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DEVELOPING MANEUVERING SYSTEM FOR MODULAR DRONE USING RASPBERRY PI

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DEVELOPING MANEUVERING SYSTEM FOR DRONE USING RASPBERRY PI

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for the degree of Bachelor of Engineering with Honours
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To my beloved family and friends.

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ABSTRACT

Drone or quadcopter is one of the Unmanned Aerial Vehicles (UAV) that are more stable than the helicopter as it has a wider base. UAV is any flying vehicle that can be controlled from far away without needing a pilot on board. Drone is basically a combination of electronic and mechanical with the knowledge in aviation that usually uses a remote control to communicate with the driver of the drone. Most of the UAV is used for military and surveillance purposes. However, in this paper will explain regarding a low cost drone that will be built using Raspberry Pi as the main component for daily usage. Apart from that, this study also involves one of the hardest parts which is preparing the coding to make the drone work using python programming. This project also discussed the usage of a shield that can combine the both Arduino and raspberry Pi together to make a powerful drone system of drone.

ABSTRAK

Drone atau *quadcopter* merupakan salah satu kenderaan udara tanpa pemandu yang lebih stabil berbanding helikopter kerana ia mempunyai asas yang lebih luas. UAV merupakan kenderaan terbang yang boleh dikawal dari jauh dan tidak memerlukan pemandu berada di dalam kenderaan tersebut. Drone pada asasnya merupakan kombinasi elektronik dan mekanikal dengan menggunakan ilmu penerbangan yang selalunya menggunakan alat kawalan jauh untuk berhubung dengan pemandu drone. Kebanyakan UAV digunakan di dalam ketenteraan dan untuk pengawasan. Walaubagaimanapun, makalah ini akan menerangkan tentang sebuah drone kos rendah yang akan dibina dengan menggunakan *Raspberry Pi* sebagai komponen utama untuk penggunaan harian. Selain itu, kajian ini juga melibatkan salah satu bahagian yang paling sukar iaitu menyediakan kod supaya drone dapat berfungsi dengan menggunakan pengaturcaraan Bahasa Phyton. Kajian ini turut membincangkan tentang penggunaan beberapa aplikasi yang akan digunakan untuk mengawal drone.

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TABLE OF CONTENTS

ACKNOWLEDGEMENT iv
ABSTRACT v
ABSTRAK vi
TABLE OF CONTENTS vii
LIST OF TABLES x
LIST OF FIGURES xi
LIST OF ABBREVIATION xiii

CHAPTER 1 1
INTRODUCTION 1
1.1 BACKGROUND STUDY 1
1.2 PROBLEM STATEMENT 2
1.3 OBJECTIVES 3
1.4 EXPECTED OUTCOMES 3
1.5 PROJECT SCOPES 3

CHAPTER 2 4
LITERATURE REVIEW 4
2.1 INTRODUCTION 4
2.2 UNMANNED AIRCRAFT SYSTEM (UAS) 4
2.3 DRONE 6
2.4 SMALL SIZED COMPUTER – RASPBERRY PI 9
2.5 OPERATING SYSTEM (RASPBIAN) 11
2.6 BRUSHLESS MOTOR 12
2.7 POWER SUPPLY 14
2.8 INERTIAL MEASUREMENT UNIT 16
2.9 ULTRASONIC SENSOR 20
2.10 THEORY OF INVENTIVE PROBLEM SOLVING (TRIZ) 22

CHAPTER 3 24
METHODOLOGY 24
3.1 INTRODUCTION 24
3.2 WORKING PRINCIPLE OF DRONES 26
3.3 THE SYSTEM OF THE DRONE 30
3.4 HARDWARE ASSEMBLY PROCESS 36
3.5 WIRING & SOLDERING 36
3.6 TRIZ METHOD 37

CHAPTER 4 43
RESULT & DISCUSSION 43
4.1 INTRODUCTION 43
4.2 FINAL PRODUCT 43
4.3 BILL OF MATERIAL 46
4.4 COMPLETE CODING SYSTEM 47
4.5 WIRING SYSTEM CONNECTION 48
4.6 APPLICATION TO CONTROL DRONE 50
4.7 DRONE'S TESTING 53
4.8 PROBLEM ENCOUNTER 54

