Quadcopter Take Off and Landing System with Blob Detection Method and Optical Flow

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Abstract – **Quadcopter is a type of UAV (Unmanned Aerial Vehicle) which is currently developing and very useful in various fields. With four motors as the main propulsion, the quadcopter has the ability to maneuver, take-off and land vertically in places that have limited space. However, in an autonomous system, the quadcopter is still difficult to operate, one of which is to keep it stable, when in a position where there is minimal GPS signal. Therefore, in this study, we will use the Blob detection method that uses the OpenCV library to determine the landing place and is assisted by an optical flow sensor, aiming to catch roll, pitch and yaw motions. The results of this study indicate that the accuracy of the lidar sensor as a height sensor with an accuracy of 82.16 % is more accurate above 30 cm, the results of distance accuracy for image processing successfully detect up to a height of 600 cm with a light intensity value of around 50-70 lux. optical flow, light intensity and altitude distance greatly affect the motion produced by the quadcopter, but it can still move stably at a minimum value of light intensity of approximately 300 lux at an altitude of 300 cm.**

Keywords— Blob Detection, FPV, Optical Flow, Quadcopter

I. INTRODUCTION

Unmanned Aerial Vehicle (UAV) or unmanned aircraft, has been developed in recent years, proven to be used in various fields, both indoors and outdoors, such as operations, freight forwarding, security and surveillance. And there is also an Indonesian flying robot contest, where the contest aims to improve the ability to seek innovation in the aviation world. One type of UAV is a quadcopter which has four rotors and propellers as its propulsion [1-5]. In its operation, UAV aircraft can be operated manually by the pilot or automatically (autonomous). Quadcopter itself has a few advantages that can be obtained such as small size, good stability, and can operate well in a limited space or outdoors [6-10]. Therefore, the quadcopter can perform vertical landing and take-off, and maneuver in confined spaces.

Automatic take-off and landing are one of the missions commonly applied to drones. With the automatic mechanism, things that are not wanted during the mission can be minimized. In general, a drone or UAV is controlled by humans remotely using a radio transmitter (remote control) so that it often experiences errors in the control in its mechanism, because this mechanism is the most important in controlling a quadcopter that requires stability and accuracy to avoid collisions or unwanted damage. desired. However, in order to achieve the task or mission, especially indoors, the Global Positioning System (GPS) which is used as a quadcopter to move may not always be right, because the place or area is not covered by GPS signals, therefore the mission is confirmed that it cannot be carried out. These problems can be solved by various methods, including by using several supporting sensors such as proximity sensors or optical sensors, it can also use visualization for target detection with digital image processing via optics to determine the landing location.

Several studies about blob detection have been conducted. A study designed how a flying robot can detect objects quickly and precisely in real time, using the color filtering method as a filter color and blob detection as a noise remover by distinguishing dark colors from light. And the test results show that this method is capable of detecting objects up to a distance of x meters and able to eliminate noise from other objects with similar colors and vibration noise [11-15].

In this study, an automatic take-off and landing system will be designed and implemented on a quadcopter using a blob detection method. It can detect colors taken by the camera which later will be used as a waypoint visualization for landing and used by optical flow sensors which aim to reduce measurement error from the sensor fusion process and maintaining the pitch and roll angles that make the quadcopter able to maintain a stable position (hover).

II. METHOD

A. *Stages of Research*

The stages of research carried out as an initial stage in conducting research, are shown in Fig. 1. Everything related to research must be planned in advance, from searching for references to making reports.

B. *System Flowchart*

The design that will be made to facilitate system design requires a flowchart. In this study the flowchart of the system design is shown in Fig. 2

