UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND DEVELOPMENT OF CAMERA GUIDED TURRET SYSTEM

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics & Automation) (Hons.)

by

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ABSTRACT

The purpose of this project is to develop a viable prototype of a camera guided turret system (CGTS). The system has two degrees of freedom to provide rotation and tilt movement. In the beginning of project implementation, five designs had been made for consideration. All-purpose designs are being evaluated accordingly before selecting the best possible design being develop. The main body is being made using prototype machine using ABS as its main material. The system has the capability to operate in both automatic and manual mode. In automatic mode, the system acquires an image from the camera mounted in front of the turret system. The images are then being process in order to extract the coordinate information of the target. In manual mode, the system is being control by a human operator via a computer. The operator also has an options to control the system using an air mouse. The system also has the capability to be monitored using a custom phone application. All this extra features has definitely increased the control flexibility of the whole system. Necessary testing and evaluation has been carried out to ensure the system accuracy, repeatability and durability. CGTS has an opportunity to participate in a few engineering competitions. In Mini UTeMEX 2015, the project manage snatch silver medal while in IIDEX 2015, CGTS manage to snatch bronze. Even though CGTS was initially being made with military applications in mind, the system can also be marketed in other applications as well as security, research platform or even high tech toys for those thinker to play with. The deterrent agent can be customizes so suits applications it's intended to serve. A few suggestions of improvements also being made at the end of this report and hopefully the next version of this project will be more innovative and manage to get higher recognition in the future.

ABSTRAK

Tujuan pembinaan projek ini adalah untuk pembangunan dan rekabentuk untuk sentri kamera yang dibimbing kamera. Projek ini membincangkan khususnya dalam rekabentuk mekanikal dan menjejaki gambar. Sistem sentri ini memunyai dua arah gerakan iaitu berpusing dan memutar. Selalunya pegerakan manusia di kesan mengunakan inframerah sensor. Gambar yang ditangkap oleh kamera di proses untuk menjejaki pergerakan seseorang manusia. Projek ini juga merangkumi pergerakan condong dan sisi pada paksi, seterusnya menjadikan projeck ini fleksibel. Sistem ini mampu beroperasi dalam dua keaadan iaitu paduan automasi dan pegerakan manual. Dalam pergerakan automasi, sistem ini beroperasi mengunakan kamera untuk menagkap gambar pergerakan. Manakala dalam sistem pergerakan tanpa automasi, pergerakan ini deiselia oleh manusia dengan menggunkan tetikus asngin. Sistem ini juga mampu diawasi mengunakan aplikasi khas dari telefon bimbit.. Lima rekabentuk diusulkan di dalam projek ini untuk dinilai dan dianalisa. Di dalam projek ini juga turut dijalankan beberapa siri analisa. Antara analisa yang dijalankan adalah analisa pegerakan dan analisa rekabentuk. Analisa ini dijalankan bertujuan untuk memastikan rekabentuk yang dibina adalah yang terbaik. Sistem ini juga berpeluang memasuki beberapa pertandingan teknologi lalu berluang mendapat pingan perak di Mini UTeMEX 2015 dan memperoleh gangsa di IIDEX 2015. Walaupun pada mulanya system ini dibuat untuk ketenteraan, walaubagaimanapun system ini juga mampu dipasarkan untuk tujuan keselamatan, paltfom untuk penyelidikan dan mainana berteknologi tinggi. Beberapa cadangan juga telah dibuat diakhir laporan dengan harapan versi seterusnya mampu mendapat penganugerahan yang lebih baik di masa hadapan.

DEDICATION

Specially dedicated to my beloved mother, Hasfah Binti Md Yussof, my brother Muhammad Zammin Alif Bin Zulkifli, my supervisor, En Mahasan bin Mat Ali, and all my friends who have encouraged, guided, and inspired me throughout the study process.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

CGTS	-	Camera Guided Turret System
CPU	-	Central Processing Unit
DC	-	Direct Current
FKP	-	Fakulti Kejuruteraan Pembuatan
FYP	-	Final Year Project
LED	-	Light Emitted Diode
PC	-	Personal Computer
RGB	-	Red Green Blue
HSV	-	Hue, saturation and value
CAD	-	Computer aided design
USB	-	Universal Serial Bus
PWM	-	Pulse with modulation
RAM	-	Random access memory
IDE	-	Integrated development environment
GPIO	-	General purpose input/output
I/O	-	Input/Output
UART	-	Universal asynchronous receiver/transmitter
SPI	-	Serial peripheral interface
ADC	-	Analog digital converter
CCD	-	Charge couple device
CMOS	-	Complementary metal oxide semiconductor
ABS	-	Acrylonitrile butadiene styrene

CHAPTER 1

INTRODUCTION

This section tells the reader about turret and it applications. The applications also explains issue that arise in development of the turret as a motivation to run this project. The important point in this chapter is objective of the project, where developer need to plan and manage this project to achieve the target.

