UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MINI SITE SURVEY USING DRONE AND ARDUINO

This report submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

by

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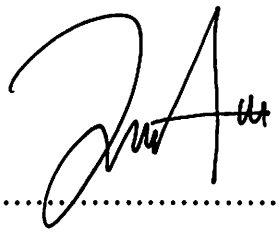
Signature : 

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunications) (Hons.). The member of the supervisory is as follow:

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DEDICATION

I would like to dedicate this thesis to my beloved mother, Rusliza Binti Abd Halim, also to those who are always on my side which is my brother and sisters, my nephews, lectures and all my friends. There is no doubt in my mind that without their continued support and encouragement I could not have completed this thesis.

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ABSTRACT

This project elaborated the process on how to build our own quarter by applying a Mechatronic design methodology and concurrently taking into account mechanical, electronic, software and control component design. The results of this investigation include recommendations for proper selection of components such as motors, propellers, batteries and electronic speed controllers so that anyone interested can build his/her own quarter.

A quadcopter can achieve vertical flight in a stable manner and be used to monitor or collect data in a specific region such as panoramic view. Technological advances have reduced the cost and increase the performance by using the ArduPilot Mega (APM). The goal of this project is to build, modify, and improve an existing quadcopter kit to obtain a stable flight, monitor the drone by directly, and also perform autocommands such as auto-landing.

The arcade software was modified to properly interface the components with the quadcopter kit. The individual components were tested and verified to work properly. Calibration and tuning of the proportional–integral–derivative controller (PID controller) was done to obtain proper stabilization on each axis using custom PID test benches. Most of the goals in this project have been achieved, resulting in a stable and maneuverable quadcopter. For this project, the maximum operated time of Quadcopter is six minutes using 4500mAh Lipo battery and operate time can be increased by using largest battery capacity.

ABSTRAK

Projek ini menceritakan proses untuk membina quadrotor kita sendiri dengan menggunakan metodologi reka bentuk mekatronik dan selaras dengan mengambil kira mekanikal, elektronik, perisian dan kawalan reka bentuk komponen. Hasil siasatan ini termasuk cadangan untuk pemilihan komponen yang sesuai seperti motor, kipas, bateri dan pengawal kelajuan elektronik supaya sesiapa yang berminat boleh membina quadrotor sendiri / beliau.

Quadcopter boleh melakukan penerbangan secara menegak dengan cara yang stabil dan digunakan untuk memantau atau mengumpul data di kawasan tertentu seperti pandangan panorama. Kemajuan teknologi telah mengurangkan kos dan meningkatkan prestasi dengan menggunakan ArduPilot Mega (APM). Matlamat projek ini adalah untuk membina, mengubah suai, dan meningkatkan "anexisting quadcopter kit" untuk mendapatkan penerbangan stabil, mengawal Drone secara langsung dengan monitor, dan juga melaksanakan arahan secara automatik seperti auto-mendarat.

Perisian aeroquad telah diubahsuai untuk menjadi perantara komponen dengan kit quadcopter itu sendiri. Setiap komponen telah diuji dan disahkan untuk beroperasi dengan baik. Penentu ukuran dan penyesuaian pengawal PID itu dilakukan untuk mendapatkan kestabilan yang betul pada setiap paksi menggunakan kaedah PID bangku ujian. Target utama dalam projek ini telah dicapai, iaitu quadcopter yang stabil dan mudah dikendalikan. Untuk projek ini, masa maksimum yang dikendalikan pada quadcopter adalah enam minit menggunakan 4500mAh Lipo bateri dan kendalian masa quadcopter boleh dipertingkatkan dengan menukarkan kapasiti bateri yang lebih besar.

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LIST OF SYMBOLS AND ABBREVIATIONS

ESC.....Electronic Speed Control

APM..... ArduPilot Mega

UBEC.....Universal Battery Eliminator Circuit

PID..... Proportional-Integral-Derivative

UAV..... Unmanned Aerial Vehicles

BTS..... Base Transceiver Station

QRO..... Quad Rotor Observer

ACSS..... Android Control and Sensor System

RPV..... Remote-Person View

FPV..... First-Person View

FC..... Flight Controller

IMU..... Inertial Measurement Unit

RTL..... Return To Lunch

PWM..... Pulse Width Modulation

OSD.....On-Screen Display

CHAPTER 1

INTRODUCTION

1.0 Background of Study

Nowadays, one of the most popular types of Unmanned Aerial Vehicles (UAV), is the quadrotor helicopter, commonly known as quadcopter. Quadcopter can build yourself, applying a Mechatronic design methodology by concurrently taking into account mechanical, electronic, software and control component design. This report also presents the simulation results for altitude control (pitch and roll and yaw). The results of this investigation include recommendations for proper selection of components such as motors, propellers, batteries and electronic speed controllers so that anyone interested can build his/her own quarter. The aim of this project was to build and program a quadcopter that can be used to collect image information of a surrounding area. This project was a great learning opportunity for us to apply our engineering knowledge. Choosing the quadcopter parts was not a simple process. In order to complete the quadcopter a battery, transmitter, receiver, Arduino module, and the motor was selected. Each component was then interfaced, tested, and verified to be working properly. The tuning of the PID control system was accomplished using a custom test benches. A proportional-integral-derivative controller (PID controller) is a control loop feedback mechanism (controller) widely used in industrial control systems. A PID controller calculates an error value as the difference between a measured process variable and a desired setpoint. The controller attempts to minimize the error by adjusting the process

through the use of a manipulated variable. This project covers the design, implementation and application of a Mini Site Survey Using Drone and Arduino. The design process of an optimal quadcopter requires knowing the flight mechanics that governs its motion. The adequate design of the vehicle facilitates the job for the corresponding control system.

