REFURBISHMENT AND UPGRADING THE DIFFERENT TYPES OF MOTOR USING RASPBERRY PI

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DECLARATION

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ABBREVIATION

AC	Alternating Current
DC	Direct Current
EDM	Electrical Discharge Machine
SCARA	Selective Compliance Assembly Robot Arm
UK	United Kingdom
IDLE	Integrated Development and Learning Environment
REPL	Real, Eval, Print, Loop
GUI	Graphical User Interface
2D	Two Dimension
UART	Universal Asynchronous Receiver/Transmitter
SPI	Serial Peripheral Interface
I2C	Inter-Integrated Circuit
GPIO	General Purpose Input/Output
PC	Personal Computer
OS	Operating System
RAM	Random Access Memory
BLDC	Brushless Direct Current
LED	Light Emitting Diode
IC	Integrated Circuit
CPU	Central Processing Unit
PWM	Pulse Width Modulation
CW	Clockwise
CCW	Counter-clockwise

ABSTRAK

Projek ini adalah untuk menaiktaraf beberapa jenis motor menggunakan Raspberry Pi. Motor yang digunakan terdiri daripada DC servo motor EDM mesin, AC servo Denso robot, AC servo motor OTIS-LG dan DC motor. Jenis arus yang digunakan oleh kesemua motor ini adalah arus terus (DC) dan arus ulang-alik (AC). Di Pusat Pengajian Kejuruteraan Mekanikal USM, terdapat satu EDM mesin (Mitsubishi EDM model M35J 1993) yang telah rosak dan masalah yang dikenalpasti adalah Z-axis tidak boleh berfungsi dengan baik. Walaupun mesin telah rosak tetapi bahagian-bahagian mekanikal sistem mesin boleh digunakan untuk menaik taraf keadaan sistem motor tersebut. Tetapi, setelah kajian dibuat mesin ini tidak boleh dinaik taraf sama sekali kerana kesemua bahagian litarnya telah terputus dan mesin ini tidak mempunyai manual yang lengkap. Seterusnya, kajian diteruskan menggunakan Denso robot arm tetapi tidak dapat diteruskan kerana mempunyai masalah yang sama iaitu tidak mempunyai manual penggunaan sistem motor yang lengkap. Kemudian, kajian diteruskan menggunakan OTIS-LG servo drive FDA 5000C Series dengan menggunakan bahagian motor dan pemandu. Terdapat beberapa modifikasi dilakukan pada bahagian pemandu mengikut kesesuaian eksperimen yang dijalankan untuk menggerakkan motor. Modifikasi pada litar juga dilakukan untuk menggerakkan motor dengan mengawal arah dan kelajuan putaran. Satu program Raspberry Pi digunakan dalam kajian ini. Setelah eksperimen dilakukan, pemandu yang diubahsuai tidak dapat menggerakkan motor mengikut arah dan kelajuan yang ditetapkan. Seterusnya, kajian digantikan dengan menggunakan DC motor. Satu program Raspberry Pi juga digunakan dalam kajian ini untuk mengawal arah dan kelajuan putaran. DC motor akan mengeluarkan nadi pada setiap putaran dan setiap nadi yang dikeluarkan akan dikira.

ABSTRACT

This project is to upgrade some type of motor to use Raspberry Pi. Some motors used are EDM machine DC servo motor, AC servo Denso robot, AC servo drive OTIS-LG and DC motor. Type of current used by the motor is a direct current (DC) and alternating current (AC). At School of Mechanical Engineering USM, there is an EDM machine (EDM Mitsubishi model M35J 1993) that have been damaged and the problem identified is the Z-axis cannot function properly. Although the machine was damaged but some of the mechanical parts of the machine can be used to upgrade the situation. But, after an observation is made, this machine cannot be upgraded because all the circuit has been disconnected and the machine does not have a complete manual. Next, the study continued using Denso robot arm but could not proceed because it has the same problem that does not have full use of the manual. Then, the study continued using OTIS-LG FDA 5000C Series servo drive with the main part are motor and driver. There are some modifications carried out on the driver's that suit the experiment conducted to drive the motor. Modifications were also made to the circuit to drive the motor by controlling the direction and speed of rotation. The Raspberry Pi program used in this study. After the experiments carried out, a modified driver cannot move to the intended direction and the speed of the motor cannot be controlled. Next, the research was replaced by a DC motor. The Raspberry Pi program is used in this study to control the direction and speed of rotation. DC motor will produce a pulse on each round and each pulse issued will be calculated.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The motor or an electrical motor is a device that has brought about one of the biggest advancements in the fields of engineering and technology ever since the invention of electricity. A motor is nothing without an electro-mechanical device that converts electrical energy to mechanical energy. There are different types of motor have been developed for different specific purposes that produces rotational force. The very basic principal of functioning of an electrical motor lies on the fact that force is experienced in the direction perpendicular to magnetic field and the current, when field and current are made to interact with each other (Billd, 2016). The primary classification of motor or types of motor can be figured as shown below,