1.1 Background

Turret is a structure whereby projectile firing weapon mounted on it. Primarily it move in two axis which are axis X wherever it's rotate and axis Z wherever it's atilt. A turret may be a weapon mount that protects the mechanism of a projectile-firing weapon and at a similar time lets the weapon be aimed and discharged in several directions. The turret is additionally a rotating weapon platform. According to (Sharp, M., & Williams, 2011)**.** This platform is mounted on a fortified building or structure like an anti-naval land battery, or on a combat vehicle, a military service ship, or a military craft. Turrets could also be armed with one or a lot of machine guns, cannons, huge-caliber guns, or missile launchers. It's going to be manned or remotely controlled, and is usually armored. For automatic turret, it aimed and discharged at targets that area unit detected by sensors. The earliest functioning military sentry guns were the close-in weapon systems point-defense weapons for police work and destroying short vary incoming missiles and enemy craft 1st used solely on military service assets, and currently additionally as land-based defenses.

While the idea of an autonomous turret isn't new, nothing has been antecedently developed to be used on this scale. According to (Raytheon, Z.A, 2014), the sole similar system is that the Phalanx Close-In weapon, made by Raytheon. Figure 1.1 show the Phalanx turret mount on the naval ship yard. This method is employed on massive military service vessels as a defense against missile threats. It verify motion and tracks incoming missiles employing a high-powered radio detection and ranging system and so engages these targets with its integral cannon. This method weighs fourteen, 500 lbs, attracts 70kW of power, and price many million ringgit. The Phalanx is incapable of the sort of operation that the system is meant for.

Figure 1.1: Phalanx turret (Downson, 2011)

1.2 Problem statement

In normal practice, human operator are required to stay on full alert during sentry operation. Fatigue and loss of concentration are two main enemy of human operator. Due to that an autonomous system capable of performing the same task is required. Current sentry platform normally too rigid and not flexible to change. This will limit the type of deterrent agent can be mounted on the platform. The software used to control the system also does not provide enough flexibility in the age of internet of things we are living in right now.

1.3 Objective

The purpose of this project is to develop a viable proof-of-concept prototype of the Camera Guided Sentry Turret System

1.4 Scope

The scope of this project had been categorized as listed below

I. To develop two axis motion platform
II. To develop image motion tracking system and firing system
III. To develop manual and wireless control

CHAPTER 2

LITERATURE REVIEW

This section basically explains about the ideas in designing a turret mechanism based on existence parts and components. This study focused on designing and analyses hardware of camera guided turret system mechanism.

2.1 Overview

To design and develop this project, research on sentry gun equipment such as camera equipment for image processing, driver motor servo, microcontroller, battery pack and programing software has been carried out. Throughout using resource such as internet, books, IEEE articles, journal and other sources has been conduct to extract information for literature review research. For the early research were focus on the understanding how this project can be archive.

2.2 The study and research of microcontroller

Selecting the proper microcontroller for a product may be according the specify task. Based on Table 2.0 the listed microtroller which is arduino, raspberry pie and beagle being analyze for advantage and disadvantages. The desired microtroller can determine by the look a list of required hardware interfaces (Augarten, Stan, 2012). Using the overall hardware diagram, select an inventory of all the external interfaces that the microcontroller can supportThese two interface sorts can estimate the quantity of pins that may be needed by the microcontroller. Figure 2.1 shows a generic example of a diagram with the I/O and hardware listed.

