QUADCOPTER REPROGRAMMABLE VIRTUAL PATH FOLLOWER DESIGN

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To my beloved father and mother

ABSTRACT

Quadcopter is an unmanned aerial vehicle (UAV) and colloquially known as drone. Drones are extremely popular because they come in different shapes, sizes, and prices. There are many different models on the market are ready to use and have fun with it. However, quadcopter that sell in market needs to control and drive the flight manually by someone with use of a wireless joystick controller. The main goal of this project was to build autonomous quadcopter that could fly itself without needed of someone to control it manually for photography. The virtual path was designed which would be followed by quadcopter. The APM flight controller, GPS with compass and software Mission Planner played an important role in direct the quadcopter to autonomous. After the product was done, it will be analyzed to check the accuracy and stability of quadcopter by few experiments. The experiment on compare the system altitude and practically measure altitude of drone was done to evaluate the accuracy of the sensor in measure the height. Moreover, the trajectory set in Mission Planner and the flight trajectory pass through by the quadcopter was evaluated in the result part. Finally, the suggestion for future work for this project will be commented at the last chapter.

ABSTRAK

Quadcopter adalah Kenderaan Udara Kawalan Jauh (UAV) dan dikenali sebagai drone. Drone sangat populat kerana ia mempunyai pelbagai bentuk yang menarik, saiz dan harga. Terdapat banyak model yang berbeza di pasaran yang telah sedia digunakan dan bersenang-senang dengan ia. Walau bagaimanapun, quadcopter yang menjual di pasaran perlu mengawal dan memacu penerbangannya secara manual oleh seseorang dengan mengunakan pengawal joystic. Matlamat utaman projek ini adalah untuk membina quadcopter autonomi yang boleh terbang sendiri tanpa memerlukan seseorang untuk mengawalnya secara manual untuk fotografi. Laluan maya telah direka yang akan diikuti oleh quadcopter. Pengawal penerbang APM, GPS dengan kompas dan perisian Mission Planner memainkan peranan penting dalam mengarahkan quadcopter kepada autonomi. Selepas produk selesai, ia akan dianalisis untuk memeriksa ketepatan dan kestabilan quadcopter oleh beberapa kajian. Kajian untuk membandingkan ketinggian sistem dan ketinggian drone semasa telah dilakukan untuk menilai ketepatan sensor untuk mengukur ketinggian sensor untuk mengukur ketinggian. Selain itu, trajektori yang ditetapkan dalam Mission Planner dan trajektori penerbangan yang dilalui oleh quadcopter dinilai pada bahagian hasil. Saran untuk kerja masa depan untuk projek ini akan dikomentari .

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LIST OF SYMBOLS AND ABBREVIATIONS

PID	:	Proportional Integral Derivative
APM	:	ArduPilot Mega
GPS	:	Global Positioning System
OSP	:	Open Source Project
FPV	:	First Person View
USB	:	Universal Series Bus
MP	:	Mission Planner
GCS	:	Ground Control Station
KML	:	Keyhole Markup Language
IMU	:	Inertial Measurement Unit
ESC	:	Electronic Speed Controller

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CHAPTER 1

INTRODUCTION

1.1 Project Background

There are myriad of multirotors configuration nowadays, namely based on tricopters, quadcopters, hexacopters and octocopters. As a beginner of multirotor, quadcopter is more suitable for this project. A quadcopter is an aerial vehicle and colloquially know as drone that uses four rotors for lift, stabilization and steering [1]. The quadcopter can achieve aerial flight in more stable condition with electronic assistance, in contrast, it will be extremely herculean process to control multiple rotors manually without electronic assistance [2]. Moreover, quadcopter is easier to construct and maintain due to its cyclic design. The technology becomes more advanced nowadays and the decrement in cost of microcontroller and microprocessors which also give accessibility to the public, engineers and researchers have started to implement and design quadcopters for various functions which lead to this multirotor

are getting famous in recent years [1]. Therefore, the area of applications of quadcopter is numerous today such as surveillance, search and rescue, mapping, military services and photography[3].

Normally, quadcopter manual control system by transmitter and receiver on the drone. In this project will build an autonomous quadcopter which able to balance itself during flying and build a drone able to follow the predetermine virtual trajectory. In order to achieve autonomous flight in a rural environment, it is needed to plan a virtual path which are more robust and reliable. Path following is the concept of following the predetermine waypoint or path with the least errors in position and velocity [4].

Aerial photography has been started for long after photography was invented. The vehicle, tools and places to create aerial photos initially use manned hot balloons, kites, small scale unmanned balloons, airplanes, helicopters, tall buildings, satellites and finally drones. [5]. So far, businesses have used quadcopters or drones for the most part in photography and video particularly for promoting purpose[6]. The application of drone in photography principally is used in media coverage. Before the generation of drone, aerial shots were available only to large news corporation by using a news helicopter. Now, local journalists and small-scale media outlets can easily capture aerial footage for news coverage [7]. Furthermore, quadcopter has more ability get into tighter area or inaccessible places for photography, however, this cannot be done by a news helicopter. A simple task like recording a face to face interview can easily done by a camera-equipped drone hovering nearby. Drone capable to open up new territories and reveal undetected vantage points. Moreover, quadcopters are less loud, less visible and of course less perceptible than helicopters thus it can capture a more candid aerial footage.

