DEVELOPMENT OF ARDUINO FLIGHT CONTROLLER FOR QUADCOPTER DRONE SYSTEM

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Development Of Arduino Flight Controller For Quadcopter Drone System

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DECLARATION

I declare that this thesis entitled "Development of Arduino Flight Controller for Quadcopter Drone System" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this report entitled "Development of Arduino Flight Controller for Quadcopter Drone System" and in my opinion, this thesis it complies the partial fulfillment for awarding the award of the degree of Bachelor of Mechatronics Engineering with Honours

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DEDICATIONS

To my beloved father, Abdul Khalid Bin Mansor and my mother Norlaila Binti Sa'arani.

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ABSTRACT

Drones or Unmanned Aerial Vehicles (UAVs) are getting popular in several sectors such as aerial photography, cinematography, search and rescue operation, aerial surveillance, advertising, site surveying, mining, humanitarian projects, environmental projects, structural inspection, agriculture, courier servicing and etc. Most of the drone flight controllers in the market are have limited input and output pins and limited customization while good drone flight controllers are high in cost. The purpose of this study is to produce and build a low cost and customizable flight controller using C++ programming language and Arduino microcontroller. The process of this study was started with drone parts and components selection. Then, the code and circuit to test the BLDC motor, gyroscope sensor, remote controller were developed and designed. The BLDC motor speed was controlled by supplying PWM signal from Arduino microcontroller to the ESC. The gyroscope sensor were set to read the roll, pitch and yaw signal and display the signal through the serial plotter in the Arduino IDE. The remote controlled were tested to control the brightness of the LED. Arduino microcontroller were used to read input signal from the remote controller and convert it to PWM output signal to control the LED brightness. The drone hardware were assembled and the code for the flight controller were sketched. Five different test were done to test the code which are the throttle test, roll test, pitch test, yaw test and the PID test.

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ABSTRAK

Dron atau Pesawat Udara Tanpa Pemandu (UAV) semakin popular dalam beberapa sektor seperti fotografi udara, sinematografi, operasi mencari dan menyelamat, pengawasan udara, pengiklanan, pengawasan tapak, perlombongan, projek kemanusiaan, projek alam sekitar, pemeriksaan struktur, pertanian, servis kurier dan sebagainya. Kebanyakan ‘flight controller’ dron yang terdapat di pasaran mempunyai pin masukan kan keluaran yang terhad dan mempunyai pengubahsuaian yang terhad. Tujuan pengajian ini adalah untuk menghasilkan dan membina ‘flight controller’ yang berkos rendah dan boleh diubahsuai menggunakan bahasa pengatucaraan C++ dan pengawal mikro Arduino. Proses pengajian ini dimulakan dengan pemilihan bahagian dan komponen dron. Kemudian, ‘code’ dan litar bagi menguji motor BLDC, sensor giroskop dan alat kawalan jauh dibangunkan dan dirancang. Kelajuan motor BLDC dikawal dengan cara membekalkan isyarat PWM dari pengawal mikro Arduino ke ESC. Sensor giroskop di tetapkan untuk membaca isyarat ‘roll’, ‘pitch’ dan ‘yaw’ dan paparkan ke ‘serial plotter’ pada Arduino IDE. Alat kawalan jauh diuji untuk mengawal kecerahan LED. Pengawal mikro Arduino digunakan untuk membaca isyarat masukan daripada alat kawalan jauh dan mengubah isyarat itu kepada isyarat keluaran PWM untuk mengawal kecerahan LED. Pemasangan deon dijalankan dan kod bagi ‘flight controller’ telah ditulis. Lima ujian telah dijalankan bagi menguji kod ‘flight controller’ tersebut iaitu ujan ‘throttle’, ujian ‘yaw’, ujian ‘roll’, ujian ‘pitch’ dan ujian PID.