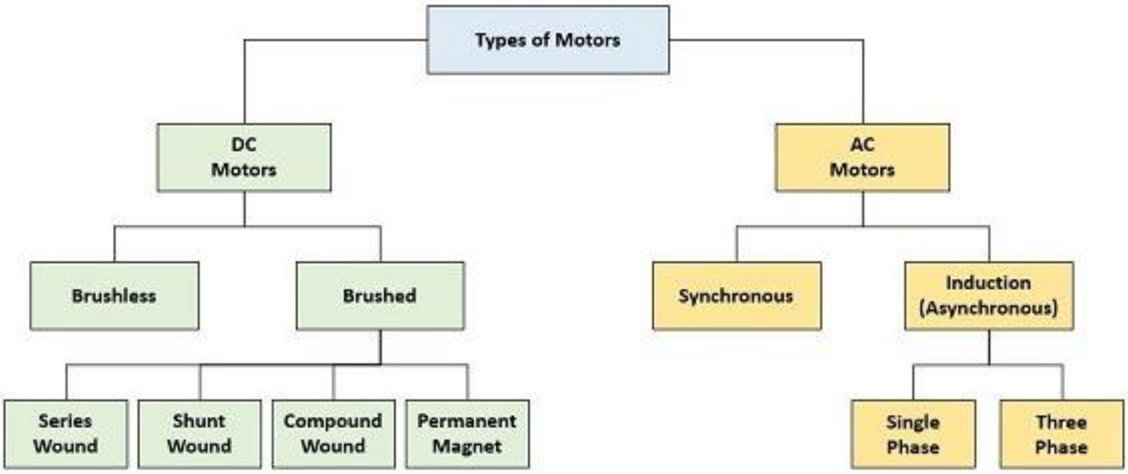


Figure 1.1 Types of Motors

AC motor is an electric motor driven by an alternating current and highly flexible in many features including speed control. Some of the key advantages are low power demand on start, controlled acceleration, adjustable operational speed, controlled starting current, adjustable torque limit and reduced power line disturbances. Types of AC motor include synchronous that the rotation of the rotor is synchronized with the frequency of the supply current and the speed remains constant under varying loads, so is ideal for driving equipment at a constant speed and are used in high precision positioning devices like robots, instrumentation, machines and process control. Induction (asynchronous) uses electromagnetic induction from the magnetic field of the stator winding to produce an electric current in the rotor and hence torque. These are the most common type of AC motor and important in industry due to their load capacity with single-phase induction motors being used mainly for smaller loads, like used in household appliances whereas three-phase induction motors are used more in industrial applications including compressors, pumps, conveyor systems and lifting gear.

DC motors were the first type of motor widely used and the systems (motors and drive) initial costs tend to be typically less than AC systems for low power units, but with higher power the overall maintenance costs increase and would need to be taken into consideration. The DC motors speed can be controlled by varying the supply voltage and are available in a wide range of voltages, however the most popular type are 12 and 24V, with some of the advantages being easy installation, speed control over a wide range, high starting torque and linear speed-torque curve. Brushed motor are typically used in cost-sensitive applications, where the control system is relatively simple, such as in consumer applications and more basic industrial equipment, these type of motors can be broken down as series motor, shunt motor, compound motor and permanent magnet. Brushless motors alleviate some of the issues associated with the more common brushed motors that has short life span for high use applications (Kenneth Sleigh, 2011).

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It is typically paired with some type of encoder to provide positioning and speed feedback and some error correcting device which actuates the supply signal. A servo drive is a special electronic amplifier used to power electric servomechanisms. A servo drive monitors the feedback signal from the servomechanism and continually adjusts for deviation from expected behaviour. There are mainly two types of servomotors that are AC servomotor and DC servomotor. AC servomotors are generally preferred for low-power use and for high-power use DC servomotors are preferred because they operate more efficiently than comparable to AC servomotors (Lin Yao and Zhong Chong Quan, 2015).

1.2 Problem Statement

Industrial application used motors because the speed-torque relationship can be varied with the direction of rotation. The motors must be operate in perfect condition to avoid non-smoothly movement. Some motor also need to use any addition controller to control the performance of rotation. By using Raspberry Pi, the condition of motors such as rotation and speed can be control. So, the motors can operate in stable condition and the motion of motors can run very smoothly.

