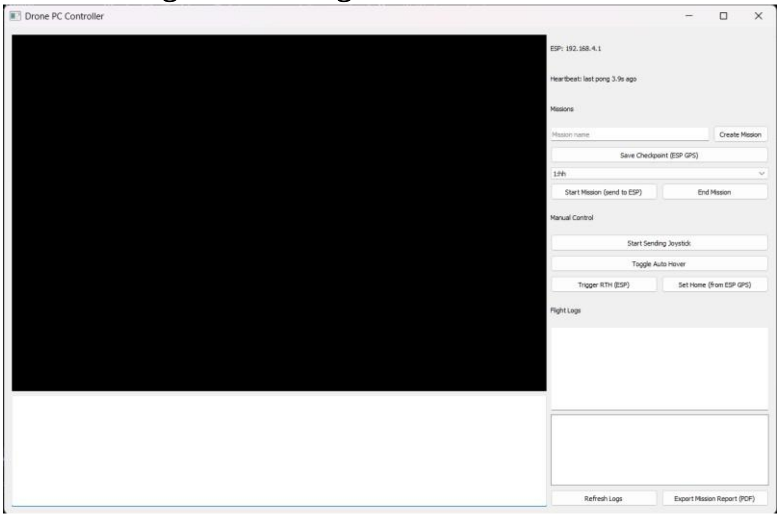


Figure 4.4: Application

4.1.2.4 Accessories & Finishing

Unfortunately, the camera did not have high-definition resolution. Installing powerful cameras requires some more money. Machine Learning is a feature of the camera's technology that is displayed on the monitor. The items was there if the camera picked up on the pitot, 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.

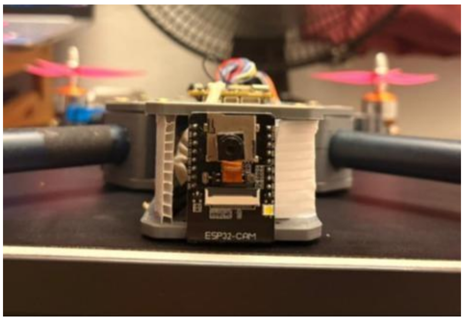


Figure 4.5: Camera positioned 90°

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 and return to home. 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

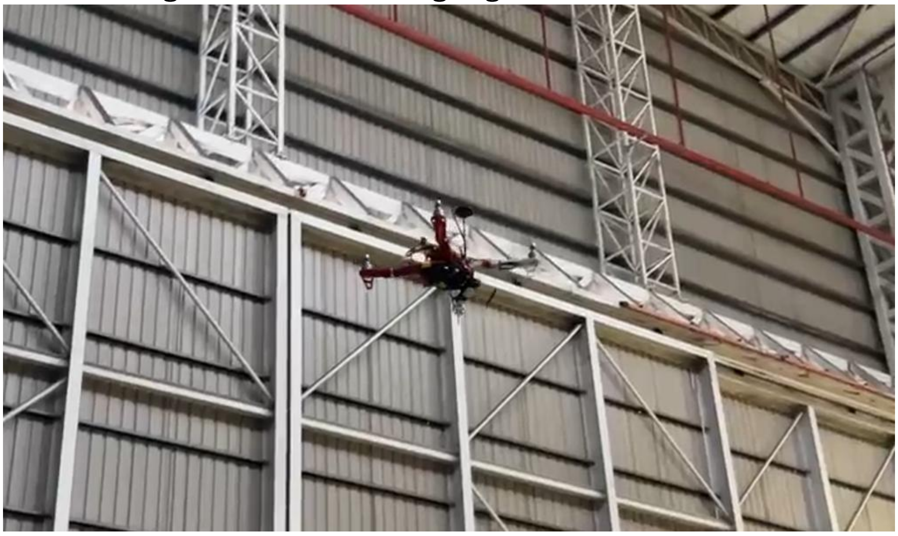


Figure 4.8: Drone on flight

4.1.4.3 Software / Programming

Machine can be done on flight, which is from the ESP 32, 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 OV2460 camera that is not a 360° camera which has been integrated into esp 32. Due to low quality recording, machine learning can be done at a very near distance.

