The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10656668

DRAKE's (DRONE KECE UNESA) AS A SMART SOLUTION FOR SURVEYING, MAPPING, AND MODELING BASED ON ARTIFICIAL INTELLIGENCE TO DETERMINE THE FEASIBILITY OF PALM OIL PLANTATION LAND

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Abstract

Plantation is a sector that plays a very large role in developing the economy in Indonesia, especially oil palm plantations. Oil palm is one of the plantation crops that is in great demand by entrepreneurs in Indonesia. Apart from that, palm oil hasbecome one of the main commodities produced by Indonesian plantations which has been exported to several countries. Based on the final report by the Indonesian Ministry of Trade in 2015, it was stated that in the future the amount of world consumption of palm oil will be higher than the amount of production. Looking at the problem, the proposer found a solution that could help palm oil business players map land locations. The proposer offers a solution to this problem, namely by using drone tracking DRAKE's (Drone Kece Unesa) is a smart solution based on drone technology that can be used to survey, map, and model coconut plantation land by utilizing Artificial Intelligence (AI) technology. This tool is equipped with AI technology which can process data collected by drones in a short time and produce accurate and detailed results about the condition of coconut plantation land. AI technology also allows this tool to recognize and map coconut plants andanalyze the suitability of land for coconut plantations. By using this technology, farmers or coconut plantation investors can obtain accurate and detailed information about the condition of the land to be planted with coconuts and analyze the suitability of the land for coconut plantations more easilyand quickly. This can help them make the right decisions in developing coconut plantations and increase the productivity and efficiency of coconut plantation businesses. With this tool, the process of surveying and mapping coconut plantation land can be carried out more efficiently, quickly, and accurately than traditional methods. This technology can also help oilpalm farmers make better decisions regarding plantation location selection, crop planning, and overall land management.

Keywords: Artificial Intelligence, Determine the Feasibility, Oil Palm Plantations.

INTRODUCTION

Plantation is a sector that plays a very large role in developing the economy in Indonesia, especially oil palm plantations. Oil palm is one of the plantation crops that is in great demand by entrepreneurs in Indonesia. Apart from that, palm oil has become one of the main commodities produced by Indonesian plantations which has been exported to several countries.

Based on the final report by the Indonesian Ministry of Trade in 2015, it was stated that in the future the amount of world consumption of palm oil will be higher than the amount of production. Apart from that, oil palm often gets the image of being able to damage the ecosystem, so mapping of land suitability for oil palm plantations is needed so that they continue to develop. Land suitability evaluation has experienced a lot of development,

ISSN 1533-9211
DOI: 10.5281/zenodo.10656668

especially with the existence of Artificial Intelligence (AI) which can solve multi-index decision-making problems so that it can produce very different evaluation results.

Looking at the problem, the proposer found a solution that could help palm oil business players map land locations. The proposer offers a solution to this problem, namely by using DRAKE's drone tracking (Drone Kece Unesa) based on Artificial Intelligence with quality image results using drones applying the Convolutional Neural Network (CNN) method to determine the location of oil palm land development. This method is a deep learning system because the data processedis image data. In this case, the urgency of creating DRAKE's (Drone Kece Unesa) by the proposing team is focused on carrying out AI-based surveying, mapping, and modeling to determine the suitability of oil palm plantation land.

