DESIGN AND DEVELOMENT OF IoT QUADCOPTER USING MICROCONTROLLER

MUHAMMAD IMANUDDIN BIN AHAMAD

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DR. KHAIRUDDIN BIN OSMAN
Pensyarah Kanan
Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
Universiti Teknikal Melaka (UTeM)
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

Tarikh: 2/6/2017

Tarikh: ....

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Author: MUHAMMAD IMANUDDIN BIN AHAMAD

Date: ……………………………………...

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Signature: ……………………………………………….

Supervisor's Name: DR KHAIRUDDIN BIN OSMAN ……………………………………………….

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"So verily with the hardship there is relief, verily with the hardship there is relief "

(Quran Ch 94:5-6)

Dedicated especially to my mother, Norul 'In Binti Mokhtar, father Ahamad Bin Ali ,my siblings and my fellow friends who always be with me through these hardships and success.

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ABSTRACT

Quadcopter or widely known as ‘Drone’ is one of the emerging technologies nowadays. Controlling the quadcopter using RF transmitter sometimes offers threat to the user in terms of hacked controller. Hence, building this IoT quadcopter using Arduino Uno as the flight controller offers a least threat to be hacked. By building the flight controller using a simple and specific coding, all of the quadcopter users can design their own quadcopter freely with knowing the risk to be hack is low.With the additional features in this IoT quadcopter, an analysis of angular rate of the quadcopter can be obtain. User can easily monitor the angular rate of the quadcopter using the designed Blynk apps. This offers a great aid to all of the quadcopter’s researchers for their project studies

ABSTRAK

Di masa kini, ‘Quadcopter’ atau lebih dikenali sebagai ‘Drone’ merupakan salah satu teknologi yang sedang membangun. ‘Quadcopter’ yang dikawal menggunakan pemancar RF kadang kala mendatangkan ancaman kepada pengguna dalam aspek alat kawalan digodam. Dengan menghasilkan ‘IoT quadcopter’ menggunakan ‘Arduino Uno’ sebagai pengawal penerbangan, risiko untuk digodam dapat dikurangkan. Dengan menghasilkan pengawal penerbangan menggunakan kod yang mudah dan spesifik, para pengguna dapat menghasilkan ‘quadcopter’ mengikut citarasa sendiri tanpa memikirkan risiko untuk pengawal penerbangan digodam. Analisis kadar sudut ‘quadcopter’ juga dapat dihasilkan dengan penambahan fungsi baru. Para pengguna dapat memerhatikan kadar sudut menggunakan aplikasi ‘Blynk’ yang direka. Hal ini membantu para penyelidik ‘quadcopter’ untuk kerja pnyelidikan mereka.

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LIST OF ABBREVIATION

UAV- Unmanned Aerial Vehicle

IoT- Internet of Things

RF- Radio Frequency

ESC- Electronic Speed Controller

LiPo- Lithium Polymer

IMU- Inertial Measurement Unit

BLDC- Brushless DC

DC- Direct Current

AC- Alternating Current

PPM- Pulse Position Modulation

PWM- Pulse Width Modulation

CW- Clock Wise

CCW-Counter Clock Wise

CHAPTER 1

INTRODUCTION

1.1 Introduction

A quadcopter is an aerial vehicle with four rotors and famously known as “drone” at these day. The first designs made for manned flight was introduced in the beginning of the 20th century. Today, quadcopters are almost exclusively unmanned, small, electrical and used as hobby toys or within research. Over the last few years we have seen a massive growth in the manufacture and sales of remote control airborne vehicles known as Quadcopters. These Unmanned Aerial Vehicles have four arms and fixed pitch propellers which are set in an X or + configuration with X being the preferred configuration [18].

IoT (Internet of Things) can be defined in simple words as a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction [22]. Hence this IoT quadcopter enable the user to analysis the angular rate using the sensor that being used in the quadcopter. The microcontroller, Arduino Uno, that built as the quadcopter’s flight controller creates a new element in building the quadcopter which enable the user to create their own flight controller.