CHAPTER 5 56
CONCLUSION AND RECOMMENDATION 56
5.1 INTRODUCTION 56
5.2 CONCLUSION 56
5.3 RECOMMENDATION 57

CHAPTER 6 59
QUESTION & ANSWER 59
.6.1 EXAMINER 1 (Dr. Aidil Azli bin Alias) 59
6.2 EXAMINER 2 (Dr. Mohd Syahmi bin Jamaludin) 60

REFERENCES 62
APPENDICES 65
APPENDIX A 65
APPENDIX B 71
APPENDIX C 72

LIST OF TABLES

Table 2.1: Comparison of top three Raspberry Pi 10
Table 2.2: Specification of the MT2204 2204 2300KV Brushless Motor 13
Table 2.3: The specification of Batteries 16
Table 2.4: The Gyroscope features of the IMU 17
Table 2.5: The Accelerometer Features of IMU 18
Table 2.6: The Additional Features of the IMU 19
Table 2.7: 39 Engineering Parameters 23
Table 3.1: The TRIZ Analysis of the Drone 42
Table 4.1: The Cost of Making The Prototype 46

LIST OF FIGURES

Figure 2.1: Example of UAS 5
Figure 2.2: One of the latest drones in 2019 7
Figure 2.3: One of the Modular Drone 9
Figure 2.4: The Raspberry Pi 3 Model B+ 11
Figure 2.5: The Logo of Raspbian 12
Figure 2.6: MT2204 2204 2300KV Brushless Motor 13
Figure 2.7: 1300mah Lipo Li-Po Rechargeable Lithium Battery 15
Figure 2.8: Inertial Measurement Unit 20
Figure 2.9: HC-SR04 Ultrasonic Sensor 21
Figure 2.10: An explanation on How Ultrasonic Sensor works 21
Figure 2.11: 40 Principle of TRIZ 23
Figure 3.1: The Methodology Flowchart 25
Figure 3.2: The Four Forces Applied on UAV 26
Figure 3.3: The Basic Process of Drones 27
Figure 3.4: The correct rotation of the propellers 28
Figure 3.5: The Schematic Diagram of The Drone 30
Figure 3.6: The Flowchart of the Drone's System 31
Figure 3.7: Coding for ESC's calibration 33
Figure 3.8: Coding to control ESC individually 33
Figure 3.9: Coding for the Ultrasonic Sensor 35
Figure 3.10: Coding for gyroscope sensor 35
Figure 3.11: Soldering Process on a Circuit Board 37
Figure 3.12: Components Analysis of the Drone 38
Figure 3.13: Interaction Analysis of the Drone 39
Figure 3.14: Functional Analysis of the Drone 40
Figure 3.15: Cause and Effect Diagram of the project 41
Figure 4.1:The Final Product from Top 44
Figure 4.2: The Final Product from Side 44

Figure 4.3: The Cap that Protect the Wires and Sensors 45
Figure 4.4: The Compartment can easily take off 45
Figure 4.5: Some Coding for Drone's System 48
Figure 4.6: Wiring system of the Drone 49
Figure 4.7: The connection between ESC, Motor and Power distribution Board 49
Figure 4.8: Interface of RaspController 51
Figure 4.9: Interface of Drone Remote 52
Figure 4.10: Interface of Distance Checker 53

LIST OF ABBREVIATION

ESC	-	Electronic Speed Controller
RPM	-	Revolution Per Minute
TRIZ	-	Theory Russian
UA	-	Unmanned Aircraft
UAS	-	Unmanned Aircraft System
UAV	-	Unmanned Aerial Vehicle

CHAPTER 1

INTRODUCTION

In this chapter, it will describe briefly regarding some parts of the drones that need improvements. The background study, problem statements, objectives, job scope and expected outcome will also be presented throughout this chapter.