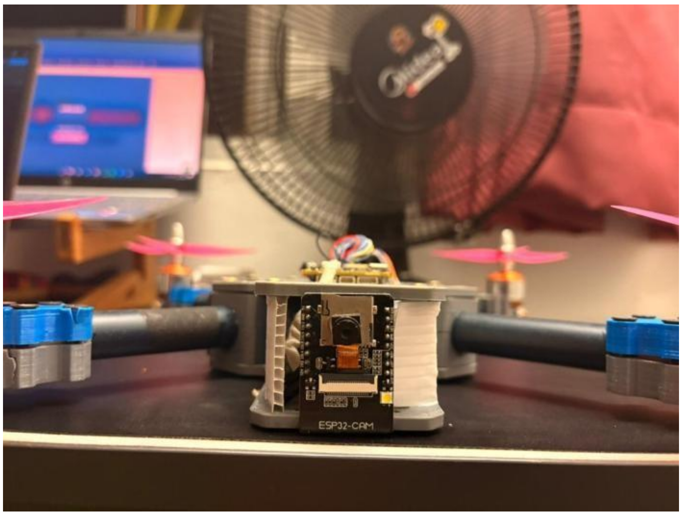


Figure 4.10: Drone with camera below the structure

4.2 PRODUCT OUTPUT

Firstly, the purpose of this project is to **improve the pre-flight inspection process of aircraft** because traditional manual inspections have several disadvantages, such as being timeconsuming, labor-intensive, and prone to human error. Therefore, our team came up with the idea of an **Aerolytix smart drone for pre flight inspection** to overcome these problems and assist the traditional inspection process.

Next, the purpose is to **enhance drones that can access hard-to-reach areas** and capture detailed visual data of critical components, such as wings, engines, and landing gear, which may be difficult or unsafe to inspect manually.

The impact of our project is that **issues caused by traditional inspection limitations can be reduced**, making the pre-flight inspection process faster, more accurate, and safer. By using this system, aircraft readiness can be improved, potential faults can be detected earlier, and overall safety during flight operations can be increased.

4.3 ANALYSIS OF PROBLEM ENCOUNTERED & SOLUTIONS

4.3.1 Product Structure

The structure 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 3d print a new structure 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 30 minutes maximum as the battery was a big and heavy battery. 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 esp32. 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 machine learning hard to be done from far range. It can only be done if the camera is 10-15m away from a inspected item , 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 primary aim of this research was to develop a smart drone system capable of performing pre-flight inspections for aircraft, addressing the inefficiencies of traditional manual inspections which are time-consuming, labor-intensive, and prone to human error. The AI drone system was designed with strategically placed smart cameras to monitor blind spots, entry points, and critical areas such as aircraft storage and maintenance zones. By leveraging AI-powered video analytics, the system can identify unauthorized access and detect suspicious activities. In addition, the integration of drones with real-time video streaming allows aerial monitoring of large hangar spaces and facilitates quick inspections in areas with limited fixed camera coverage. A sophisticated Drone Management Algorithm optimizes flight paths for efficient patrolling and ensures a prompt response to alerts generated by the cameras. The system employs a decentralized processing architecture, enabling independent operation of its components, which is crucial for maintaining inspection capability during potential connection loss. Furthermore, environmental monitoring and motion detection in critical zones provide a comprehensive 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 was to design a safe flight drone that adheres to precise drawing and sizing specifications, specifically tailored for pre-flight inspection tasks in both hangar and narrow areas. The drone features a robust frame made from strong plastic materials, ensuring durability and resilience during operation. Its quadcopter configuration, with two clockwise and two counterclockwise rotating propellers, provides exceptional stability and precise control, making it suitable for both beginner and experienced operators. The aerodynamic efficiency is enhanced by a meticulously crafted frame cover that reduces drag and turbulence, thereby improving flight performance, operational effectiveness, and overall stability.

5.1.2.2 Product Mechanisms

Mechanically, the drone is equipped with brushless motors controlled via an ArduPilot flight controller, complemented by durable ABS plastic propellers. The brushless motors provide electronically commutated operation, ensuring a longer lifespan, energy efficiency, and stable flight. However, due to the outdated flight controller, some software functions such as auto take-off, auto landing, and SLAM mapping could not be fully realized. The current motor and propeller setup provides sufficient stability and control for the drone's intended inspection tasks, balancing weight and power efficiency.

5.1.2.3 Software / Programming

The machine learning functionality operates effectively on-board using the ESP32 programmed in VSC and .ino, enabling automated pre-flight inspection tasks. Challenges arose with the implementation of additional features like auto take-off, auto landing, and SLAM mapping due to flight controller incompatibility with the ESP32. Despite these limitations, the system demonstrates successful execution of core inspection functionalities, and plans to upgrade the flight controller are in place to fully realize all programmed features.

5.1.2.4 Accessories & Finishing

Currently, the drone's camera is a repurposed low-resolution model lacking advanced features such as 360° recording. This limits machine learning-based inspection to a short range of approximately 10–15 meters. Integration of the camera onto the drone has considered weight and balance, ensuring stable flight while allowing inspection of critical aircraft components. Upgrades to higherresolution cameras are planned to extend inspection range and improve data quality.