1.2 Problem Statement

Nowadays quadcopter or well known as “drone” technology is widely use RF transmitter to control the quadcopter itself. This type of controller give a threat to the user as it can be easily hacked by other parties. This IoT quadcopter which based on the Arduino Uno as the flight controller offer a less threat for being easily hacked by the third party. Next, most of the apps in the market did not have the ability to analysis the angular rate. Hence, through IoT application, angular rate of the quadcopter can be determined easily.

1.3 Project Objectives

The project objectives are follows:

i. To create a flight controller using Arduino Uno microcontroller.
ii. To analysis the angular rate through IoT application.

1.4 Project Scope

The project scopes are as follows:

i. This project will need to design a quadcopter with a frame, brushless motors, propellers, ESC (electronic speed controller), Transmitter and Receiver and LiPo battery.
ii. This main focus on this project is on building the flight controller using the Arduino Uno that connected with MPU 6050 module and Wifi module, ESP8266.
iii. An analysis of angular rate of the quadcopter can be determined by the application of the IoT using the Blynk apps.

1.5 Thesis Outline

This report consists of five chapters that described the project of Design and Development of IoT Quadcopter Using Microcontroller. In the first chapter, the objective and scope of this project and problem statement is discussed. While Chapter 2 will discuss more on theory and literature reviews that have been done, this includes a brief introduction to Arduino UNO, brushless motors, and further explanation about the standard in detail.

In Chapter 3, the discussion is about the methodology of the project, which includes the hardware and software implementation of the project. The result and discussion will be presented in Chapter 4. Last but not least, Chapter 5 discusses the conclusion of this project and future work that can be done.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The project is needed to design and develop an IoT quadcopter using microcontroller. Four brushless motors with four propellers, four ESC, quadcopter frame, LiPo battery, receiver and transmitter will be used to build a quadcopter. This project also will be using a wifi module (ESP8266) to connect with the Arduino Uno that act as a flight controller. IMU (Inertial Measurement Unit) that consists gyroscope and accelerometer sensor also will be used in this project. This IMU will provide the analysis of the angular rate through the IoT application via the Blynk apps created.