1.1 BACKGROUND STUDY

Drones are one of the unmanned aerial vehicles (UAV) and a proof that our aerial vehicle is evolving. The aerial vehicle is evolving from a vehicle that needs to be on board to control to something that we can control from far. The UAV is made as an experiment in order to achieve a high resolution, near surface vertical profiling in recent years because the non-maneuverable and expensive other way such as the aircraft and the hot air balloons (Gu, Michanowicz, & Jia, 2018). Drones have existed since the First World War in 1918 for military purposes. Since then, the features have evolved not only for military but also for surveillance and racing purposes. However, since there are already specific purposes for a drone, therefore, it is hard to find a modular drone that can be used for many features. The design for the drones in the market is specifically fit for one feature only. The first modular drone was built in 2016 which is the Airblock^{tm} drone which can be turned into a hovercraft, car and also various shapes of drones. In accordance with its flexibility, it cost a fortune. The price for a modular drone in 2019 can reach up to 10, 000MYR depending on its functionality.

The system of the modular drones also needs to find one program that can suit all designs that the modular drone could be. Depending on the functionality, the program of the drones needs to be suitable to be used in all situations especially when the drone will work in two different areas of surroundings. For the system of the drones in this project, Raspberry Pi will be used as the main components that act as a flight controller for the drones. Apart from that, some sensors are also being implemented to improve the drone's features such as

gyroscope sensor to detect the location and acceleration of the drone and ultrasonic sensor to detect obstacles.

1.2 PROBLEM STATEMENT

Nowadays there are many types of drones developed by the manufacturer. The drones also have been divided into few categories depending on the customer demand. There are drones specifically for race or even some with cameras for surveillance purposes. However, all of these drones are available at very high prices. The basic drones with the basic function which is to fly and move around for less than ten minutes can reach up to 100MYR which is not worth the price. Besides, the drone itself has a limited functionality. The drone that has been built these days is mostly focusing on photography, surveillance and racing purposes only. There is not much exposure of the drones being used as other functions such as for delivery systems.

The drone is a very sensitive and fragile flying vehicle. The connecting arm of the propeller and the body can be easily cracked when the system is overloading or have experienced major crashes during landing. These cracks can cause failure to the drone and make it unstable to fly. The usual drone that has been sold in the market usually has a direct connecting arm and cannot be replaced once broken. The only choice for the customer is to buy a new drone which is costly.

Last but not least, the concept of controlling the drone using a specific joystick is less user-friendly. Some drones need a specific joystick which when the controller broke down, the drone will be useless. Some manufacturers do not include the joystick into the drone package and the customer needs to buy it separately which will increase the cost. The lack of flexibility of the drones causes disappointment for the customer and needs to be improved by using a more user friendly concept.

1.3 OBJECTIVES

Based on the problem statement above, below are the objectives for this Final Year Project that need to be done during 14 weeks' time period.

- To develop a system of a modular drone using Raspberry Pi.
- To combine at least two sensors on the drone's system.
- To build at least one application that can ease the control system of the drone.

1.4 EXPECTED OUTCOMES

Below are the expected outcomes for this project:

- Developing a drone's system using the raspberry Pi
- To implement ultrasonic sensor and gyroscope sensor to the drone's system.
- To build a more user- friendly controller for drones such as the application that can be used in smartphones.

1.5 PROJECT SCOPES

In this project, there are two main parts that need to be successfully done to make the drone work as planned. The two section are: -

- Coding

As Raspberry Pi is used as the main component in this project, the coding will be done using Python language. This coding is where all components such as sensor and motor need to be connected to the Raspberry Pi.

- Assembly

To assemble all parts together, soldering is the most frequent method used to combine the initial components of the drone. This part needs to be carefully done as the components are all tiny and mistakes in soldering can only ruin the components.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will provide an overview regarding the topic of this project which is to develop a maneuvering system for drones using raspberry pi. All of the topics and components related to this project will be elaborate here. All writing in this chapter is based on scholarly sources such as journal articles, books and theses. The aim of this chapter is to make the reader understand more about this project.

2.2 UNMANNED AIRCRAFT SYSTEM (UAS)

Unmanned aircraft means any aircraft that are flown without the presence of a pilot inside it and usually it is far from the pilot at a certain range. Unmanned Aircraft System (UAS) is the unmanned aircraft plus the system that is used to control the UA. Based on Skybrary (2019), there are three components of UAS which are

- A system which is usually on land or in other ships or other aircraft platforms that are automatic or controlled by humans.
- An Unmanned Aerial Vehicle (UAV);
- A command and control (C2) system - sometimes referred to as a communication, command and control (C3) system - to link the two.