Table 2.1: List of microcontroller

Name	**Arduino** 	**Raspberry Pi** 	**Beagle Bone** 
Model	R3	B+	REV A5
Price	RM 60	RM75	RM98
Size	2.95”x2.1”	3.37”x2.2”	3.4”x2.1”
Processor	ATMega 328	ARM11	ARM Cortex –A8
Clock Speed	16MHz	700Mhz	700MHz
RAM	2KB	256MB	256MB
Input Voltage	7-12V	5V	5V
Min Power	42mA	700mA	170mA
Digital GPIO	14	8	66
Analog Input	6 10-bit	N/A	7 12-bit
Dev IDE	Arduino Tool	Squeck/Linux	Python, Scratch, Linux
USB Master	N/A	2 USB 2.0	1 USB 2.0

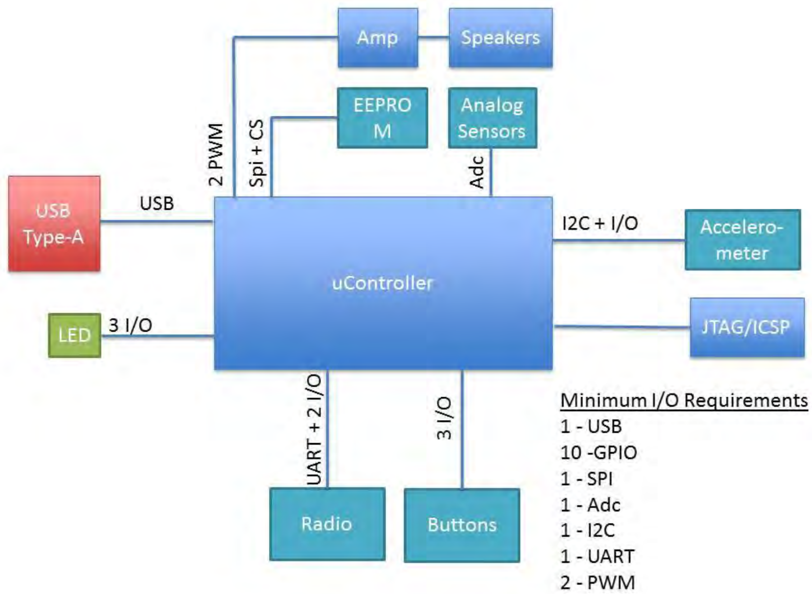

Figure 2.1: List of Hardware Features

The microcontroller were examine by looking at software architecture. The package design and needs will greatly have an effect on the choice of a microcontroller. However the process needs can verify whether or not with eighty mhz or associate eight mhz 8051. For instance any of the algorithms need floating purpose mathematics. High frequency management loops or sensors (Jan Axelson, 2011). Estimate how long typically every task can run. Verify process power are going to be required. The number of computing power needed are going to be one in every of the most important needs for the design and frequency of the microcontroller (Jan Axelson, 2011). The next thing to do is to examine costs and power constraints. If the device are going to be charged from battery and mobile, then the low-power is totally unwarrantable. This can look at the piece of microcontroller worth of the processor. Investigate the compilers and tools. The selection of the kit may also determine the selection of microcontroller. Most microcontrollers have variety of selections for compilers, example code and debugging tools (Jan Axelson,, 2011). It's necessary to know that each one the required tools unit are available. Because the incorrect tools and method might become tedious and costly

2.3 The study of DC electric motor

DC electric motor capable of generate a mechanical movement. This motor typically converting energy. Based on Figure 2.2 motor were supply with electrical energy and produced mechanical energy (R. Valentine, 2010). Generally DC electric motor used to power variety of devices everyday. It comes in different specification of capability. DC motor operate by direct current.

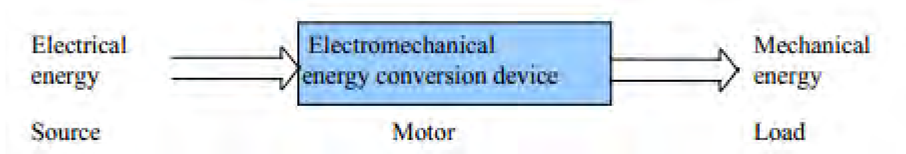

Figure 2.2: Electric motor power conversion (R.Velentine, 1998)

The principle of electric motor movement are coil in the magnetic field as shown in Figure 2.3. The current flows when both end coil connected across DC voltage source when the coil interact it produced the force between interaction of magnetic field and electric current (R. Valentine, 2010).