1.3 Research Objectives

The objectives of this project are as follows:

- To design a circuit to control the direction and speed of the motor.
- To build programming coding in Python in order to drive the circuit using Raspberry Pi.

1.4 Project Scope

The scopes of work for this project are as follows. First, identify the requirement and significance of the research. Second, study the manual operation of the motors that involved. Then, study about the Raspberry Pi microcontroller and Python language. Next, design a circuit to control the direction and speed of the motor. Lastly, build programming coding in Python in order to drive the circuit using Raspberry Pi.

1.5 Thesis Outline

This thesis consist of five chapters. The first chapter is the introduction to the project. All the introductory part such as problem statement (Section 1.2), research objectives (Section 1.3) and project scope (Section 1.4) are explained.

In the second chapter, the literature review, term that related to the topic in this project are explained. The term such as types of motor used, operation of the motors and Raspberry Pi microcontroller is mentioned in Section 2.2 until Section 2.9. Some of existing works by researchers and students are addressed in Section 2.10.

Methodology is in third chapter. In this chapter, the introduction and project methodology flow explained in Section 3.1 and Section 3.2. The required hardware and software component for this project is explained in Section 3.3 until Section 3.6.

The result and discussion are explained in the fourth chapter. The final chapter of this thesis is the conclusion where a brief summary of this project on the objective and successfulness of this project is discussed. The limitations of the system made in this project are mentioned in Section 5.2. Some ideas of future work that may help to improve this project are described in Section 5.3.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

In this chapter, terms that related to the topic in this project are explained. The term such as types of the motor used, operation of the motors and Raspberry Pi micro-controller is mentioned in Section 2.2 until Section 2.9. Some of existing works by researchers and students are addressed in Section 2.10.

2.2 Mitsubishi EDM Machine Model M35J

Mitsubishi EDM's represent the ultimate in their field and provide a full range of functions and capabilities for the next generation of machining facilities. Mitsubishi power-supply waveform slope-control (patented worldwide) offers machining with ultra-low electrode wear and high-precision, high-rigidity mechanisms to make operation easy. A wide range of functions respond in full measure to the need for automation and unattended operation (Henry G. Dash, 2000).

Figure 2.1 Mitsubishi EDM Machine Model M35J

2.3 Die-sinking EDM machine

Die-sinking or sinker EDM have of an electrode and workpiece submerged in an insulating liquid or dielectric fluids. The electrode and workpiece are connected to a suitable power generator. The power generator generates an electrical potential between the two parts. When the electrode near the workpiece, dielectric breakdown occurs in the fluid produced a plasma channel and a small spark jumps.

When the current is switched on, an electric tension is produced between the two metal parts. If the two parts are carried together to within a fraction of an inch, the electrical tension is discharged and a spark jumps across. Where it attacks, the metal is heated up so that it melts. These sparks usually strike one at a time because different locations in the inter-electrode space have the different electrical characteristics which would enable a spark to occur simultaneously in all such places. These sparks happen in huge numbers at seemingly random places between the electrode and the workpiece. As the base metal is eroded and the spark gap subsequently increased, the electrode is lowered automatically by the machine so that the process can continue without any disturbances (F. Scalari & Vignale, 1982).

The EDM consists of following major parts that are dielectric fluid, power supply, movable electrode, working tank with work holding device, x-y table accommodating the working table, the tool holder and the servo system to feed the tool. Dielectric reservoirs and pump are used to circulate the EDM oil for every run of the system and also used to filter the EDM oil. The power supply control the amount of energy consumed. First, it has a time control function which controls the length of time that current flows during each pulse called “on time.” Then it is control the amount of current allowed to flow during each pulse. These pulses are of very short duration and are measured in microseconds. There is a handy rule of thumb to determine the amount of current a particular size of electrode should use for an efficient removal rate. Conversely, too heavy a current load can damage the workpiece of electrode. The control unit is control the all function of the machining for duty cycle, putting the values and maintain the workpiece of the tool gap.

All the EDM oil kept in the working tank is used to the supply the fluid during the process of machining. x-y table accommodating the working table are used to the move of the workpiece from X and Y direction. The tool holder hold the tool with the process of machining. The servo control unit is provided to maintain the pre-determined gap. It senses the gap voltage and compares it with the present value and the different in voltage is then used to control the movement of servo motor to adjust the gap (Koji Akamatsu & Atsushi Taneda, 1997).

