QUADCOPTER EMBEDDED CONTROLLER FOR ALTITUDE HOLD AND
SURVEILLANCE

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UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : QUADCOPTER EMBEDDED CONTROLLER FOR ALTITUDE
HOLD AND SURVEILLANCE

Sesi Pengajian : | 1 | 1 | / | 1 | 2 |

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Name   : Muhammad Noorazlan Shah Bin Zainudin

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Dedicated to my beloved family especially my father and mother, lecturer, and also to all my friends

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ABSTRACT

These projects Quadcopter are commonly designed to be unmanned aerial vehicle (UAVs). This project cover about the main component on Quadcopter such as battery, propeller, brushless motor, Electronic Speed Control and the suitable frame that consist of the light weight material. These vehicles is lifted and propelled by four rotor and use an electronic control system.The controller use in this project is Atmega Microcontroller. Arduino 1.0 compiler software is used to compile the program for Quad-copter. For altitude hold function this project will use the ultrasonic range finder to comparing the current altitude with the target altitude, by adjusts the throttle and elevator to provide negative feedback to drive the altitude toward the target values. For surveillance system this project will use video camera that mount into Quad-copter frame to take a video.

ABSTRAK

Projek Quad-rotor biasanya direka untuk menjadi kenderaan udara tanpa pemandu. Projek ini menerangkan tentang komponen utama pada Quad-rotor seperti bateri, kipas, motor tanpa berus, Kelajuan Kawalan Elektronik dan rangka yang sesuai yang terdiri daripada bahan ringan.Quad-rotor ini diterbangkan oleh empat kipas dan menggunakan kawalan elektronik sistem. Pengawal dalam projek ini adalah Mikrocontroller lAtmega. Arduino 1,0 pengkompil perisian yang digunakan untuk menyusun program untuk Quad-rotor. Untuk fungsi penentu altitude projek ini akan menggunakan ultrasonic sensor untuk membandingkan ketinggian semasa dengan ketinggian sasaran, dengan mengubah sasaran kelajuan dan memberi maklum balas untuk memacu altitud ke arah nilai sasaran. Bagi sistem pemantauan projek ini akan menggunakan kamera video yang diletakkan pada rangka Quad-rotor untuk mengambil video.

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CHAPTER 1

INTRODUCTION

1.1   Project Overview

Quad-copter are commonly designed to be unmanned aerial vehicle (UAV).These vehicles is lifted and propelled by four rotor and use an electronic control system. With their small size, this Quad-copter can be flying indoors as well as outdoors. The controller use in this project is Atmega Microcontroller. AVR Studio 5.0 and Arduino Compiler software is used to compile the program for Quad-copter. This project has using the Hobby King T6A mode 2 as a transmitter and receiver to control the Quad-copter. For surveillance system this project will use video camera that mount into Quad-copter frame to take a video.

1.2   Objective of Project

The objective of this project is radically modifies the design of a conventional helicopter. Besides that, this project will create the talent of student to apply their knowledge in this final year project. The objectives are:

- To create a light weight Quadcopter
- To create a altitude hold function on Quadcopter
- To create the Quadcopter that have a capability to take a video for surveillence system

The first objective is to build the unmanned aerial vehicle (UAV) by using the light weight material that can lift by using four rotors and this quadcopter can be using by everyone. Therefore, a design and controller based on a beginner level pilot skill are essential to the project. The second objective is to use the ultrasonic range finder sensors for throttle correction during hover the Quadcopter and hold the Quadcopter on their position. The ultrasonic range finder will do the altitudes hold function by adjusts the throttle and elevator to maintain a target altitude set by user.

The third objective is to mount the video camera into Quadcoter. The Quadcopter was intended to be a UAV (Unmanned Aerial Vehicle). The main part of UAV must have the camera video in order to capture the life time video transmitting, so its purpose could be for surveillance. This Quadcopter will give the stable video during live time video capture, because this Quadcopter propelled by four rotor that give a good balancing in any condition.