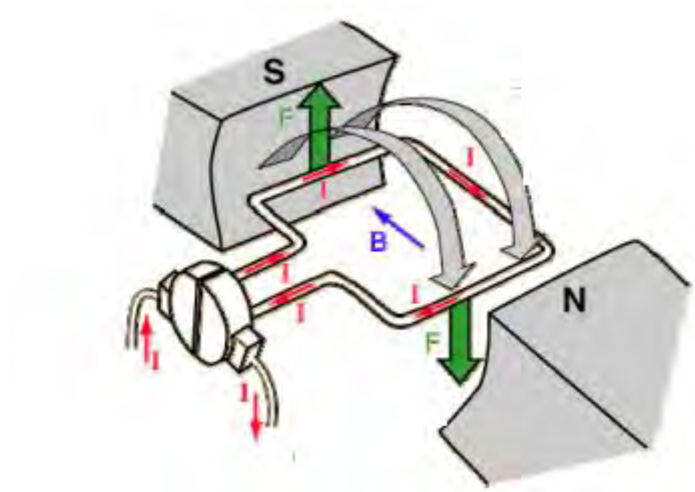

Figure 2.3: Torque production in a DC motor (R.Velentine, 1998)

According to Lenz's law counter-voltage tends to oppose the very cause due to the current. The force created by the magnetic field (F = Bil) equals the load force acting on the shaft. Constant velocity moves the system.

2.3.1: Servo motor

A servo system, or servo, is an automatic device that uses error sensing negative feedback to correct the performance of a mechanism. The term is properly applied solely to systems wherever the feedback or error correction signal helps to regulate a selected parameter of the mechanism. Attributable to their helpful operate, servo mechanisms were used long time ago, the Greek were the one who explore to use of servo. They have used by adjusting the heading of the windmill (Edward L. Owen, 2010)**.** In 1868 Farcot in his work on hydraulic steam engines for ship steering used the term "Le-Servomoteur" for the primary time. a number of years later H. Calendar developed his initial electro servo mechanism and in 1911 Henry state capital outlined the term "servo-motor" in his technology wordbook (Liu Yu-Cheng, Zhou Yajun. 2011).

Servo motor are system consists of part categorized into mechanical and electrical, diverse parts are integrated on to perform the utilization of the servomotor**.** Figure 2.4 bellow shows a typical model of a servomotor system

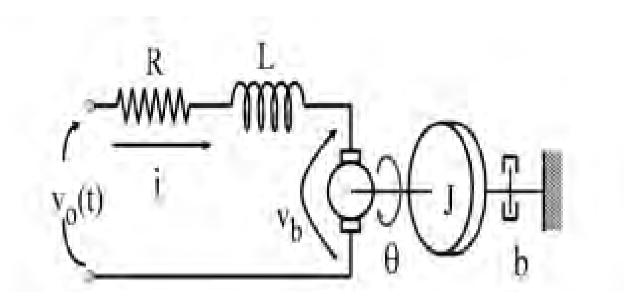

Figure 2.4 Servo Motor Winding Diagram (R.Velentine, 1998)

It’s clear that the servomotor has two main parts, the first is that the electrical component; it consists of resistance, inductance, input voltage and so the back electrical phenomenon. The second a part of the servomotor is that the mechanical half, from that it have a tendency to tend to urge the useful mechanical motion movement at the shaft. The mechanical parts are the motor’s shaft, inertia of the motor and inertia and damping. Refers to the position of the output shaft which could be used later to find out the angular speed of the shaft. DC Servomotors have good torsion and speed characteristics; and power is required to be controlled by variability the voltage signal link to the (I/O Liu Yu-Cheng, Zhou Yajun. 2011). These characteristics ready to produce powerful actuators used to move and rotate.

DC Servo motors are DC motors that are changed to figure employing a closed-loop system management system during which the shaft position or angular velocity are the control part. Either digital or analog controller will be accustomed direct the operation of the servo motor by causing position or velocity program signals to the electronic part that drives the motor **(**Hawkins,Audel. 2012). Figure 2.5 show the structure of servo that have a feedback function. An integral feedback device (resolver) or devices (encoder or tachometer) are either incorporated within the servo motor or are remotely mounted, usually on the load itself. These devices provide the servo motor’s position and rate feedback to the controller, that successively twenty two use these information to check them with a programmed motion profile and use them to alter the speed signal.

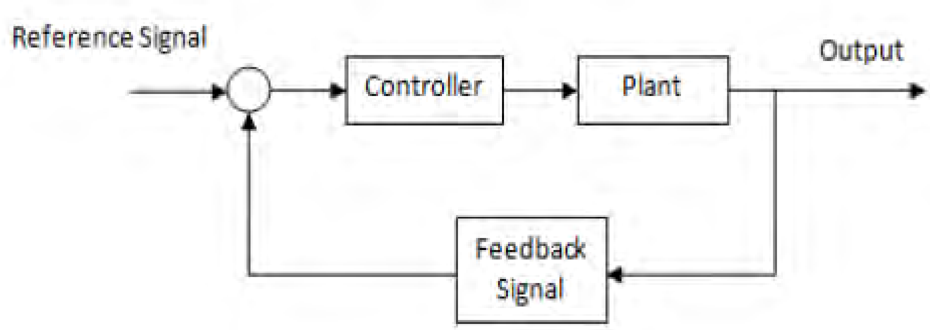

Figure 2.5: Servo mechanism basic structure (XU Yanping, 2002)