METHOD

Research Design

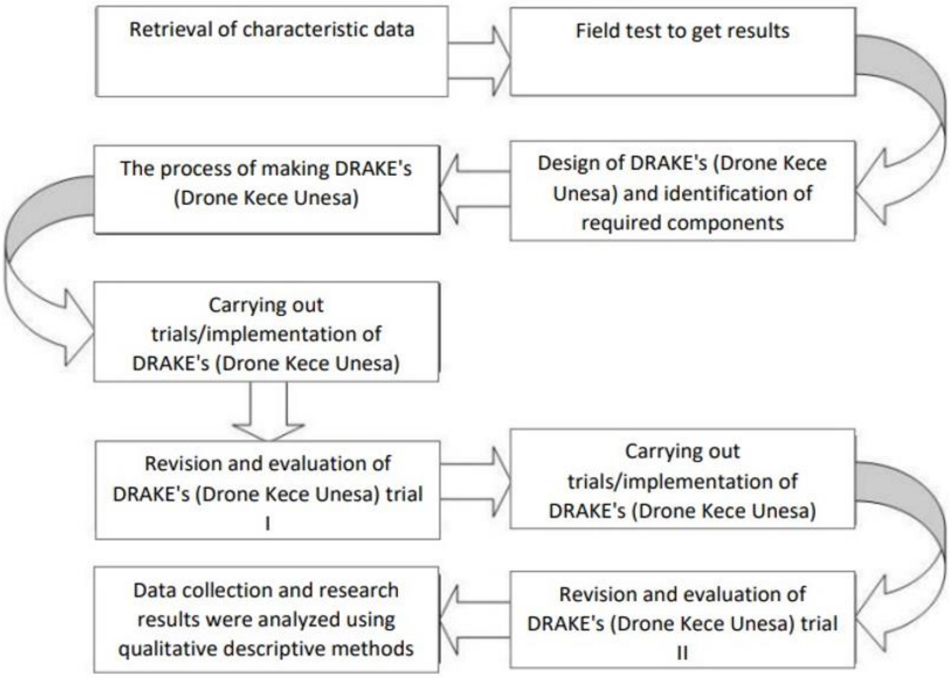

Figure 1: Research Flow Chart

The research method for DRAKE's (Drone Kece Unesa) as a Smart Solution Surveying, Mapping, and Modeling Based onArtificial Intelligence to Determine the Feasibility of Palm Oil Plantation Land is as follows:

a. Determining Research Objectives

The research aims to develop the Unesa Kece Drone system as a smart solution for conducting surveys, mapping, andmodeling to determine the suitability of oil palm plantation land.

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DOI: 10.5281/zenodo.10656668

b. Study of Literature

A literature study was carried out to obtain a comprehensive understanding of drone technology, mapping systems, modeling, and the sophistication of artificial intelligence used in this research.

c. Determination of Research Variables

The research variables used are mapping and modeling data obtained via drones, as well as known data on the feasibility of oil palm plantation land.

d. Research Design

The research uses an experimental design consisting of surveying, mapping, and modeling using drones. The collected data is then analyzed using artificial intelligence techniques to determine the suitability of oil palm plantation land.

e. Data Collection

Data collection was carried out using drones to carry out aerial surveys and mapping. The collected data is then processed and analyzed using artificial intelligence techniques.

f. Data Analysis

Data analysis is carried out using artificial intelligence techniques such as artificial neural network algorithms or decision trees to determine the suitability of oil palm plantations based on the mapping and modeling data that has been obtained.

g. Interpretation of Results

The interpretation results obtained from data analysis are used to determine the suitability of oil palm plantation land which will be used as a recommendation for land owners.

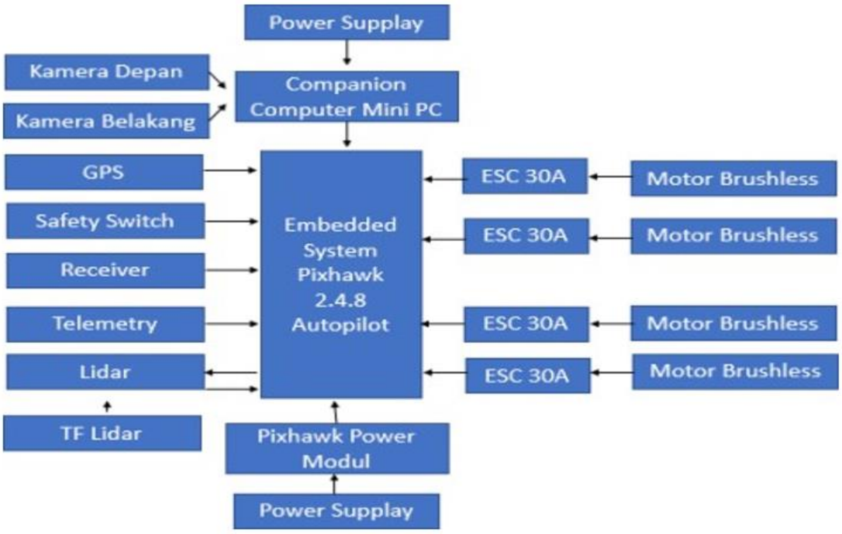

Figure 2: DRAKE's System Workflow

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This robot has a control system using the Pixhawk Cube Autopilot Embedded system as a navigation controller and robot movement. The robot can move due to the thrust of six thrusters, all of which are controlled by Pixhawk.