5.2 Contribution or Impact of the Project

The project contributes significantly to enhancing pre-flight inspection efficiency, safety, and accuracy. By using drones, inspectors can access hard-to-reach areas without risk, capturing detailed visual data of aircraft components including wings, engines, and landing gear. Real-time video streaming and automated workflows reduce human error, accelerate inspection processes, and provide comprehensive documentation for maintenance records. Decentralized processing ensures continuous operation even during network interruptions, while AI-based anomaly detection improves situational awareness. The system demonstrates practical, scalable, and cost-effective improvements to pre-flight inspection processes, enhancing aircraft readiness and overall operational safety.

5.3 Improvement & Suggestions for Future Research

5.3.1 Product Structure

Future improvements include upgrading the drone frame from traditional plastic to advanced lightweight composites such as carbon fiber or fiberglass. These materials offer increased durability and significant weight reduction, optimizing flight performance during prolonged inspections. Heat-resistant coatings could enhance resilience in high-temperature hangar environments. Installing propeller guards would improve safety in confined spaces, while noise reduction measures could be considered for stealth operations.

5.3.2 Product Mechanisms

Performance enhancements could include the use of high-energy-density batteries, such as lithium-polymer or solid-state types, for longer flight times and faster charging. Energy recovery systems, like regenerative braking for propellers during descents, could convert kinetic energy back into battery power. Alternative energy sources, including solar-powered surfaces or hydrogen fuel cells, may support extended mission durations. Integrating 5G technology would enable lowlatency real-time video feeds and effective remote control across longer distances.

5.3.3 Software / Programming

Future software development could integrate advanced AI algorithms to improve autonomous navigation, path planning, and obstacle avoidance in confined environments like hangars. Efficient real-time data processing for video and environmental information will enhance situational awareness and seamless IoT integration, ultimately increasing inspection effectiveness and operational reliability.

5.3.4 Accessories & Finishing

Planned upgrades include high-resolution cameras with 360-degree gimbal rotation and thermal imaging to detect heat signatures, allowing inspections at greater distances and in low-light conditions. These improvements will enhance drone functionality, facilitating clearer imagery for machine learning analysis and providing comprehensive monitoring without the need to reposition the drone. Together, these upgrades will significantly increase the efficacy of the pre-flight inspection system.

5.4 CONCLUSION

In conclusion, the development of the pre-flight inspection drone using ESP32 and Arduino IDE (VSC) has successfully demonstrated the potential to improve traditional manual inspection methods. The project has achieved its primary aim of designing a functional and safe drone capable of accessing hardto-reach areas of the aircraft, capturing detailed visual data, and assisting in preflight inspections efficiently. The integration of machine learning algorithms enables basic object recognition and analysis, although limitations in hardware, such as the outdated flight controller and low-resolution camera, restricted the full implementation of autonomous functions like SLAM, auto take-off, and landing.

Despite these constraints, the drone system has proven its capability to enhance safety, reduce human error, and save time during pre-flight inspections. The project also highlights areas for future improvement, such as upgrading the flight controller, enhancing camera quality, and integrating more advanced sensors and AI features to enable fully autonomous inspections. Overall, the project contributes significantly to the field of aircraft maintenance by providing a practical, innovative, and scalable solution that combines UAV technology, software programming, and automation to support efficient and reliable preflight checks.

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APPENDIX A: DECLARATION OF TASK SEGREGATION

MUHAMMAD HARIS BIN SYFULL HAFEZ	
SUBCHAPTER	**DESCRIPTION**
1.3.2.4	**Project Objective: Accessories & Finishing**
1.5.2.4	**Specific Individual Scope: Accessories & Finishing**
2.1.1	**Scope of Project – Product Structure & Mechanism**
2.1.2	**Fundamentals Of Pre-Flight Procedures**
2.2.1	**Product Structure**
2.2.2	**Hardware System**
2.2.4	**Accessories & Finishing**
2.3.1.4	**Review of Patented Product**
2.3.2.4	**Recent Market Product**
2.4.4	**Comparison between product in market**
3.2.2.4	**Specific Project Design Flow / Framework: Accessories & Finishing**
3.4.1.1	**Questionnaire Survey**
3.4.3	**Evaluation & Selection: Pugh Matrix**
3.5.4.4	**Specific Part Drawing / Diagram: Accessories & Finishing**
3.6.2.4	**Specific Project Fabrication**