Selecting the proper instrumentation is also an important part of the Mechatronic design methodology, it is necessary to have the appropriate elements for correct aircraft operation. Mini Site Survey Using Drone and Arduino is a drone that uses Arduino system that stabilizes the drone when positioned in the target area. At the same time, when the drone reach of the target area, the camera at the drone start capturing image surrounding area guided by setting from the Arduino automatically. The target that the camera must capture is every 30 degrees, the camera will be snapping the surrounding area until 360 degrees in panoramic view. The main function of this project was to design and implement drone system to take the picture by controlling using the Arduino. The function of Arduino is to control the drone in the static position. Besides, by using the Arduino application, it is possible to make the own program so that the drone able to capture the image at the several positions and several degrees. Besides, when the Mini Site Survey Using Drone and Arduino captures the image, it directly sends the image automatically and wirelessly to the computer. In addition, the camera that connects with Arduino can make a decision based on the color of the image that's been captured. Besides that, this device was to get experience working with a real-time system on a device that would provide a motivating learning experience in a real situation, This Mini Site Survey had been implemented to catch the panoramic image at the antenna area on top of the tower.

1.1 Problem statement

Getting a panoramic picture at the top of the tower is the one of the works for the telecommunications company. To get the picture of the tower, the rigger must climb first

until he reaches at the top of the tower. After the rigger reach at the top of the tower, the rigger must find the right and safe place to capture the picture. The problem that always been faced by the rigger is there is a risk for the rigger to face, which is probability to fall down from the top of tower if they are not careful. Besides, when climbing the tower, the time taken for the rigger to reach the top of the tower is long. As an example, there were cases involving death that happens at the employee died after falling from a Base Transceiver Station (BTS) of Telecommunication Company is dropped from a height of approximately 15m. From the information available, the victim slipped while doing maintenance work on the tower. The victim fell and landed on the paving blocks with the prone position.

1.2 Project Objectives

The objectives of this project are as stated below:

1. To design and implement drone system to capture the picture and record live view.
2. To be able to take the picture with several degrees and using short time taken to ease processing.

1.3 Project Scope

The function of the Arduino system in the drone is to guide the motion of the stepper motor to get the position of camera with rotating every 30 degrees. By the rotation every 30 degrees the camera will start to record the view with the panoramic concept at every 30 degrees. The drone must be flying with the "loiter mode" that's mean the drone fly at the same position and the same height. This situation implements because to get the best quality picture and the best quality recording. In other hand, this

project will be implemented to capture and record the panoramic image of the antenna area, on top of the tower. To solve the problem the time taken for the rigger to reach the top of the tower is long, the view that recording will automatically send wirelessly to the screen or PC using wireless application and at the same time, all the views of drone flying will save in the memory of the camera. Last but not least, at the top of the tower have many antennas from the various telecommunication companies. So to know which one the antenna wants to survey, the person on the screen or a PC can make a decision based on the color of the sticker that has been captured at the antenna.

1.4 Thesis Outlines

There are 5 chapters in this thesis which are included of introduction, literature review, project methodology, result and discussion and finally a conclusion and recommendation. Each chapter will discuss its own aspects that related to the project.

Chapter 1 is the introduction to the project or study. There is the background of study, problem statements, object and scope of the project along with the summary of works have been discussed and presented in this chapter.

Proceed to chapter 2, in this chapter previous studies are reviewed. This chapter is discussing about the approaches and methods used in previous studies. The comparison of strength and weakness can be used as a guideline to develop an efficient Mini Site Survey Using Drone and Arduino. The own idea also proposed and justified in this chapter.

For the chapter 3 focus on the methodology and approaches of the project. This includes the software implementation and hardware development of the project. This chapter also explains briefly about the flowchart of the project activity.

Results and discussion are presented in chapter 4. This chapter explains about the fullness of the block diagram that used in the project. The simple programming that use on the circuit is included in this chapter. Lastly, is the chapter 5 that presents a comprehensive conclusion of the project. The suggestion and recommendation for future improvement in the functional also mentioned.

1.5 Conclusion

Unmanned Aerial Vehicles, UAV is the drone that can be used in the telecommunication sector. This project is the one way solution to help the problem of the rigger. By using the Arduino, so many interfaces can do. For this project Arduino system will be is to guide the motion of the stepper motor to get the position of the camera with rotates every 30 degrees. Besides, Arduino also can get the trigger signal from the remote control that the command will start to take the panoramic view. From the creation of this drone, the problem facing from the rigger will be solved. The time taken for the rigger reach at the top of the tower take the picture will be decrease and to easiest of the rigger take the picture. One important thing that makes this drone is to prevent a risk for rigger to face, which is probability to fall down from the top of the tower.