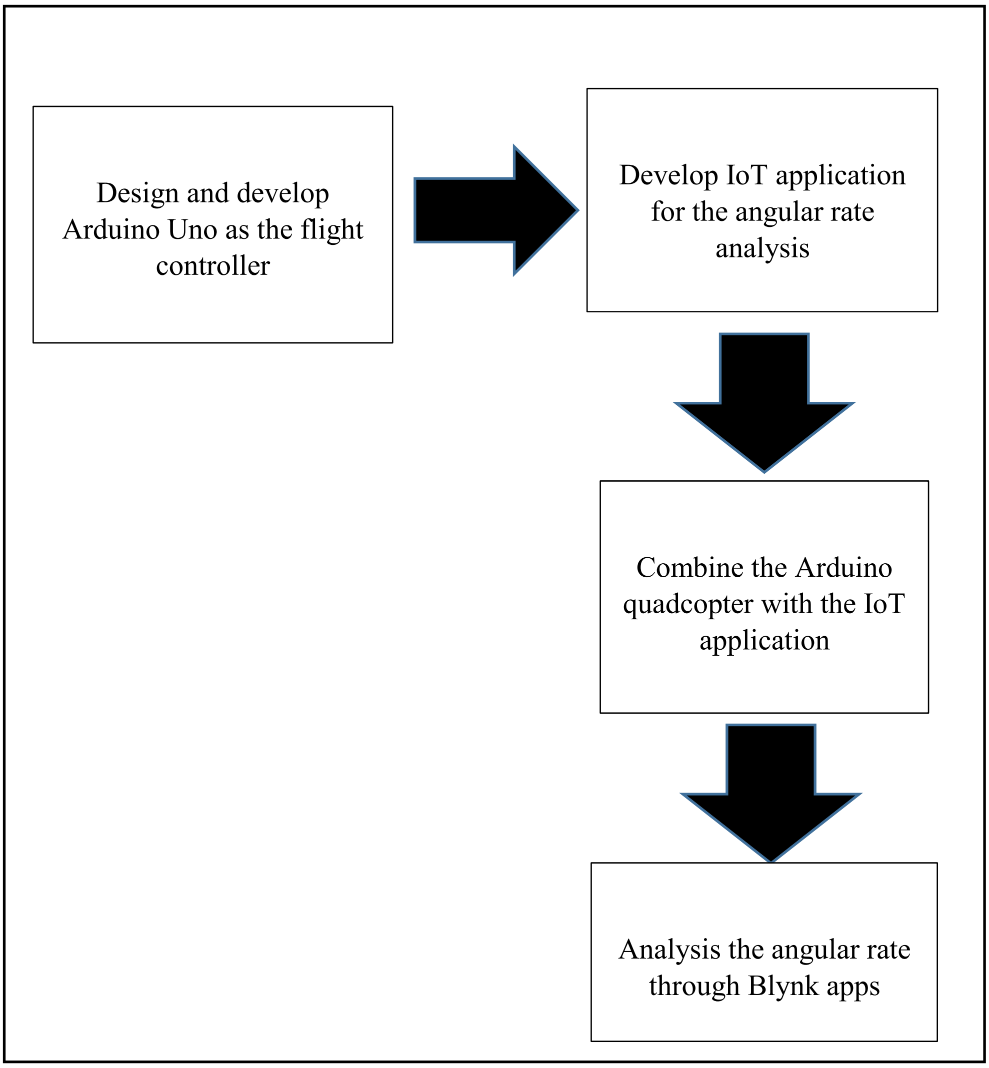

Figure 2.1: Block Diagram of The System

2.2 Multi-Rotor UAV

Multi-rotor UAV utilizes differential thrust management of independent motor and propeller units to provide lift and directional control. The multi-rotor UAV which is also known as Multi-copter can be defined as variable flying multi-propeller platform. The variability is ensured by a puzzle construction which allows the designer to use any number of arms with propulsion drives. The large scale of small UAV applications has increased vastly with the past few years as an aid to provide the capabilities of more complex and expensive manned systems. These small UAVs are most suitable for jobs that too dirty, dangerous or dull for a human, thus, showing capabilities of market potential in the years to come. Among various types of UAVs, quadrotor platforms namely Quadcopter have been extensively used in Research and Development area to test algorithms and techniques due to their simplicity, ease of use and maintenance and low cost.

2.3 Flight Control of Quadcopter

In contrast to a classical helicopter with main and tail rotor, a Quadcopter is propelled by four horizontal rotors directly attached to the airframe. The Quadcopter motion is controlled by the thrust generated by individual propellers regulated by the motor velocity [17].

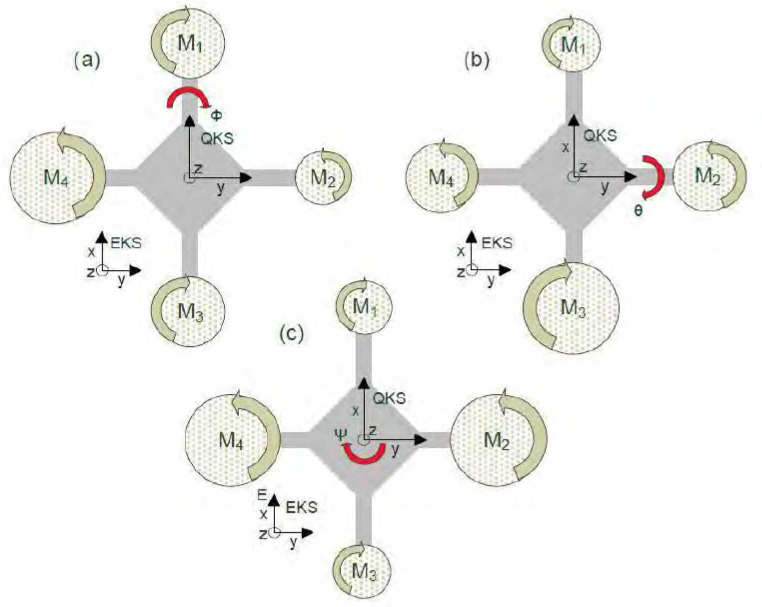

Figure 2.2: Quadcopter frame with propeller and rotor velocity configurations [17]

Figure 2.1 shows the Quadcopter body frame and the external frame, the location of propellers and combination of rotor velocities to independently generate roll (a), pitch (b) and yaw (c) motion. The Quadcopter six degrees of freedom are controlled by the four motors resulting in an under-actuated system . Figure 2.3 shows the basic movements of a quadrotor.