1.3   Problem Statement

Nowadays, in order to prevent crime issues we have to take precaution to avoid this criminal and take an action to solve this problem. The Quadcopter is a new way to solve this problem by implement the surveillance system to decrease the criminal around the city.

Next, Firefighters are rescuers extensively trained primarily to put out hazardous fires that threaten civilian populations and property, to rescue people from car incidents, collapsed and burning buildings and other such situations. The increasing complexity of modern industrialized life with an increase in the scale of hazards has created an increase in the skills needed in firefighting technology and a broadening of the firefighter-rescuer's remit. The Quadcopter is a new technology that can be use to monitoring around the building or in hazards area that human cannot reach.

1.4   Scope of Project

This project have using the aluminum frame that is the best material and suitable to create the frame for Quadcopter. The Altitude Hold function can be use between range 0 to 255 inches (0 to 6.45m).The reason of using this ultrasonic range finder because this sensor small and light weight module that can be easily attach to Quadcopter. For surveillance system the video that transmit from Quadcopter can be view directly through the laptop and this video also can be record via Easycap device.

1.5   Project Planning

This project is implemented base on the project planning schedule. The project started from September 2011 and finish on 15 June 2012.

1.6   Thesis Outline

This report contains 5 chapters that explain in detail about entire project to provide the understanding of the whole project.

Chapter one is introduction of the project. This chapter present an overview to Quadcopter embedded controller for altitude hold and surveillance, the objective of project, project schedule and thesis outline.

Chapter two covers the literature review on the component that will use in this system. This chapter discuss about the source or article that related to the project. This chapter is also reveals the product that been appeared in the market nowadays. This chapter is also relates the theory of components, equipment and programming language that is used in the project. So, it is very important to understand the overall concepts and how this system work.

Chapter three discuss about the project's methodology, project planning, project finishing. This project planning will shown all the progress is keep running due to the date, which had been set before the project is in progress. A flow chart is built to help understand the course of the project in detail. On this chapter also show the Gantt chart for semester I and semester II.

Chapter four is about the result and discussion for this final year project. In this chapter discuss about the basic theory of aviation that an important part before develop this Quadcopter. Next, the flight pattern also discuss in this chapter for more understanding on Quadcopter frame pattern. Then, discuss how to setup the Quadcopter and how to test before fly this Quadcopter. Besides that, this chapter also discusses the result for altitude hold function and surveillance system.

Chapter five discuss about the conclusion based on the objective that specified in introduction part. Next, discuss about the future work suggestion for improvement on this project.

CHAPTER 2

LITERATURE REVIEW

This chapter will explain and discusses the sources or articles that are related to the project. It consists of the products that have been appeared in the market nowadays. This chapter is also describes about the theory of the components, equipments and programming languages that is used in the project. The literature review must be done to comprehend the whole system and decide the best inputs, outputs and devices. From literature review, there will be an analysis concerning the advantages and disadvantages for each phase in this project. Equipment and part manuals include information such as dimension, operation and specification.