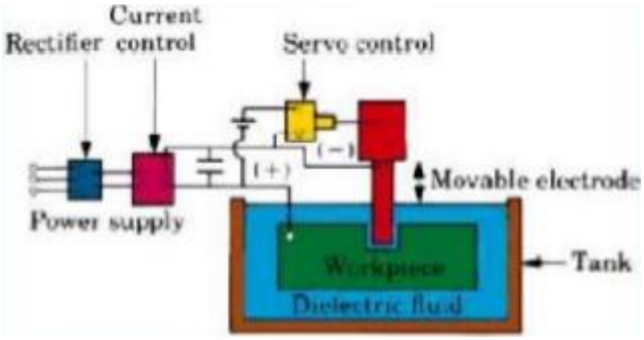


Figure 2.2 Basic Element in EDM Die Sinker

2.4 Denso Robot Arm

The most common manufacturing robot is the robotic arm. A typical robotic arm is made up of seven metal segments, joined by six joints. The computer controls the robot by rotating individual step motors connected to each joint (some larger arms use hydraulics or pneumatics). An industrial robot with six joints closely resembles a human arm. It has the equivalent of a shoulder, an elbow and a wrist. Typically, the shoulder is mounted to a stationary base structure rather than to a movable body. This type of robot has six degrees of freedom, meaning it can pivot in six different ways. The robotic arm's job is to move an end effector from place to place. For Denso Robot Arm, there have four-axis robot arms, SCARA and 4-axis articulated arm robots.

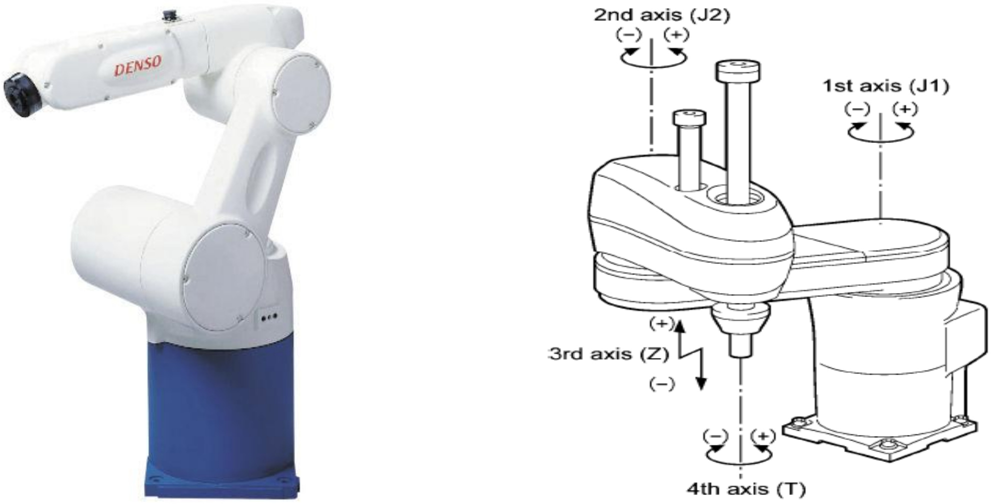
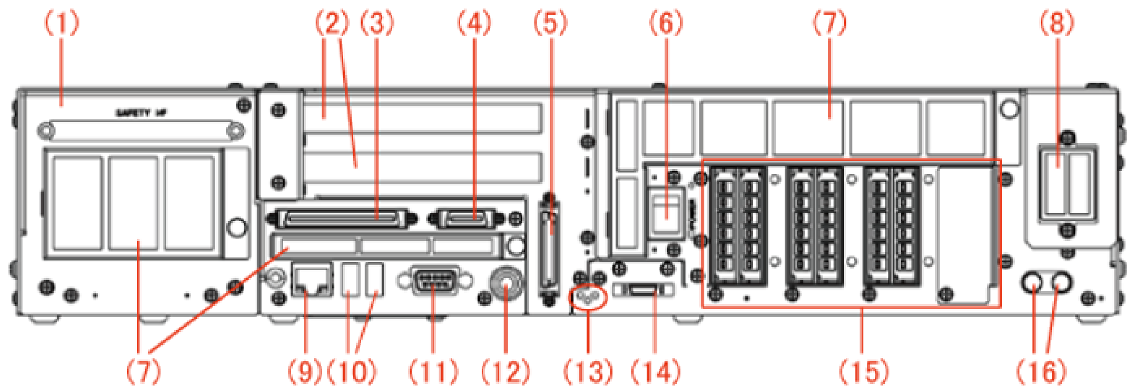


Figure 2.3 The 4-axis Denso Robot Arm

2.5 RC3-V6A Controller

This controller is used as the driver to move the axis of the Denso robot arm. The controller is the "brain" of the industrial robotic arm and allows the parts of the robot to operate together. It works as a computer and allows the robot to also be connected to other systems. The robotic arm controller runs a set of instructions written in code called a program. The program is inputted with a teach pendant. Many of today's industrial robot arms use an interface that resembles or is built on the Windows operating system.