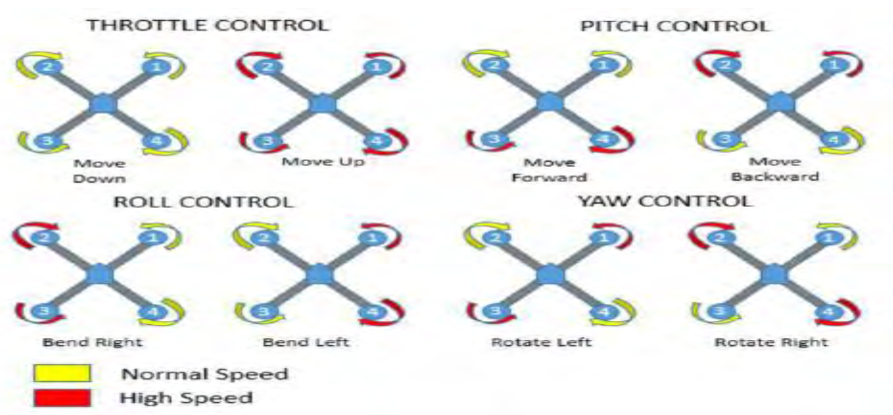

Figure 2.3: Basic movement of quadrotor [18]

2.4 Brushless DC Motor (BLDC)

Brushless DC Motor is also known as electronically commutated motors (ECMs). It is a synchronous motors that are powered by a DC electric source via an integrated inverter or switching power supply which produces an AC electric signal to drive the motor. Brushes used in shunt DC motors are not needed in brushless DC motors, therefore the maintenance costs are reduced. BLDC motors change the current direction by means of electronic commutation through switching electronics. The electronic commutation is done by the switch mode DC to AC converters by using Electronic Speed Controller (ESC) .For a safety margin and sufficient agility of a multi-rotor, demands a thrust weight ratio of about 2:1[19]. The suitable brushless DC motor, propellers and battery must be selected because it might cause the multi-rotor unable to lift or lift for a very short duration. The formulas in section 2.4.1, 2.4.2 and 2.4.3 are taken from The Electric Motor Handbook by Bob Boucher [16].

The advantages of using BLDC are is has better speed versus torques characteristics, high efficiency with noise less operation and very high speed range with longer life. The KV rating refers to how many RPM it turns per volt. The KV rating on a BLDC motor is equal to RPM applied to the motor and in this project, 1000KV rating will be used. The 1000KV will spin at 1000 RPM when 1 volt is applied.

Figure 2.4: BLDC Motor

2.4.1 Formulas to Calculate Static Thrust

$$F = ma \times 2 / N \quad (1)$$

Where, m = mass of multi-rotor

N = number of propellers providing the lift thrust

F = Static thrust required

$F = 4.392399x10{-}8 \cdot RPM \cdot d3.5\sqrt{pitch}(4.2333x10{-}4 \cdot RPM \cdot pitch - Vo)$

Where, RPM = speed of motor in rev/min

d = diameter of propeller in inch

pitch = pitch of propeller in inch

Vo = initial velocity of multi-rotor UAV

2.4.2 Formula to Calculate Power Drawn by Motor

$$P = Kp \cdot D4 \cdot PITCH \cdot RPM3 \quad (3)$$

Where, P = power drawn by brushless DC motor

Kp = propeller constant

D = diameter of propeller in feet

PITCH = pitch of propeller in feet

RPM = RPM in thousands (RPM/1000)

2.4.3 Formula to Calculate Flight Duration

$$FD = 60\ (BC)/Irequired \quad (4)$$

Where, FD = flight duration in minutes

BC = battery capacity in mAH

$Irequired$= current drawn by motor