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LIST OF SYMBOLS AND ABBREVIATIONS

ESC	-	Electronic speed controller
BLDC	-	Brushless DC motor
DC	-	Direct current
AC	-	Alternate current
PWM	-	Pulse-Width Modulation
UAS	-	Unmanned Aerial Systems
UAV	-	Unmanned Aerial Vehicle
VTOL	-	Vertical Takeoff Landing
IMU	-	Internal measurement unit
RF	-	Radio frequency
LED	-	Light emitting diode
SRAM	-	Static random access memory
EEPROM	-	Electrically erasable programmable read-only memory
IDE	-	Integrated Development Environment
LCD	-	Liquid crystal display

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CHAPTER 1

INTRODUCTION

1.1 Overview

This chapter provides the introduction of project background, the Development of Arduino Flight Controller for Quadcopter Drone System. It also includes the research motivation, problem statement, objective, scopes and outlines how the overall chapter is organized in this report.

1.2 Background

Drones, also called Unmanned Aerial Systems (UAS) or Unmanned Aerial Vehicle (UAS) are the aircrafts that able to fly without a pilot and passengers on board [1]. Drones concept were created when Venice were attacked by Austria in 1849 using unmanned balloons staffed with explosives [2]. Since that, the needs for drones with various abilities for both civilian and military applications are increasing.

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Drones offered wide range of services and application for various sectors which include search and rescue, real time monitoring, aerial surveillance, cinematography, advertising, site surveying, mining, humanitarian projects, environmental projects, structural inspection, courier servicing and other areas [3, 4, 5].

Since 1849, there are wide variety of drone configuration to fulfill variety of mission and platform. The drones were categorized into multiple classification which are Nano Air Vehicles (NAVs), Micro or Miniature Air Vehicles (MAVs), Vertical Take-Off & Landing (VTOL), LASE Close, Low Altitude Long Endurance (LALE), Low Altitude, Short-Endurance (LASE), Medium Altitude Long Endurance (MALE), and High Altitude, Long Endurance (HALE). The drones were classified based on its size, flight endurance and capabilities [6].

1.3 Motivation

Drone flight controller is the most important part of the drone system. Without flight controller, drone will never can be stabilize. There are a lot of specifications and brand of flight controller in the market. But, the price for a good and reliable flight controller is too high for a low cost drone. Price for flight controller board such as Pixhawk, Diatone and Matek can reach as high as RM300 to RM 500 per board.

1.4 Problem Statement

On the average, drone flight controller has limited intput and output pin due to its specific design for specific task. It is a problem to add other input or output components or devices when the input or output pins are fully used.

Other than that, common flight controller also has very limited customization. It is because, the flight controller hardware and firmware were already designed and build for a specific tasks.

There are many flight controllers from different types and brands available in the market. But, most of the good flight controller that have more input and output pins, features and customization are cost too high.

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This project was done to solve these issues by developing an alternative way which is flight controller from Arduino microcontroller which is cheaper, high customizability and have more input and output pins.

1.5 Objective

1. To develop a customizable flight controller using C++ language programming

2. To develop a low cost flight controller using Arduino microcontroller

3. To verify the capabilities of Arduino microcontroller as a drone flight controller

1.6 Scopes

This project mainly focuses on;

1. Design the circuit for the drone

2. Produce PWM signal to control the speed of the brushed DC and BLDC motor

3. Gain signal from the gyroscope sensor using Arduino microcontroller

4. Gain signal from the remote controller using Arduino microcontroller

5. Assemble the drone hardware

6. Build PID controller code for drone stabilization

7. Perform throttle, yaw, pitch roll and PID test

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1.7 Project Outline

In the next following chapter, the report is organized as follows;

Chapter 2: Provides the overview of constructions, parts and components of a drone and the theories behind it.

Chapter 3: Provides the details how the PWM signal, BLDC motor, gyroscope sensor and remote controller will be tested using Arduino microcontroller, the hardware assembly and the explanation about the flight controller code.