Number	Label	Name	Purpose
1	-	Safety I/O	
2	-	Expansion board slot (2 slots)	Install expansion board. PCI board is installed to upper slot and PCI Express board to lower slot.
3	MINI I/O	Mini I/O user, system connector	
4	HAND I/O	Hand I/O connector	
5	PENDANT	Pendant connector	Install teach pendant and mini-pendant.
6	POWER	Power switch	Used for power ON and OFF of controller.
7	-	Intake filter	Prevent invasion of dust to inside controller. 3 locations.
8	INPUT AC	Power connector	Connect power cable.
9	LAN	Ethernet connector	Use for communication with outside device through Ethernet circuit.
10	USB	USB connector (2 lines)	Connect with USB memories or USB devices.
11	RS-232C	Serial communication connector	Use for serial communication with outside devices.
12	VGA	VGA connector	Use for output images.
13	P (POWER) R (RUN) E (ERR)	Status display LEDs	
14	ENC	Encoder connector	Connect encoder cable.
15	SLOT1, SLOT2, SLOT3, SLOT4	Motor connector	Connect motor cable.
16	⏚	Earth terminal (protective earth)	Protect from electric shock.

Figure 2.4 Hardware Overview of Controller

2.6 OTIS-LG Ac Servo Motor Drive

A servo drive is a special electronic amplifier used to power electric servomechanisms. A servo drive monitors the feedback signal from the servomechanism and continually adjusts for deviation from expected behaviour. A servo drive receives a command signal from a control system, amplifies the signal and transmits electric current to a servo motor in order to produce motion proportional to the command signal. Typically, the command signal represents a desired velocity, but can also represent a desired torque or position. The servo drive then compares the actual motor status with the commanded motor status. It then alters the voltage frequency or pulse width to the motor so as to correct for any deviation from the commanded status (Rana M Shakeel, 2004).

Figure 2.5 The OTIS-LG Driver

Figure 2.6 The OTIS-LG Servo Motor

2.7 Brushless DC Motor

The brushless DC motor is the ideal choice for applications that require high reliability, high efficiency and high power-to-volume ratio. The motor is considered to be a high performance motor that is capable of providing large amounts of torque over a vast speed range. The motors are a derivative of the most commonly used DC motor, the brushed DC motor, and they share the same torque and speed performance curve characteristics.

Commutation is the act of changing the motor phase currents at the appropriate times to produce rotational torque. In a brush DC motor, the motor assembly contains a physical commutator which is moved by means of actual brushes in order to move the rotor. With a brushless DC motor, electrical current powers a permanent magnet that causes the motor to move, so no physical commutator is necessary (Jian Zhao, Yangwei Yu, July 2011).

Figure 2.7 Brushless DC Motor

2.8 Raspberry Pi Microcontroller

Raspberry Pi is a credit card sized single board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science. The Raspberry Pi Foundation is a registered educational charity based in the UK. Foundation’s goal is to advance the education of adults and children particularly in the field of computers, computer science and related subjects. Raspberry Pi is powerful enough to process many of the same programs as PCs, from word processors to games. It small size makes Raspberry Pi ideal for programming connected home device.

The language to read the Raspberry Pi microcontroller is Python language. The Python programming language actually started as a scripting language for Linux. Python programs are similar to shell scripts in the files contain a series of commands that the computer executes from top to bottom. Python is a very useful and versatile high level programming language with easy to read syntax that allows programmers to use fewer lines of code than would be possible in languages such as assembly, C or Java.

Python programs do not need to be compiled before running them. However, the Python interpreter need to be install on the computer to run them. The interpreter is the program that reads the Python file and executes the code. There are program like Py2exe or Pyinstaller that can package Python code into standalone executable programs. Like shell scripts, Python can automate tasks like batch renaming and moving large amounts of files. Using IDLE, Python’s REPL (read, eval, print, loop) function can be used just like a command line. Programmers use Python to create things like web applications, desktop applications and utilities, special GUI (graphical user interface), small databases and 2D games (Basavaraj Sagar, 2014).