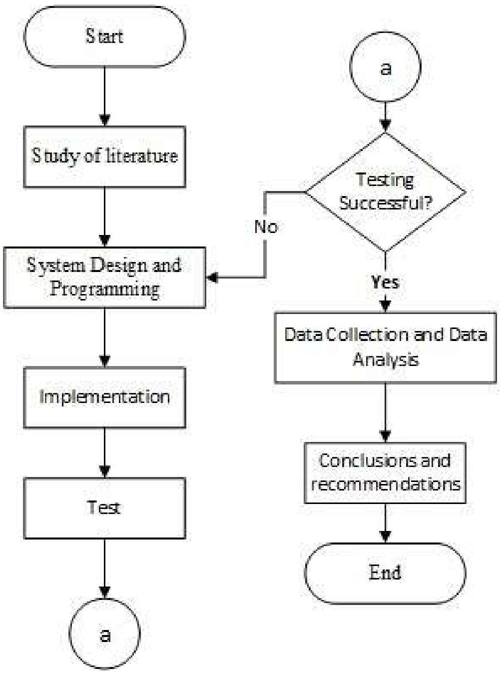

Figure 1. Stages of Research

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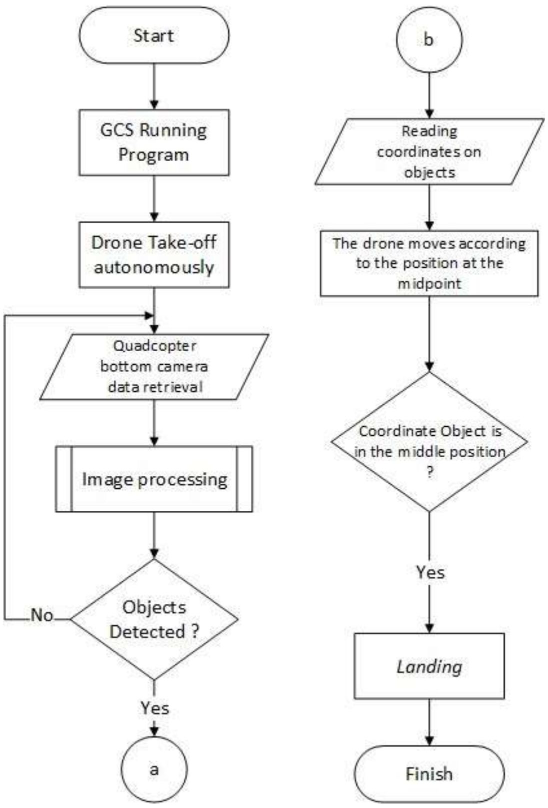


Figure 2. System Flowchart

C. System Block Diagram

Diagram block of the entire tele controlling system of this research can be seen in Fig. 3. Fig. 3 explains the planning of the quadcopter takeoff and landing system using blob detection and optical flow. In this system there is an optical sensor that is connected to the Flight Controller via I2C where the sensor is used to lock the image under the drone so that the drone can hover stable, and there is a lidar sensor that measures the height of the quadcopter connected via serial 4 on the Flight Controller. There are 4 BLDC motors as drone propulsion which are controlled by the Flight Controller with the help of the ESC Motor driver which is powered directly from the li-po battery. In addition to supplying the ESC, that battery also supplies the Flight Controller and camera. The flight controller in this system communicates with the ground control (Laptop) wirelessly using radio telemetry, for the method of taking pictures is carried out by an analog FPV type camera which is sent directly to ground control (Laptop) wirelessly which is then processed using the vision library to obtain coordinates, These coordinates are processed using python whose output value is adjusted for the quadcopter drive, and sent to the Flight Controller wirelessly from the ground control (Laptop). This system is run automatically via ground control (Laptop), and also in this system the quadcopter is not only operated programmatically, but generally can be controlled by remote control as in general, due to security reasons if the drone fails to complete its mission or loses control.

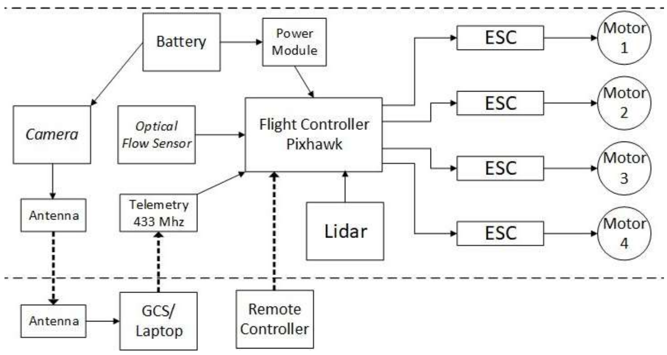


Figure 3. System Block Diagram

III. RESULTS AND DISCUSSION

A. Quadcopter Stability Testing Data

This test was conducted to determine the stability of the quadcopter when taking off, landing, and hovering by observing the pitch and roll motion of the quadcopter. The procedure carried out to carry out this test is to prepare a quadcopter and laptop, adjust the height of the program that has been made, then run the program, quadcopter take off, hover and landing, then record the pitch and roll motion.