2.1   Microcontroller

A microcontroller is a small computer on single integrated circuit consisting of a relatively simple CPU combined with support function such as a crystal oscillator, timers, and watchdog timer, serial and analog I/O etc. In this project was using the ATMEL AVR microcontroller. The AVR is a modified Harvard architecture 8-bit RISC single chip microcontroller which was develops by Atmel. The AVR was one of the first microcontroller families to use on chip flash memory for program storage, as opposed to one time programmable ROM, EPROM, or EEPROM used by other microcontroller at the time.
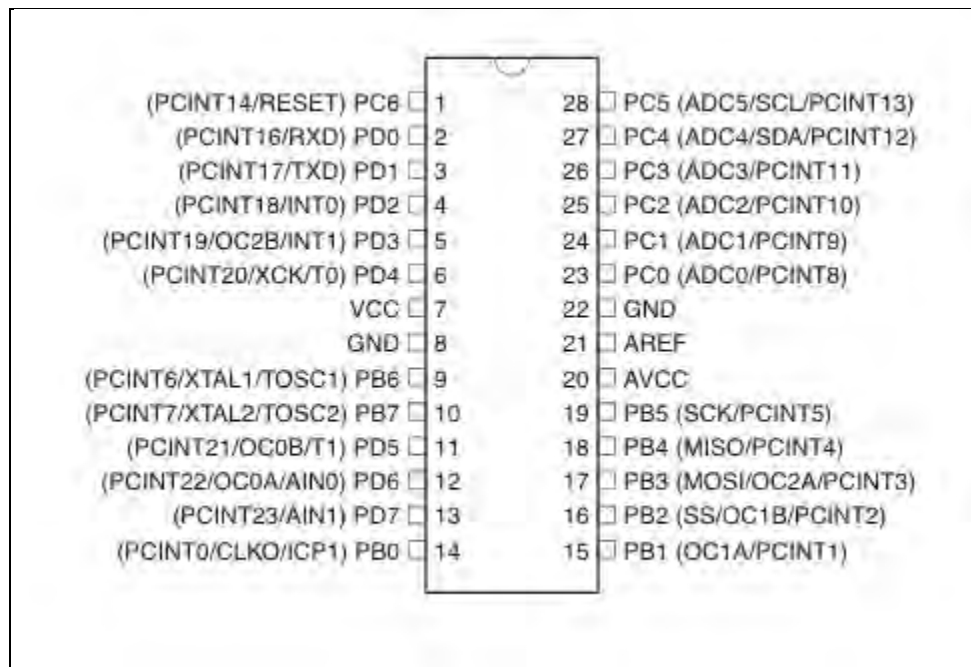

Figure 2.0: ATmega 328P pin mapping

In order to complete this project as soon as possible and reduce time from create PCB or etching, the arduino main board is the best idea because the Arduino is an open source physical computing platform based on a simple I/O board and a development environment that implements the Processing. This Arduino also can be used to develop stand alone interactive object or can be connected to software on computer. This Arduino Duemilanove will automatically select the appropriate power supply.

Table 1: Microcontroller ATmega 328P Specification

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 2 KB used by boot loader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

2.2 Board Arduino Duemilanove

The arduino duemilanove is an open source physical computing platform based on a simple I/O board and development environment that implements the processing/wiring language. Arduino can be used to develop stand alone interactive object or can be connected to software on computer. The benefit of using this arduino is, the user can upload their program direct into microcontroller by using bootloader via USB without external programmer. Besides that, user also has the option either wants to use bootloader or external programmer. The arduino boards can directly using the USB power source as an input voltage. This circuit provides 6 PWM output from digital I/O. If circuit using the bootloader as an uploader to microcontroller, the 2KB out of 32KB flash will be used on bootloader function.
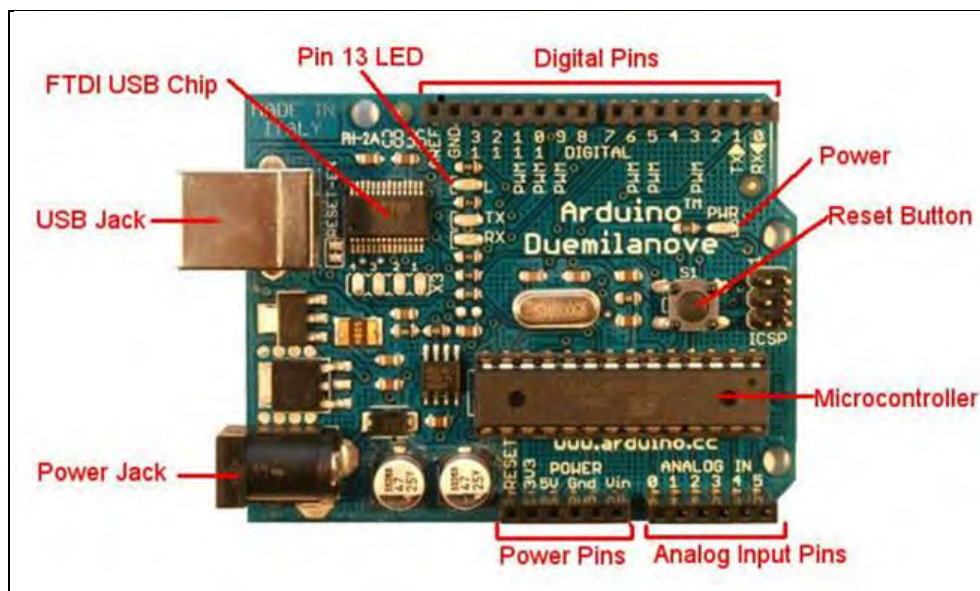