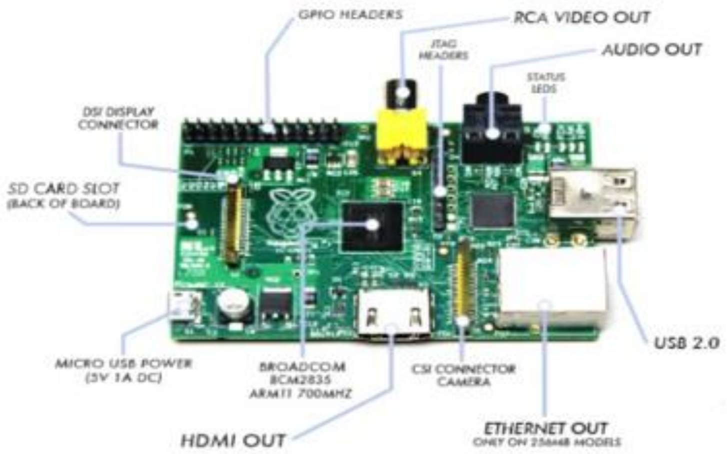


Figure 2.8 Basic Element of Raspberry Pi

2.9 Raspberry Pi Pin

The Raspberry Pi 3 Model B is used and the hardware interfaces for the Raspberry Pi is exposed through the 40-pin header on the board. The functionality includes 24 GPIO pins, one serial UARTs, two SPI bus, one I2C bus, two 5V power pins, two 3.3V power pins and eight ground pins.

Pin Description	Function
GPIO (General Purpose Input / Output)	Standard pins that can be used to turn devices on and off.
UART (Universal Asynchronous Receiver / Transmitter)	Serial pins that are used to communicate with other devices.
SPI (Serial Peripheral Interface Bus)	Pins that allow to connect and talk to hardware modules that support SPI protocol.
I^2C (Inter-Integrated Circuit)	Pins that allow to connect and talk to hardware modules that support I^2C protocol.
Power	These pull power directly from the Raspberry Pi 3.
Ground	Pins used to ground the devices.

Table 2.1 Raspberry Pi Pin Description

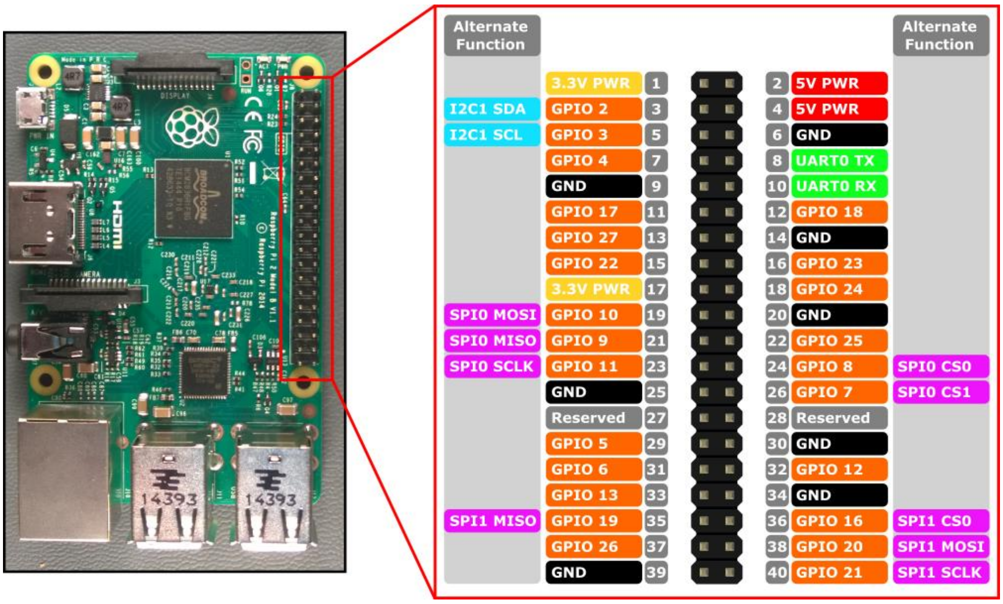


Figure 2.9 Raspberry Pi Pin Arrangement

2.10 Existing Work

2.10.1 Electrical Discharge Machine (EDM)

1) Digital Control of an Electro Discharge Machining (EDM) System

This work is done by Azli Yahya from Loughborough University as his PhD project (Azli 2005). The research presented in this thesis proposes a model of the complete Electro Discharge Machining (EDM) system and the design and implementation of a digital controller for the servomotor control and the gap voltage and current pulse power generator. The complete EDM system model consists of two sub models, namely an EDM process model and the servo system model. The EDM process model was developed using a dimensional analysis technique and the servo system model was developed using the differential equations of Newton's and Kirchhoff's laws. The complete EDM system model was used in a Matlab or Simulink simulation to investigate the EDM system model behaviour. The results of the simulation were used to aid in the design of the compensated EDM control system. The design and development of the digital EDM control system were performed mainly in software with minimal hardware. The control software was designed using the structure programming methodology that combines a flowchart and program structure diagrams for clear description of program code.