For balance and stability, this robot can balance itself even in air because the Pixhawk has an IMU (Inertial Measurement Unit) each consisting of an Accelerometer, Gyroscope, and Magnetometer. The IMU is processed in Pixhawk using the EKF (Extended Kalman Filter) algorithm so that the robot can determine the estimated position so that it can dive stably.

The Mini PC functions as a data processor from the camera. Then the data is processed using the existing program to produce a command which is sent to Pixhawk. Mini PC is not only a sender, but also a receiver. The Mini PC receives information from sensors which are processed in Pixhawk which then becomes the data the robot needs to be able to moveautonomously. Communication between the robot and the GCS (Ground Control Station) uses telemetry as an intermediaryso that the robot and GCS can send and receive data to each other simultaneously. Therefore, users can monitor data and conditions underwater even though the user is on the surface.

Mapping Process

For mapping itself, it uses a combination camera with lidar sensor that is integrated with ROS (Robot Operating System) and AI Computing by YOLO (You Look At Once). As in the image below.

Movement is controlled by an automatic control system integrated with sensors and artificial intelligence software, such as machine learning algorithms. This drone can be controlled remotely or even independently.

This drone is equipped with various types of sensors such as lidar, cameras, and GPS navigation systems, so it can collect various data, ranging from seabed morphology to temperature levels and salt content of seawater. After collecting data, thesubmarine is programmed to analyze and process the information using artificial intelligence strategies to create complete and easy-to-understand visualizations and analytical data. This can help identify patterns and develop better spatial modeling. In many cases, these drones can be connected to online systems and provide real-time data, which allows data collected andprocessed by drones to be directly sent to the control center and used for real-time decision-making. With its ability to collect, analyze, and process data automatically, as well as using artificial intelligence algorithms to build and model land,it is very suitable for efforts to determine the suitability of oil palm plantations.

RESULTS AND DISCUSSION

DRAKE's Description

DRAKE'S (Drone Kece Unesa) is a flying drone robot whose mission is to carry out semi-autonomous monitoring and mapping which was developed to monitor agricultural land in Indonesia, especially in oil palm plantations. DRAKE'S wassuccessfully created and can be operated in the air equipped with various technologies such as LIDAR sensors, gyro sensors, and

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ISSN 1533-9211
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high-resolution cameras (1080p) which have gone through several stages of research and testing. Thus, DRAKE'S is considered capable of carrying out monitoring and mapping so that it can adapt to the environment in plantation areas with extreme situations and conditions. The following specifications of DRAKE'S include:

Mass	5 Kg
Dimensions	(length x Width x Height) (90mm x 90mm x 30mm)
Control System	Embedded System Pixhawk 2.4.8 ArduCopter Firmware
Computer system	Nvidia Jetson Nano 4GB
Navigation System	GPS Here 3 By HEX
Sensors	Logitech C922 webcam, LiDAR L2 Zenmuse, TFMini LiDAR
Power Supplies	6S 5000 mAh LiPo battery
Software Architecture	Linux Ubuntu 18.04 Mavlink & Dronekit Pymavlink Based on Python

DRAKE's design

The results of this research resulted in a DRAKE'S design whose originality can be ascertained. We designed DRAKE'S starting from the initial stage which includes the following aspects:

Mechanical Design

In the mechanical design and analysis process, DRAKE'S uses AutoCAD 2023 and Inventor Professional 2021 software. Using AutoCAD 2023 allows DRAKE'S to be designed with more precision, making the component manufacturing and assembly process easier. The final product produced is a quadcopter drone which has a compatible design so that it is easy to maneuver in the air, able to move autonomously, and capable of making maneuvering decisions, processing, and processing data in the plantation environment in real-time.

1. Manufacturing Design Strategy

The main frame of DRAKE'S Quadcopter is made of hollow aluminum and carbon plate as a body frame which is considered stronger, lighter, and resistant to rust/corrosion against water. Apart from these materials, L-nut bolts and stainless-steel spacers are also used as fasteners between the hollow components and each other. The advantages of using L bolts and nuts are high material strength, rust resistance, and an easier installation process during the manufacturing process.