Chapter 4: Provides the finding and discussion on PWM signal produced by the Arduino microcontroller, the gyroscope signals, reading of the remote that controlled the LED brightness, the controlled speed of the BLDC motor, the result test for the throttle, roll, yaw, pitch and the PID test.

Chapter 5: Provides the conclusion of this thesis and recommendation for future work.

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CHAPTER 2

LITERATURE REVIEW

2.1 Overview

In this chapter, the key studies related to this research are reviewed. It includes the studies on Pulse-Width Modulation (PWM), quadcopter flight dynamics, quadcopter frame, drone flight controller, gyroscope sensor, remote controller, electronic speed controller (ESC) for brushed motor and brushless DC motor, drone batteries, Arduino microcontroller and the PID controller.

2.2 Drones

Drones or Unmanned Aerial Systems also known as Unmanned Aerial Vehicle (UAV) or Unmanned Aerial Systems (UAS) are the aircrafts, which are able to fly without a pilot and passengers on board. The drone is controlled remotely by using radio waves or autonomously (with a predetermined route). Drones do not have a specific size or type of a drive [7].

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2.3 Multirotor Drones

Multirotor drones as shown in Figure 2-1 are drones that use more than two rotors with fixed-pitch spinning blades that generate lift . It is possible to make the drone turn or move in a horizontal direction by varying the speeds of particular rotors. It is also possible to ascend, hover or descend the drone by changing the speed of the rotors so that the thrust generated is greater than, equal to or less than the forces of gravity and drag acting on the drone [8].

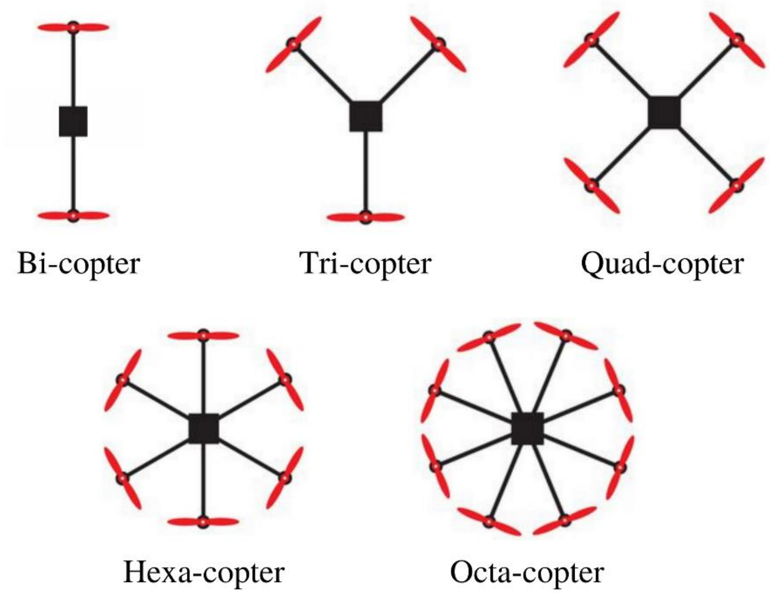

Figure 2-1 : Multirotor drones

Most of the multi-rotor drones available in the market has at least four rotors such as Phantom drone made by the Chinese giant company, Da-Jiang Innovations or widely known as DJI [7]. To stabilise multirotor drones, it is required to use an on-board computer or flight controller because multirotor design are aerodynamically unstable. The flight controller includes gyroscope and accelerometer to maintain and estimate the position and orientation [9].

Multirotor designs appear to dominate the current markets for Vertical Takeoff Landing UAVs (VTOL UAVs) [10]. Multirotor drones do not need a takeoff or landing strip, make lesser noise and can easily hover in the midair compare to the other drones [7]. Multirotor drones offer a lot of advantages compared to other designs, but most of the multicopters, are limited to batteries as a power source due to its size, which will affect their flight endurance [8].