Recently, the public tends to refer to any UAV as a drone but it is still not universally considered. UA can vary in many sizes from small to big depending on the demand of the people. For military purposes, the UAV is guided autonomously by remote control that has been implemented with sensors, target designators and electronic transmitters to interfere and destroy the enemy. UAV is very efficient and has a better range and endurance compared to the other manned system where it also does not need any crew and life-support systems.

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(Guilmartin, n.d.). Figure 1 below shows one of the examples of UAV in Turkey that are made by the Turkish Aerospace Industries being called as ANKA which consist of twin-engine, twin – boom evolution intended for broader support of Turkish in- service munitions as well the tactical over- battlefield roles.

Figure 2.1: Example of UAS

Writter.S [ANKA, turkey UAV] (2019). Retrieved from https://www.militaryfactory.com/aircraft/detail.asp?aircraft_id2150

2.2.1 HISTORY OF UNMANNED AIRCRAFT SYSTEM

UAS have been used since centuries and only used in the military. The earliest recorded use of a UAS dates back to 1849 when the Austrians attacked the Italian city of Venice using automatic explosives balloons (O'Donnell, 2019). UAS has been developed rapidly since it began being introduced in the USA in early 1990s. All countries that are using UAS utilize satellite communication to control the UAV from far. The use of UAS continues to grow especially in the military and was used by the British Royal Navy in 1935 until they retired in 1947. There are 380 UAVs have been made for the British Royal Navy for their gunnery practice purposes (Unmanned Aerial Systems (UAS), 2019).

The United States (US) began developing the UAS during the First World War in 1916 and created the first pilotless aircraft. In 1930, the US Navy began experimenting with the radio controlled aircraft and successfully produced Curtiss N2C-2 drone in 1932. The first mass production of UAS was during the Second World War, where the first remote controlled aircraft was built for military purposes.

2.3 DRONE

Drone or formally being called quadcopter is the next form of helicopter which has more dynamic stability than the helicopter itself because of the small size and the stable design. Drone or quadcopter is one of the Unmanned Aerial Vehicle (UAV) generally. This is because the drone is being controlled from far and does not need any pilot inside the drone during flight. In these few years, Unmanned Aerial Vehicles (UAVs), or drones, have attracted a lot of attention around the world because of the advantages of this UAV that can be used easily, having a high maneuverability and also a low cost for a basic UAV (Handouf & Sabir, 2019). UAV plays a very important role in military services as it is being used to monitor and tracking enemies while can be used as a destruction tools that can be used in civil applications like atmospheric research, harvest monitoring, firefighting, weather forecasting, crop and road traffic monitoring and control (Aswini, Krishna Kumar, & Uma, 2018). Recent achievement that has been recorded by the user is the low cost solution for lower troposphere sampling since the UAV has a stable position and can move in both horizontal and vertical direction although during high wind (Gu, Michanowicz, & Jia, 2018).

Nowadays, the navigation systems and smart sensors are currently being implemented in drones for rescue missions, rapid on- demand communication and surveillance operations. Drones are the unmanned aerial vehicles that have four rotors at the end of each of its arm's frame with ability of landings, hovering and vertical take offs at a desired location (Srivastava, Ninawe, Puthran, & Nirgude, 2017). A pair of the rotor will turn clockwise while another pair which is adjacent to it will turn anti clockwise which will be resulting in zero resultant torque that makes the drone fly up. The main components used for construction of a quadcopter are the frame, propellers (either fixed-pitch or variable-pitch), and the electric motors (Srivastava et al., 2017). As the drones have developed from time to time, in 2019, there are many designs and high technology drones are available in the market. From an aerial vehicle with a purposes, now, people are buying drones as their hobby and race among them can always be held among themselves.

Figure 2.2: One of the latest drones in 2019

[DJI Mavic Mini Drone With Camera] (2019). Retrieved from https://airdronecraze.com/new-drones/