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DOI: 10.5281/zenodo.10656668

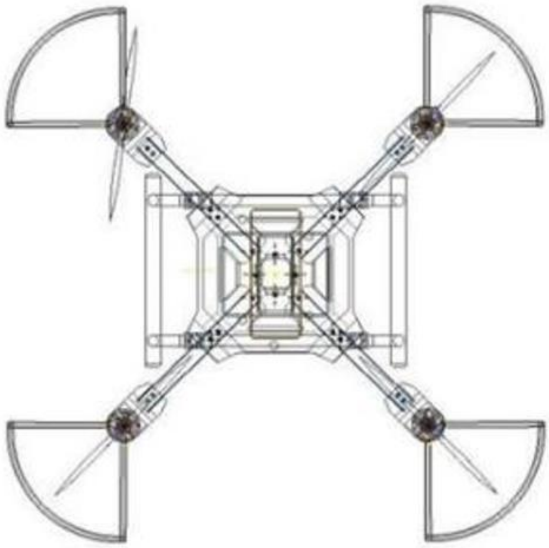

Figure 3: Frame Design

2. Brushless Motor Design

DRAKE'S uses 4 Brushless motors assembled crosswise which are equipped with a safety guard in the form of an aluminum hollow that is longer than the propeller used on each motor. The Brushless Motor installed on DRAKE'S has an additional mechanical structure that functions to maximize the vector direction and thrust of the Brushless Motor. DRAKE’S quadcopter motor configuration determines its performance and stability during flight. In the DRAKE'S motorbike design, four motors are placed symmetrically at the four corners of the frame. This helps maintain balance and control during flight. Each quadcopter motor has a rotor and propeller, or propeller, that enables thrust. The effective motor configuration depends on even load distribution, proper motor orientation, and proper motor specifications.

Figure 4: Vehicle Projection Appears Asymmetrical

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DOI: 10.5281/zenodo.10656668

3. Propulsion Configuration

DRAKE's has 4 motor BLDC as Propulsion to control vertical movement with different propeller rotation directions (CW and CCW).

Figure 5: Top View Vehicle Projection

4. Load Distribution

Even weight distribution along the DRAKE's drone ensures its weight is evenly distributed, so DRAKE'S remains stable during flight. In addition, the orientation of the motor is very important. The motor must rotate clockwise or counterclockwise so that the resulting rotating moments cancel each other out, ensuring balance.

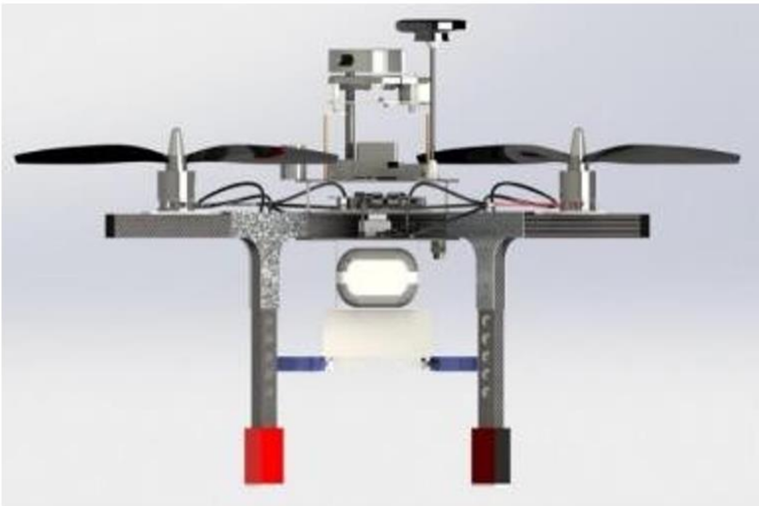

Figure 6: Side View Vehicle Projection

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ISSN 1533-9211
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5. Electrical Design

The electrical and control system of DRAKE'S Quadcopter consists of several blocks that have separate functions. These blocks consist of many passive and active components and are installed on a custom PCB so that they can carryout the tasks of the blocks properly and are interconnected with each other. These blocks consist of the supply block, computer system block, Autopilot block, ESC block, and Computer Vision. The design of data communication on DRAKE'S uses several types of communication, namely Serial, USB, and I2C (Inter-Integrated Circuit). Serial communication used between the Mini PC and Pixhawk Autopilot uses a USB to TTL converter as an intermediary. USB is used for communication between computer systems and Computer Vision. Then, communication between thePixhawk Autopilot and the Lidar sensor uses communication via I2C (Inter Integrated Circuit). The security system (Safety) on DRAKE'S already uses security in the form of a Safety Switch which can be activated at any time during an emergency. This security works by cutting off the motor driver's supply current so that the motor will immediatelystop working.