4.1.1	**General Product Feature : Accessories & Finishing**
4.1.2.4	**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**
ZULHAFIZ RAFIQUE BIN ZULFADHIL	
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 drone on market**
2.2.1	**Specific Literature Review: Product Structure**
2.3.1.1	**Review Of Recent Product / Related Product: Patented Product**
2.3.2.1	**Recent Market Product: Marketed Product**
2.4.1	**Comparison Between Recent Research and Current Product**
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**

NUR AMALINA BINTI MOHD ADIB	
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**
2.3.2.3	**Recent Market Product: Marketed Product**
2.4.3	**Comparison Between Recent Research and Current Product.**
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**
3.5.4.3	**Specific Part Drawing / Diagram: Software / Programming**
3.6.3.3	**Specific Project Fabrication**
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**

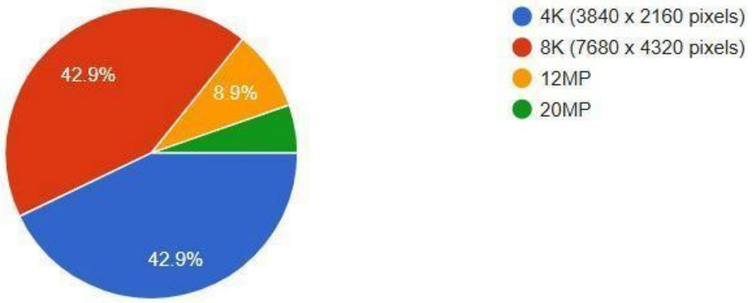
APPENDIX B : TURNITIN SIMILARITY REPORT

APPENDIX C : DATA FROM SURVEY

What resolution of camera do you believe most effective for aircraft surface scanning?

Copy chart

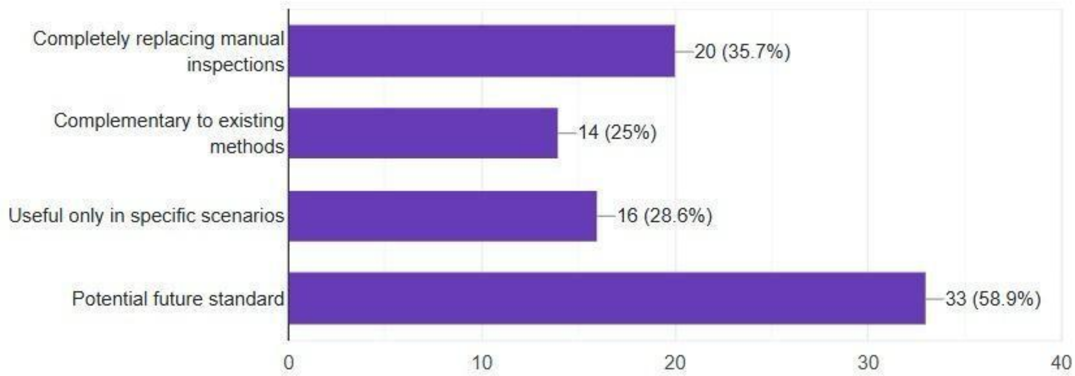
56 responses



Do you see drone technology as:

Copy chart

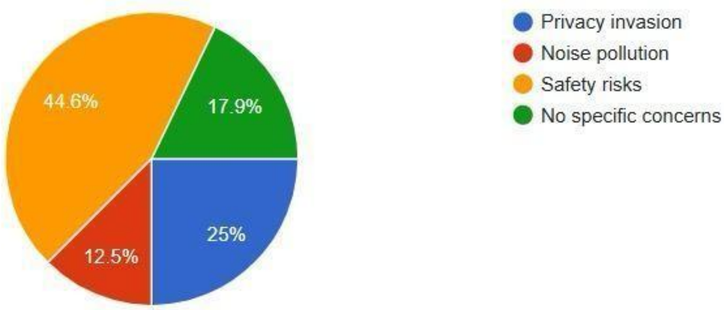
56 responses



What is your primary concern about drone usage in aircraft maintenance?

Copy chart

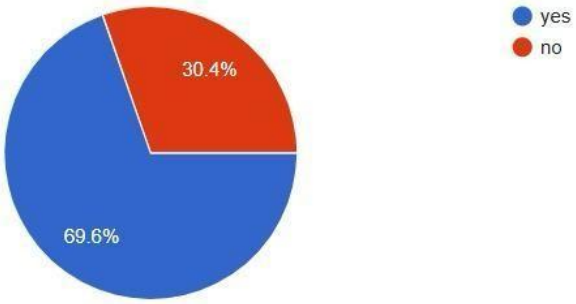
56 responses



Would you feel comfortable with drones performing aircraft inspections near your community

Copy chart

56 responses



How familiar are you with drone technology in aircraft maintenance?

Copy chart

56 responses