1. Take-off Test

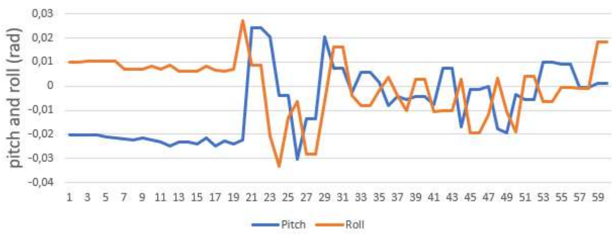


Figure 3. Takeoff Motion Graphics

Based on Fig. 3, it shows a graph of stability testing when take off with a height distance of 250 cm that produces an average pitch value of 0.0075 and an average roll of 0.00019.

2. Landing Test

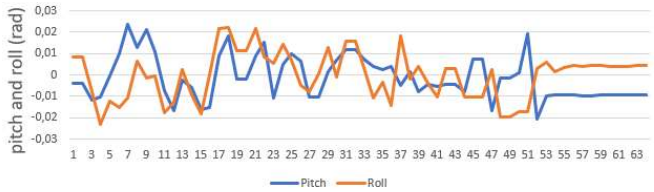


Figure 4. Landing Graphics

Based on Fig. 4, the graph of stability testing when take off with a distance of 250 cm height produces an average pitch value of 0.00130 and an average roll of 0.00014.

3. Indoor Test

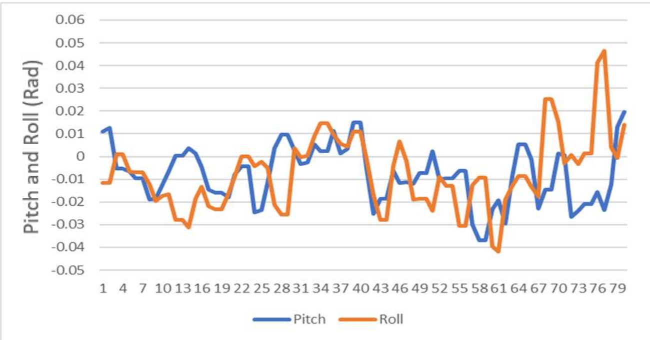


Figure 5. Indoor 150 cm Height Pitch and Roll Motion Chart

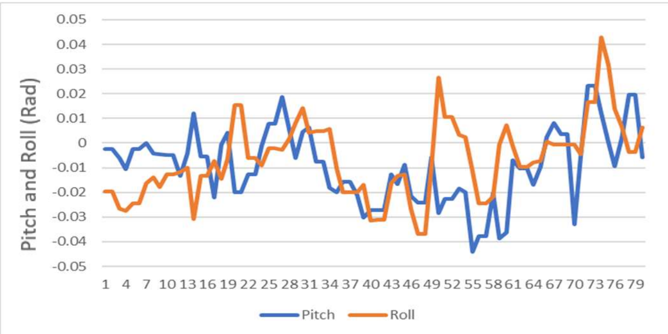


Figure 6. Indoor 250 cm Height Pitch and Roll Motion Chart

Fig. 5 and Fig. 6 above describes the movement of the quadcopter at two different heights with the same light intensity of 300 lux, and produces the average pitch and roll data as follows:

TABLE I
AVERAGE INDOOR PITCH AND ROLL

	Indoor	
Height	**Average Pitch**	**Average Roll**
150 cm	0.007925656	0.007430622
250 cm	0.009372466	0.006844567

4. Outdoor Test

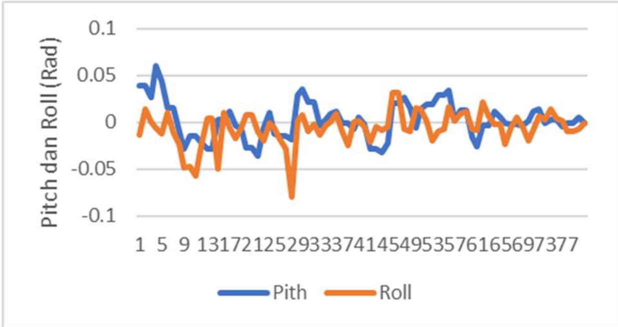


Figure 7. Outdoor 150 cm Height Pitch and Roll Motion Chart

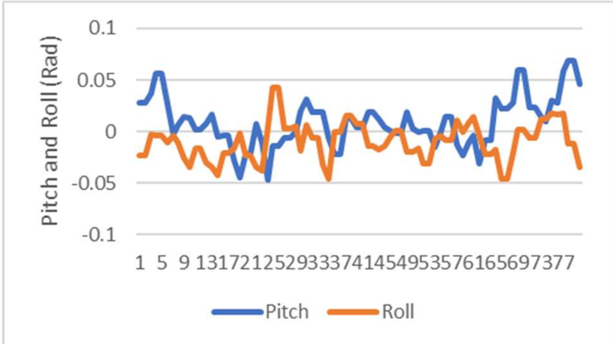


Figure 8. Outdoor 250 cm Height Pitch and Roll Motion Chart

The graphic above describes the movement of the quadcopter at two different distances with the same light intensity of 9000 lux, and produces the average pitch and roll data as follows:

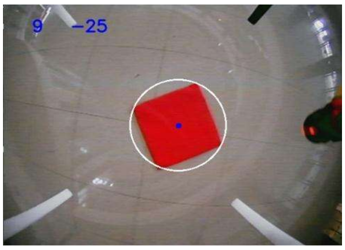
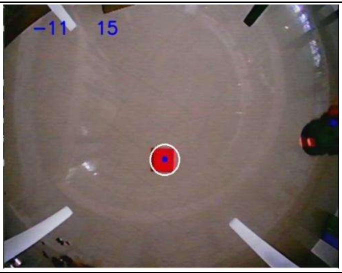
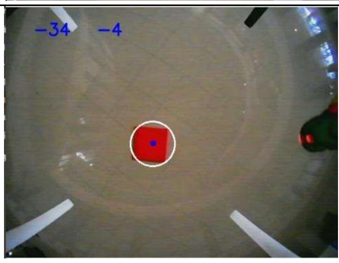
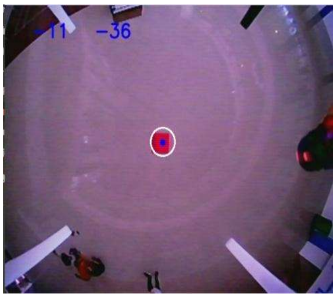
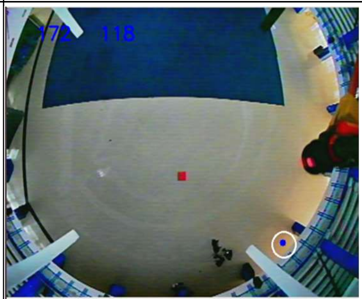
TABLE II
AVERAGE OUTDOOR PITCH AND ROLL

	Outdoor	
Height	**Average Pitch**	**Average Roll**
150 cm	0.002584171	0.005949419
250 cm	0.009275899	0.009492186

B. Object Detection Test

This test was conducted to determine the ability of analog FPV type cameras to detect objects using the Blob Detection method based on altitude. The procedure used to carry out this test, firstly prepare a quadcopter and laptop for monitoring then prepare an object as a waypoint to be detected (red color), run the altitude program and camera, and the quadcopter will take off. Table 3 shows results of object detection from a certain height using an analog FPV camera with a light intensity of around 50-70 lux. It gets a pretty good result, even in different lighting conditions. The test is carried out during the day between 9.00-13.00 WIB indoors. It can be seen in the table that objects are detected up to 6 meters distance, and 7 meters above the object cannot be detected due to the influence of lighting and the camera used.

TABLE III
OBJECT DETECTION TEST RESULTS

No	Altitude (m)	Object Detection Results	Detection
1	1		Detected
2	2		Detected
3	3		Detected
4	4		Detected
5	5		Detected
6	6		Detected
7	7		Not detected
8	8		Not detected
9	9		Not detected
10	10		Not detected

IV. CONCLUSIONS

This research has successfully implemented the blob detection method to find out landing information on the quadcopter, this can be seen from the results of image processing that can detect objects according to the coordinates of the midpoint (x, y coordinates) from a height of ± 6 meters, using an FPV camera with a light intensity of about 50-70 lux. In stability testing using an optical flow sensor, altitude distance and light intensity greatly affect the motion produced by the quadcopter, it can be seen from the results of the average pitch and roll values in indoor and outdoor there is a significant difference, the smaller the intensity value the light will be increasingly difficult for the sensor to recognize objects below it and vice versa, but use is still stable under an altitude of ± 300 m and at a minimum light intensity of ± 300 lux. Based on the results obtained from this study, suggestions can be given that for future research, other methods of blob detection can be used for digital image processing. Also, in future research, you can add light to the drone so that PX4 Flow can work in rooms with low light intensity.

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