Computer Vision

Computer Vision on DRAKE'S uses two Logitech C922 Pro webcam cameras. The camera specifications are asfollows:

- Max Resolution: 1080p/30 fps - 720p/ 60 fps
- Megapixel camera: 3
- Focus type: Autofocus
- Lens type: Glass 22
- Built-in microphone: Stereo
- Microphone range: Maximum 1 m
- Diagonal field of view (dFoV): 78°
- Digital zoom: 1.2x

Underwater visualization uses these two cameras so that DRAKE'S can observe and carry out Image Processing so thatDRAKE'S can carry out missions well. The camera is connected using a USB medium and the image data is processedon a Mini PC system.

ISSN 1533-9211
DOI: 10.5281/zenodo.10656668

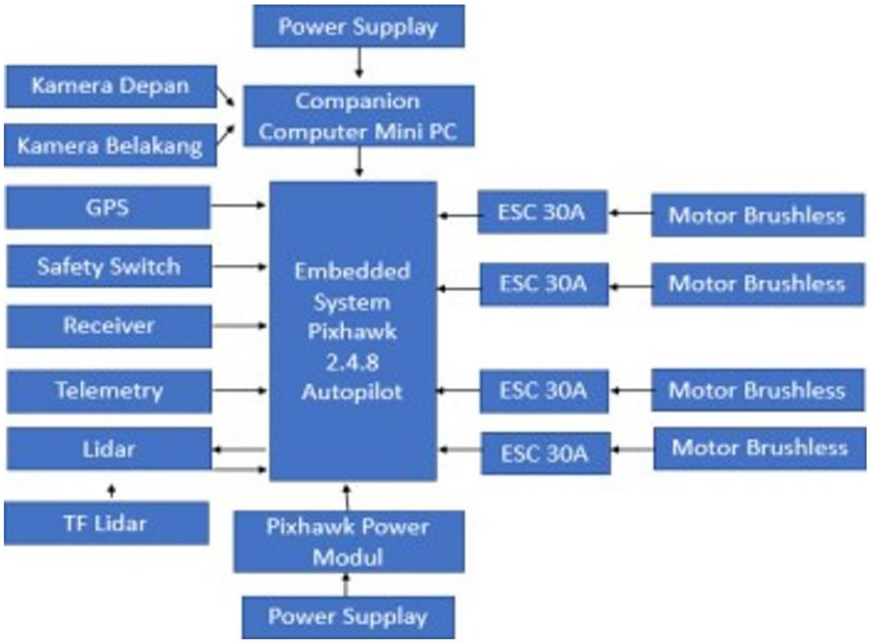

Figure 7: DRAKE's System Workflow

Power Supply and Battery

DRAKE'S is powered by one 6S LiPo (Lithium Polymer) battery with a capacity of 5000mAh. This battery can meet the electrical power needs of DRAKE's such as Brushless, Pixhawk, and Mini PC. All power requirements are regulated and distributed by the Power Management circuit. DRAKE'S Power Management circuit uses a Power Management circuit which has the function of regulating the voltage and current entering each component so that all components can work optimally. This circuit works by dividing the voltage into three outputs, namely 24V, 12V, and 5V.

The following is the function of the voltage output:

a. The 24V output is used to supply the motor driver on DRAKE'S where the current flow from the motor driver supply can be cut off using a safety switch so that if a malfunction occurs in the AUV, safeguards can be made so that the AUV does not endanger the operator or other people.

b. The 12V output is used to supply a computer system, namely a Jetson Nano 4GB. The voltage is reduced using a Buck Converter XL4016. XL4016 has a regulated voltage output and 8A current output with an efficiency of up to 96%.The voltage is lowered using Step Down so that the voltage output remains stable it does not interfere with the performance of the Mini PC.

c. The 5V output is used to supply the Pre-Driver, Pixhawk, as well as several sensors. The voltage is reduced usinga Buck Converter LM2596. The LM2596 Buck Converter has a well-regulated output voltage and a maximum current output of 3A.