The invention of drone gives a lot of benefit to the public as well as businessman. However, there are some deficiency for current basic and cheap quadcopter that it must control manually with a wireless joystick controller for photography which cause the travel path of the drone not smooth and then the photo and video takes not perfect. Due to that, this project is to find a solution by design virtual travel path for quadcopter for it to autopilot. The solution that was proposed was using an APM 2.8 flight controller combined other sensor and Mission Planner software.

1.2 Problem Statement

In general, quadcopter has been sold in shop with low price ordinary does not has camera, GPS and some advance function. This kind of quadcopter needs someone to constantly drive it manually using a wireless joystick controller. It is also not easy to get a person who well in manually control the quadcopter in Malaysia since quadcopter is more famous in other country. Moreover, the travel path will not be smooth if the drone manually controls by someone. Thus, this project is going to solve this problem and design to build a quadcopter which can flight according to the predetermined virtual path.

1.3 Objectives

a. To design a quadcopter that have capability to follow the predetermine virtual path that not need someone to constantly drive it manually.
b. To analyze the stability and accuracy of quadcopter during flight control design.

1.4 Scope of Project

For this project, an Ardupilot Mega 2.8 flight controller will be used as programmer. Inside the controller has accelerometer, gyroscope and barometer sensor will be used as the motion sensor. An accelerometer will be used to measure the linear

acceleration based on vibration, while, gyro sensor uses to sense the angular velocity. Barometer will used to measure the altitude of the drone. GPS with compass keep the drone orientated in its direction. A 3DR telemetry will used to communicate the drone with Ground control station. GCS used for this project is Mission Planner.

1.5 Thesis Outline

This final year project thesis consists of five chapter and they are introduction, literature review, methodology, result and discussion and conclusion. The report outline will elaborate each chapter briefly.

Firstly, chapter one explains about the introduction of the whole project and the reason to do this project. The problem statement and objective of the project will also be discussed in this section. Then, the scope of the project will be explained to indicate the desired achievements of the project and the field will covered or not be covered.

For chapter two will discuss the pass study related this project and the theoretical concepts that are applied in this project. Moreover, the methods used by other researcher in build up an autonomous drone will be discussed and analyzed in the section as well.

Moreover, chapter three revolves around the process of this project on how it is conducted systematically with appropriate planning. This project will discuss the method and component used to construct a quadcopter which is the minimum requirement to make the quadcopter able to follow the virtual path. Moreover, the software development, the method for data collection and graph development will be discussed clearly.

Chapter four concentrates on reviewing and discussing the Mission Planner software and Mavlink log graph. Evaluation of accuracy and performance of quadcopter will be explained in this chapter as well. The result obtain via Mavlink will be analyzed and discuss.

The last chapter is conclusion which contains the summary and conclusion of whole project. The limitations will be justified and the future possible improvement for this project will be recommended.

CHAPTER 2

BACKGROUND STUDY

2.1 Introduction

This chapter discusses the sensor and flight controller used in control quadcopter and the technique used for setting flight path and autonomous control. The theory on drone flight operation will be covered in this chapter. Besides that, the other researcher projects regarding on quadcopter will be discussed and compared the flight controller and method used to implement the drone to follow the flight path. Next, the software had been used by other researcher in program the flight controller will be discussed. In addition, this chapter also include the discussion on PID controller used in control the stability of quadcopter. Moreover, the Mission Planner open source project which will use for analyzing the telemetry data of drone will be discussed.

2.2 Literature Review

S. Sabikan [3] and Omar et al [8] presented an implementation of Open-Source Project (OSPs) platform as autonomous UAV quadcopter development that suitable for an uncontrolled environment. They selected ArduPilotMega (APM) 2.6 as the flight controller platform for quadcopter and APM autopilot was equipped with 6-DoF IMU in a single chip (MPU6000) and GPS. When quadcopter in auto mode flight, they successful obtained IMU data from the MAVlink telemetry logs. However, the graph showed base on the IMU data had some vibration. Their suggestion to reduce the vibration in IMU sensor was mounting the flight controller with an Antivibration Plate on the quadcopter frame. The drawback was the PID parameters in achieve the optimal tuning of quadcopter PID controller had to apply manually setting it. The extra experiment done by Omar et al [8] was calculated the error between actual velocity and estimated velocity that set in the mission planer program. The actual velocity of the quadcopter was calculated manually by knowing the time of drone move from one waypoint to another, the distance of them collected from the mission planner. The other paper from Sunardi et al [9], they also used the same electronic flight controller, sensor and GPS but different type and version. All three papers used mission planner software to set the waypoints which will be follow by quadcopter. Although the APM capability to do flight data logging and other feature but the cost of APM was expensive.