Figure 2.1: Arduino Dumilanove

2.3   Brushless Outrunner Motor

Brushless motor were used as opposed to brushed motors for the Quadcopter. Brushless motor provide more torque compare to brushed motors, which means the Quadcopter can lift with less work from the motor. Brushless motor do not produce heat at high speed and it is very important because the motor have to spin at very high speed to obtain flight and the brushless cannot overheat. The only problem with brushless motor is, the brushless motor are very expensive. However, the extra torque they provide makes it necessary that we use brushless motor in our design.

All of the motor will run at 11.1v and use 1050KV rating. The KV rating is the number of revolutions per minute that the motor will turn when one volt is applied with no load attach to the motor. Motor with lower KV rating can produce a higher torque, which allows them to drive a bigger propeller. This is important because the bigger the propeller used, it will become more stable on Quadcopter.

The motor is the main part of the Quadcopter. A motor is defined as a device which can convert electrical power into mechanical power. To get the good performance, motor chosen should follow the requirement bellow:

   i.   Lightweight
  ii.   High speed and torque
 iii.   Cost effective
 iv.   PWM speed controlled

This project uses four Turnigy 2217, 23A with 1050kv. The reason of using this Outrunner motor because, this Outrunner spinning much slower than Inrunner but it producing   more torque. 1050kv is the motor velocity constant by measured in Rpm pre volt.

Figure 2.2: Turnigy Brushless Motor 2217, 23A, 1050kv

Table 2: Turnigy Brushless Motor 2217 Specification

Kv	1050rpm/v
Operating Current	6A ~ 18A
Peak Current	18A
Suggested prop	10x6.0 E-prop
Suggested Battery	1700~2200mAh 3S1P
Weight	71g
Dimensions	27.6 x 36mm
Shaft Size	3.175mm

2.4 Electronic Speed Control

The Electronic Speed Control is use to vary an electric motor speed and it direction. This Electronic Speed Control commonly used on electrically powered radio controlled. One critical factor to ensure the stable flight is to have the knowledge of the exact rotor RPM, which in turn will mean a better idea of torque. At a constant PWM, the motor will spin at various RPM depending on the dynamic load placed on them. This can create unwanted force which creates more error. One option to ensure motor speed is to place an optical encoder on the motor shaft and combine it with a PID controller to ensure desired RPM.

Figure 2.3: Turnigy Plush 25A

The Turnigy Plush 25A is the best Electronic Speed Control was chosen, because this Electronic Speed Control matching with brushless motor. The idea to select this Electronic Speed control should consider their max current, brand, and packaging. To avoid the Electronic Speed Control from damage, the current for Electronic Speed Control must higher than Brushless motor. The Turnigy brand is the famous brand among the remote control fan. The performance for this turnigy is the best compare to other brand. This Turnigy Electronic Speed Control also has a bullet proof casing, to protect the Electronic Speed Control from damage during crash.