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Navigation and Autopilot

DRAKE'S uses a navigation, mapping, and autopilot system that is integrated directly into one form in the form of Pixhawk Autopilot. Pixhawk is a flight controller that has an autopilot feature that relies on data fusion from several sensors, both internal and external, to determine the estimated position of the drone. Data fusion from Pixhawk uses the EKF (Extended Kalman Filter) method. The sensors used to estimate the position of DRAKE's are the GPS sensorand the Lidar sensor.

6. Software Design

For the control panel, we use QGroundControl. QGroundControl (QGC) is a ground control station (GCS) that is verysuitable for drone-type robots that operate without a crew. A Ground Control Station is a ground control center or air control center that provides facilities for the control of unmanned vehicles in the air, sea, or in space [15]. This GCS provides full dive control and mission planning for any robot that supports the MAVLink communications protocol.

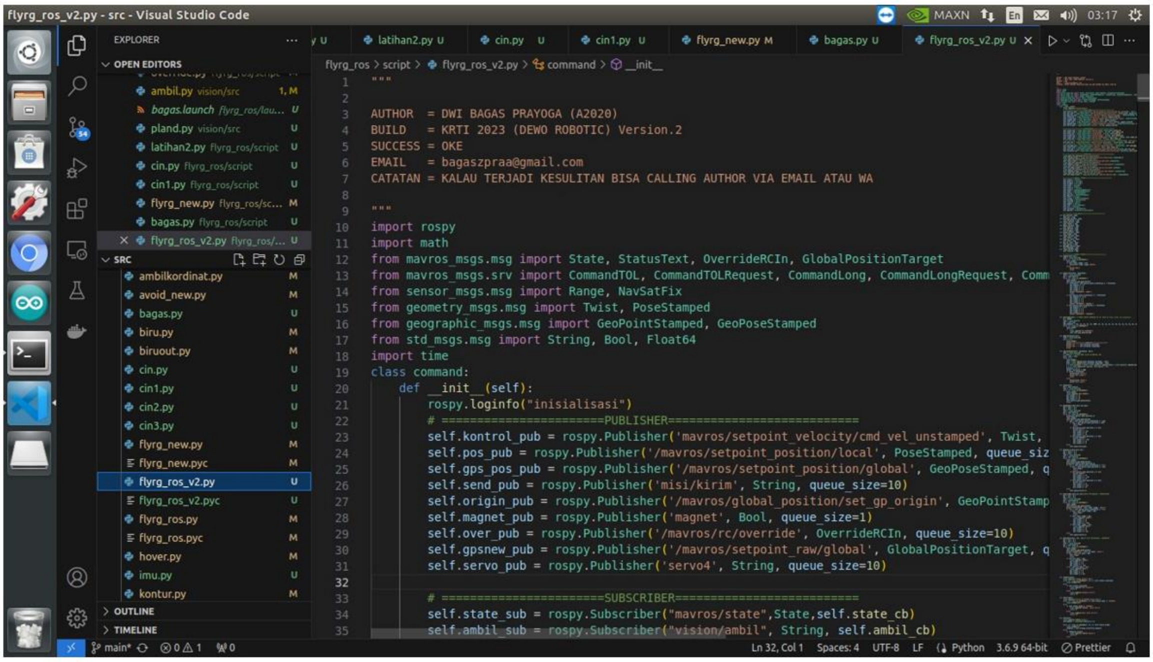

Figure 8: Programming Algorithm Overview

Field Trials

1. The Take Off vehicle uses autonomous mode, after the vehicle successfully Takes Off the vehicle maintains a height of no more than 1.5 m. After the vehicle detects the object through (image processing). After the vehicle has successfully recognized the object, the vehicle will pick up the object that has been recorded in the program as the object to be picked up and will later be dropped (object dropping).

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Figure 9: Outdoor Testing

2. Outdoor flights will start with the ride flying at a height of 15 – 25m. Flight is accomplished with a single button press. Next, the vehicle will go to the first location then maintain altitude and recognize the first location. When the vehicle is at the desired height, the vehicle takes pictures and carries out mapping.

Figure 10: Test Circuit

DOI: 10.5281/zenodo.10656668

3. Mechanical testing is used when flying at a height of 15-25m. testing the balance of the robot body and arranging the robot body to ensure the strength of the body and the weight of the body are made as light as possible so that when flying it can be light and when a crash occurs the body is still sturdy and can be used again.