2) Controlling DC Motors Using Python with a Raspberry Pi

This work is done by Jason Barnett as his assignment project (Jason 2014). The research is about to safely connect one or two motors to the Raspberry Pi with as few components as possible. Once the electronics are put together on the breadboard, it is easily to control the components using Python to make the motor spin and then some control is added to change the motor direction backwards. It will require a careful eye to catch any mistakes and a bit of courage especially when connected to the GPIO connectors. It may cause any damage to the Raspberry Pi and the components.

3) Laboratory Scaled Die Sinking EDM

This work is done by Trias Andromeda in his research project (Trias 2016). In this research, a die sinking EDM with motor DC control as an actuator to maintain the electrode movement will be implemented. In this design, a rotary encoder will be used to detect the oscillation occurred along machining process. A microcomputer based controller will be use.

Firstly, the workpiece has been properly installed and fit into tank filled by dielectric fluid connected to the negative terminal of power generator. The electrode is inserted and tighten into the ram and connected to the positive terminal of power generator. By sliding down the ram and electrode close to the workpiece, the DC motor is installed and driven by motor controller. This motor is moving in counter clockwise to come close to workpiece and in clockwise to come away from workpiece. This motor is also equipped by encoder as additional feedback signal which is useful to show the real position of gap mechanically without any distortion due to the present of debris or dielectric fluid flow. Through this encoder sensor, it can be known the oscillation occurred during machining process.

Then, the output signal from encoder is useful to control the moving state of DC motor. DSP based microcontroller will handle this condition. It will decide whether limitation is needed or not. When the encoder gave an indication that the gap is bigger or smaller than the desired setting then the control driver of DC motor will be given instruction to stop the movement further whether in clockwise or counter clockwise. The maximum of deviation of the motor movement to the right or left, can be done through a human user interface settings.

In general, there are two modes of the EDM. Mode one is an EDM system without encoder. The control gap mechanism maintaining the gap only relies on Vg

(voltage drop between electrode and workpiece) as a feedback signal. The second mode, encoder equipped in DC motor as an additional feedback signal. As stated before, through this sensor, DSP based microcontroller can sense the deviation of DC motor movement (right or left). If the deviation is bigger than the setting value, DSP based microcontroller can force to bound the movement of DC motor. It means that the EDM can enhance the ability to keep the gap.

By using the proposed control mechanism, it is expected that the electrode will reach a certain position close to the workpiece in short time. This process will ensure discharge phenomena generated, EDM run smoothly and finally accelerate mass removal from the workpiece.

2.10.2 Denso Robot Arm

1) Pick and Place Robot (Robotic Arm)

This work is done by Khairul Afikh bin Roslan in his final year project (Afikh, 2009). This project is to design and develop a "Robotic Arm for Pick and Place Application" using PIC microcontroller. His project combines the knowledge of electronic and electrical. The objective of this project is to design and build a more compact, usable and cheaper pick and place robotic arm for educational purpose uses PIC microcontroller from Microchip Technology as the control system to control all the activities. Input devices such as Infrared sensors will send a signal to PIC, then PIC will make a response accordingly. The response normally involves turning on or off output signal to some of the devices such as servo motors and switches.

2) Real Time Image Processing based Robotic Arm Control Standalone System using Raspberry Pi

This work is done by P.Hemalatha, C.K.Hemantha Lakshmi and Dr. S.A.K.Jilani for their research project (Hemalatha, Hemantha and Jilani, 2015). This paper proposes real time image processing based robotic arm control standalone system using Raspberry pi. In the present era we made a robot capable of surveillance and also with an alternate application in detecting and following a pre specified object. The detection and recognition has been done using open CV library. The whole code for object detection written in MATLAB. This all processing has been done on Raspberry Pi which works on Raspbian OS based on Debian which is Linux OS to program the controlling of one arm robot using Raspberry Pi for the identification of objects and tracking object operations without any manual control. The total programming model is developed in MATLAB. Simulink support package for Raspberry Pi hardware. The program includes capturing the object image, processing, identifying the green object and controlling of robot arm by using Raspberry Pi.