Basically the power apply to the servo motor are proportional to the distance motor travel (Hawkins,Audel. 2012). The larger shaft distance turn, the faster motor run with speed. When the speed turn in small distance, the speed of motor is slower. To communicate servo with turn, wire is used to control the angle. The pulse duration that are applied to the wire will determine the servo angle based on Figure 2.6. Normally the pulse of servo expected in every 20 milliseconds. The motor turn based on how the length on of the pulse applied. 90 degree position or also known as neutral position will turn in 1.5 millisecond. The motor turn back to 0 degree when pulse applied is shorter than 1.5 ms. If more than 1.5ms the motor turn of degree with closer to 180 degree.

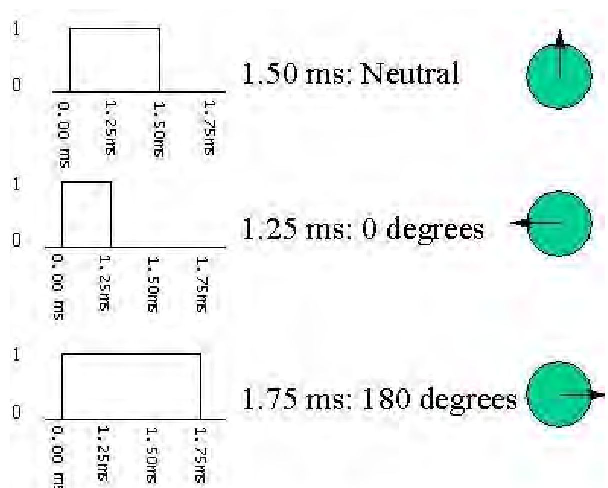

Figure 2.6: Pulse dictates the angle of the output shaft (XU Yanping, 2002)

The phase terminal with bidirectional DC servo motors can be used for mechanical direction control (Liu Yong-Piao, Zhong Yan-ru, Xu Yanping, 2012). The mode of operation will determined current has to be generated. On the circuit shown the control servo used pin RB1 from microcontroller PIC16F628A. This microcontroller operates at 4.0 MHz using external ceramic resonator. Servo arm connected to RB0 for a connected tact switch. This connection allow user to input control of position.

2.3.2 Stepper Motor

There are a number of components used in order to build this stepper motor. In order to understand the functioning of this equipment different components that are used to build up this equipment. Stepper motors are viewed as the electric motors without commutators. Commutator is a rotary electrical switch in certain types of electric motors or electric generators that periodically reverses the current direction between the rotor and the external circuit. A commutator is a common feature of direct current rotating machines (Harley H.M. 2009)**.** Figure 2.7 show the main component used in the stepper motor. In a motor all the winding are part of starter. The rotor is a permanent magnet or a tooth block of some magnetically soft material. The motor controller should handle all the commutation extremely. Audio frequencies are used to step most of the stepper motors. In such cases they spin quickly. They can be stopped and started at controlled orientations. Stepper motors are used in simple open loop control systems, suitable for the systems operating allow accelerations with static loads. A stepper over-torqued in an open loop system will result in losing all knowledge of rotor position and a re-initialization of system is required.

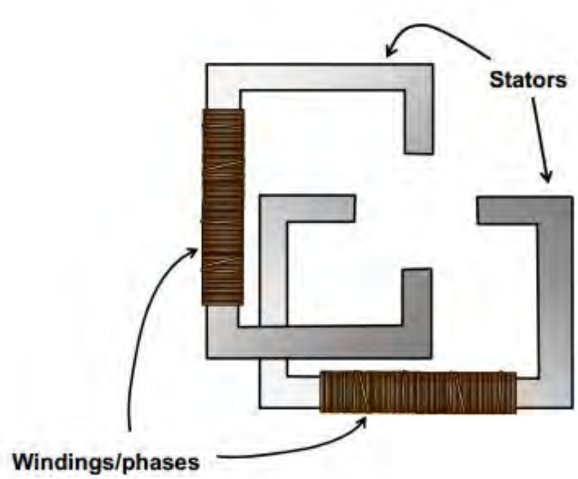

Figure 2.7: Stepper motor main component (Audel, 2005)