Figure 11: Mechanical Test

4. OffBoard Trial

DRAKE carries out trials offboard and flies autonomously according to the mission and paths or waypoints that have been set according to the destination of the mapping location. This advanced functionality allows DRAKE to efficiently explore and map diverse locations with precision and autonomy, contributing to its versatility in various aerial tasks.

5. Mapping And Classification

Mapping and classification play pivotal roles in various fields, providing valuable insights and organization of spatial data. These processes involve the systematic analysis and categorization of geographical information, enabling effective decision-making, resource management, and environmental monitoring across diverse applications. All of this can be done thanks to the combination of several sensors and algorithms and then adjusted with programming to produce mapping results as well as calculating the area of the plot captured by the sensor.

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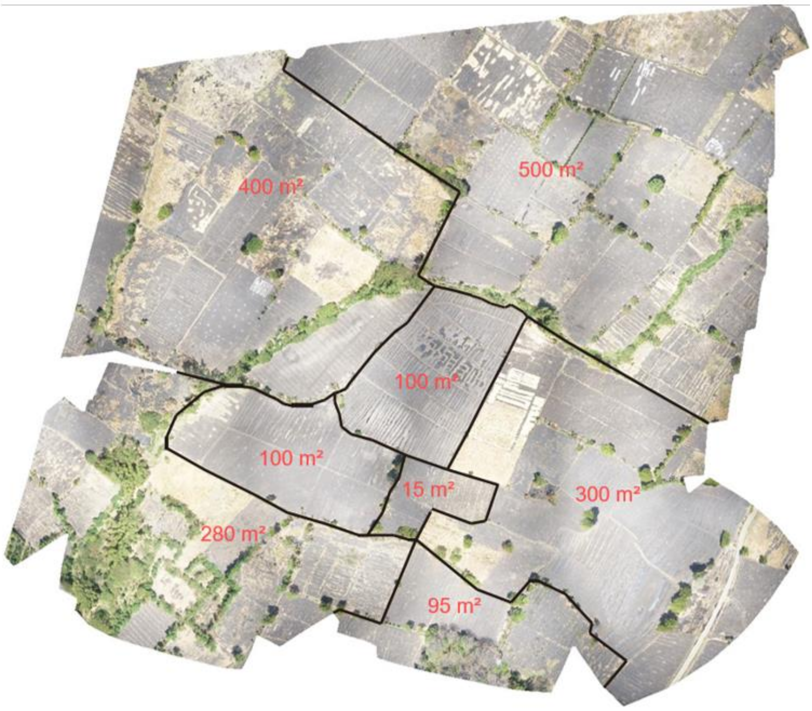

Figure 12: Mapping Result

Table 1: IMU Data While Mapping

Time **(Minutes)**	***Pitch***	***Roll***	***Yaw***
0.5	-0,00389	0,00397	-0,11751
1	-0,00388	0,00398	-0,11808
1.5	-0,00389	0,00403	-0,11855
2	-0,00387	0,00402	-0,11913
2.5	-0,0039	0,00402	-0,11967
3	-0,00395	0,00401	-0,12012
3.5	-0,0039	0,00407	-0,12074
4	-0,00397	0,00411	-0,12129
4.5	-0,004	0,0041	-0,12181
5	-0,00405	0,00411	-0,12233
5.5	-0,00404	0,00415	-0,12281
6	-0,0041	0,00411	-0,12335
6.5	-0,0041	0,00411	-0,12391
7	-0,00414	0,00416	-0,12446
7.5	-0,00414	0,00421	-0,12504
8	-0,00415	0,0042	-0,12553
8.5	-0,00415	0,00423	-0,12603
9	-0,00406	0,00423	-0,12649
9.5	-0,00405	0,0042	-0,12698
10	-0,00401	0,00413	-0,12755
Mean	**-0,004012**	**0,0041075**	**-0,122569**

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From the data collected during testing, average values were derived for pitch, roll, and yaw in static tests, yielding values of -0.004012, 0.0041075, and -0.122569, respectively. The experimental outcomes for pitch and roll are favorable due to their low error values, making them suitable for incorporation into SLAM data. However, the results for yaw are less promising, evident in the distinct error value scale compared to pitch and roll. Furthermore, between the 0.5s and 10s intervals, the yaw data consistently experiences significant increases, highlighting the inadequacy of IMU-derived yaw data for precise orientation measurements.