CHAPTER 2

THEORETICAL BACKGROUND

2.0 Introduction

A drone, in a technological context, is an unmanned aircraft to implement many applications. Unmanned Aerial Vehicle (UAV) is a vehicle to fly without a pilot whose flight either independently controlled by an onboard computer or by remote control from the pilot on the ground segment. After doing some research on several books of the electronic circuit books, websites, eBooks, and journals from the internet, the next step was starting to plan the work on how to integrate the circuit in this project. To ensure that the project can be implemented and work properly, before start the project make sure literature on the project was examined carefully. The control circuit that used in this project shall be accordance with the operational control of an electronic circuit. As a result, must do some research for the functional circuit that use in this project. This project also has some modification on several existing control circuits. It was to make sure that the functionality of the circuit is suitable for the project. All of this equipment and circuit modification had been changed based on the guidance from reference materials.

2.1 Previous Works With Quadcopter

2.1.1 How to build the Quadrocopter

According to Noudin, et al. (2011), to build the Quad Rotor Observer (QRO). This paper describes the tutorial with pictures for building yourself a quadcopter which will allow to fly anywhere (outdoor and indoor) and also to do aerial photos. Its piloting is relatively simple, that's mean simpler than a variable pitch helicopter with the help of the electronic flight controller, a Kkmulticopter type. The construction is relatively simple and cheap. The main frame of the QRO uses common components that will find in any hobby stores. Figure 2.1 shows the Quad Rotor Observe that have been done completely.

Figure 2.1: Block Diagram System

2.1.2 Designing a Spatially Aware, Automated Quadcopter Using an Android Control System

According to Gupte, et al. (2014), intelligence gathering is a critical component of military operations. Unmanned aerial vehicles (UAVs) have become an increasingly useful tool due to their surveillance and reconnaissance capabilities. However, the use of many of these vehicles is limited to outdoor environments because of their size and reliance on Global Positioning Satellites (GPS). Knowledge of indoor environments is important so that the risk of entering an unsafe or unknown building can be minimized. This paper describes the development of a spatially aware, autonomous quadcopter that uses an Android control system and functions indoors. The system consists of a laser rangefinder for sensory input, a IOIO microcontroller for data communication across platforms, an autopilot system (APM) for flight control, and an Android phone for mission control. The Android Control and Sensor System (ACSS) is currently being developed by the Department of Defense (DOD), MITRE, and academic partners, and will be integrated into the solution.

2.1.3 Modeling, Simulation and Control Study for The Quad-Copter UAV

According to Patel, et al. (2012), in the recent years UAV (Unmanned Aerial Vehicles) having quad-copter helicopter i.e. quad-copter configuration have been receiving increasing attention amongst the global researchers due to its wide-range of applications such as surveillance in military, civilian and disaster management applications. This paper presents the investigations on the modeling, simulation, altitude model validation and comparison of some popular quad-copter control schemes. Quad-copter consists of two pairs of counter rotating rotors situated at the ends of a cross frame, symmetric about the centre of gravity, which coincides with the origin of the reference systems used. The model used in our work is based on the Euler Lagrange method used to derive the defining equations of motions of the six degree of freedom system with minor changes to consider variable airdensity. This

modified model is then simulated in matlabsimulink framework to dynamically compute the quad-copter altitude and attitude.

2.1.4 Building Your Own Quadrotor: A Mechatronics System Design Case Study

This project focuses on one of the most popular types of Unmanned Aerial Vehicles, UAV, is the quadrotor helicopter, commonly known as quadcopter. This work seeks to document the lessons learned by the authors while attempting to build their own quadcopter for further studies of stability control, instead of using a commercial quadcopter for the same purpose. The article describes the process on how we can build our own quadrotor, applying a mechatronic design methodology by concurrently taking into account mechanical, electronic, software and control component design. The paper also presents the simulation results for altitude control (pitch and roll). The results of this investigation include recommendations for proper selection of components such as motors, propellers, batteries and electronic speed controllers so that anyone interested can build his/her own quadrotor (Navajas, et al. (2014).

2.1.5 A Survey of Quadrotor Unmanned Aerial Vehicles

According to Gupte, et al. (2012), in the past decade Unmanned Aerial Vehicles (UAVs) have become a topic of interest in many research organizations. UAVs are finding applications in various areas ranging from military applications to traffic surveillance. This paper is a survey for a certain kind of UAV called quadrotor or quadcopter. Researchers are frequently choosing quadrotors for their research because a quadrotor can accurately and efficiently perform tasks that would be of high risk for a human pilot to perform. This paper encompasses the dynamic models of a quadrotor and the different model-dependent and modelindependent control techniques and their comparison. Recently, focus has shifted to designing autonomous quadrotors. A summary of the various localization and navigation