2.10.3 OTIS-LG Ac Servo Motor Drive

1) Technology of Velocity Control for AC Servo Drive

This work is done by Lin Yao and Zhong Chong Quan in their research project (Yao and Zhong, 2015). In order to promote the response speed and anti- interference of the velocity loop in AC servo drive system a design for velocity loop of AC servo drive which has the velocity observer was proposed. Through modelling analysis, the closed velocity loop was divided into two parts which are the forward regulator and speed feedback controller. With the controllability and observability of the AC servo of state the method of velocity observer was used for the speed feedback controller design. Experimental results show that the proposed design method not only solves the problem that the anti-windup is hard to achieve for the conventional PI controller, but also weaken the influence on the accuracy of velocity control, caused by the speed detection method when the motor work at low speed. The design also extends the velocity regulating range, quickens dynamic responding time and enhances the controlling precision and robustness.

2) Speed Control of an Induction Motor using Raspberry Pi

The project is done by P. M. Palpankar, Shraddha Waghmare and B. Shikkewal for their research project (Palpankar,Shraddha and Shikkewal, 2015). The main objective of this project is to control the speed of induction motor at lower cost and efficient performance. The induction motor speed variation can be easily achieved for a short range by stator voltage control. The terminal voltage across the stator winding of the motor can be varied for obtaining the desired speed control by controlling the firing angle of the semiconductor power devices (TRIAC in our project). Raspberry Pi 2 (model B) plays an important in the project. Raspberry Pi has very small size and it is a low cost device. Raspberry Pi has a Quadcore broadcom BCM2836 900 MHz processor and 1GB RAM. It can perform the work like that of computer thus it can be referred as minicomputer. Python language must be used for this and it uses Raspbian operating system based on Debian distribution of Linux.

2.10.4 Brushless DC Motor

1) Brushless DC Motor Speed Control using Microcontroller

This project is done by G.Santhosh Kumar and S.Arockia Edwin Xavier for their research project (Santhosh and Arockia, 2015). The hardware project is designed to control the speed of a BLDC motor using closed loop control technique. BLDC motor has various application used in industries like in drilling, lathes, spinning, electric bikes and many more. The speed control of the DC motors is very essential. This proposed system provides a very precise and effective speed control system. The user can enter the desired speed and the motor will run at that exact speed. The hardware for closed loop control of BLDC motor using microcontroller is designed by using the PWM technique. The speed of the BLDC motor was controlled and it was made to run at exactly entered speed.

2) Speed Control of BLDC Motor using PWM Technique

This work is done by R.M. Pindoriya, S. Rajendran and P.J. Chauhan for their research project (Pindoriya, Rajendran and Chauhan, 2014). Efficiency and reliability are the key features for the development of advanced motor drives. Residential and commercial appliances such as refrigerators and air conditioning systems use conventional motor drive technology. A brushless DC (BLDC) motor drive is characterized by higher efficiency, lower maintenance, and higher cost. Therefore, it is necessary to have a low-cost but effective BLDC motor controller. PWM has been widely used in power converter control. PWM control is the most power full technique that offer a simple method for controlling of analog system with processors digital output.

CHAPTER 3
METHODOLOGY

3.1 Introduction

This chapter will explain in detail the step to setup the experiment to connect the motor and driver to the Raspberry Pi. The overall project flow is described in detail in this section.

3.2 Project Methodology Flow

The first step of this project is to study about electrical discharge machine (Mitsubishi EDM Model M35J) system and the motor that are involved. The machine actually had already damaged but some of the mechanical parts of the machine can be used to upgrade the situation. The problem of the machine is the Z-axis cannot function properly. Thus, the X-axis and Y-axis can be used to continue the project. But, after the observation is made, this machine cannot be upgraded because all the circuit has been disconnected and the machine does not have a complete manual guide.

Next, for the second experiment, the project is continued by using the Denso robot arm. The parts such as the motor, driver and end effector is important to be studied. The details of every part is needed to do the experiment. But, after the observation is made, this experiment cannot be continued because the information details of every parts are difficult to search. In addition, the manual and technical guide cannot be found.

For the third experiment, the project is used the OTIS-LG AC servo drive FDA5000C Series. The main parts that is studied is the motor and driver. The driver is the crucial part and the circuit modification is made to connect with the Raspberry Pi microcontroller. The circuit is modified based on the operation of the driver to control the direction and speed of the motor. The programming coding in Python is built in order to drive the circuit using Raspberry Pi. But, after some modification is made, the motor cannot rotate and run the programming coding.

Then, the project is replaced with the DC motor. The specification of the motor is studied and some circuit modification is made. A circuit is design to control the direction and speed of the motor. The programming coding is built in Python in order to drive the circuit using Raspberry Pi.