Table 2: LiDAR Data/Minutes While Mapping

Sudut (*Degree*)	**Real**	**RPLiDAR**	**Selisih Kuadrat**
	Jarak (mm)	**Jarak (mm)**	**Jarak (mm)**
0	*Invalid* (0)	*Invalid* (0)	*Invalid* (0)
45	3091	3000	8281
90	2250	2200	2500
135	3137	3100	1369
180	5934	5910	576
225	1054	1000	2916
270	773	700	5329
315	1113	1100	169
Average			2642,5
RMSE			51,40525265

Based on the test data, when the RPLiDAR is positioned at a 0-degree angle, it encounters difficulty in measuring the distance to the target due to the sensor's limitation, which is a maximum measurement capability of less than 8 meters. This limitation is evident in the image, where the laser scan data at a 0-degree angle or the front of the multicopter is not visible because the distance exceeds the sensor's measurement limit. Analysis of the data reveals that the RPLiDAR A1M8 exhibits an RMSE value of 51.40525265 and is effective within a measurement distance of less than 8 meters, demonstrating its accurate performance and suitability as a reliable data source for the SLAM method.

DRAKE's Advantages

The following advantages possessed by DRAKE's (Drone Kece Unesa) can be described as follows:

1. Monitoring and Supervision

To help map land locations by palm oil business actors, namely by using DRAKE's (Drone Kece Unesa) based on Artificial Intelligence with quality image results using the Convolutional Neural Network (CNN) method to determine the location of oil palm land development.

2. High Precision Image Interpretation

DRAKE's (Drone Kece Unesa) can be used to identify certain objects or features, in this case, it can also be used for remote sensing with a high level of precision. Especially in remote areas that are difficult to reach, DRAKE's (Drone Kece Unesa) can be used to increase the accuracy of long-range mapping and surveys.

3. Flexibility and Scalability

By using Artificial Intelligence software that integrates sensors so that DRAKE's (Unesa Kece Drone) can be controlled remotely or even independently. Equipped with several sensors that can collect diverse data and process information using artificial intelligence strategies to visualize analytical data that is complete and easy to understand, this can identify patterns and develop modeling that is flexible and on a large scale.

4. 3D Mapping and Realistic Modeling

by using a LiDAR sensor which is capable of producing data with a high level of precision in 3D mapping measuring accurate distances and creating real-time 3D mapping which allows users to get actual information in the environment quickly and efficiently.

CONCLUSION

From the results of DRAKE's tests that have been designed, the following conclusions can be drawn:

1. DRAKE's (Drone Kece Unesa) can help in mapping land locations by palm oil business actors by applying Artificial Intelligence with quality image results
2. By applying the YOLO (You Look At Once) method to determine the location of oil palm land development.
3. DRAKE's body weight greatly affects balance and speed when flying and when maneuvering.
4. DRAKE's (Drone Kece Unesa) capability is capable of mapping, monitoring, and surveying locations and places that are difficult to reach such as oil palm land so that it can simplify the process of collecting data and mapping locations because DRAKE's (Drone Kece Unesa) is equipped with sensors LiDAR and Nvidia Jetson Nano used for the mapping and monitoring process of DRAKE's robot (Drone Kece Unesa)
5. For balance and stability, this robot can balance itself even in water because the Pixhawk has an IMU (Inertial Measurement Unit) each consisting of an Accelerometer, Gyroscope, and Magnetometer. The IMU is processed in Pixhawk using the EKF (Extended Kalman Filter) algorithm so that the robot can determine the estimated position so that it can fly stably.

The suggestions that can be given for the development of DRAKE'S so that further research can obtain maximum results are:

1. Add sensors to the DRAKE'S robot so that its function is optimal for exploration and tracking in the air.
2. Improve the quality of mapping, mapping, and monitoring sensors so that DRAKE's can collect location and image data at the desired height more optimally.
3. Improve the quality of the LiDAR sensor and magnetic compass so that the robot can balance the condition of the robot and adjust the direction of its movement more accurately

ISSN 1533-9211

DOI: 10.5281/zenodo.10656668

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