

STEPPER MOTOR DRIVE USING PIC CONTROLLER

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MAY 2009

BEKE

–I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Power Electronic and Drive)”

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This Report Is Submitted In Partial Fulfillment Of Requirements For The Degree of
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May 2009

–I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references.”

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ABSTRACT

This project is to design and develop a Stepper Motor using PIC controller. This project will combine the hardware and software. The purpose of this project is to design a stepper motor drive circuit that can control the speed and rotating of the stepper motor using the software. A stepper motor uses a PIC as the control system to control all the movement and rotation of the stepper motor. Input devices such push button will send a signal to PIC, then PIC will make a response accordingly.

ABSTRAK

Projek ini direka untuk mengawal motor stepper menggunakan kawalan PIC. Projek ini akan menggabungkan alatan dengan perisian. Tujuan projek ini adalah untuk mereka litar pemacu motor stepper yang mangawal kelajuan dan putaran motor stepper menggunakan perisian. Motor stepper ini meggunakan PIC sebagai sistem kawalan untuk mengawal semua gerakan dan pemusingannya. Peranti masukan seperti butang tekan akan menghantar arahan kepada PIC, selepas itu PIC akan memberi tindakbalas menurutnya.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This final year project title is stepper motor drive using PIC controller. These projects are developed to control the stepper motor using the PIC controller. PIC16F877A are used as the controller for the movement of the stepper motor. This PIC16F877A will receive the signal order that programmed from the software.

1.2 Objective

The objectives of this project are:

- i. To control the speed, rotating of stepper motor using programming (software).
- ii. To make sure the stepper motor receive actual order to run properly.
- iii. To design the program (software) that controls the stepper motor operation.

1.3 Scope of the Project

The scopes of this project are:

- i. To understand the configuration of stepper motor and PIC Microcontroller.
- ii. To design the circuit for controlling the stepper motor
- iii. To select a suitable PIC Microcontroller for stepper motor controller board.

1.4 Problem Statement

- i. Exceeding the rated voltage may shorten the life of the PIC16F877A.
- ii. The stepper motor will not turn properly if not receive the correct order from the software.

1.5 Methodology

This part described about the project methodology. First stages are doing the research about the project and main component. Second stages are constructing the circuit, after that create the software. Third stages are combining the hardware and software. Lastly, writing the full report and presentation.

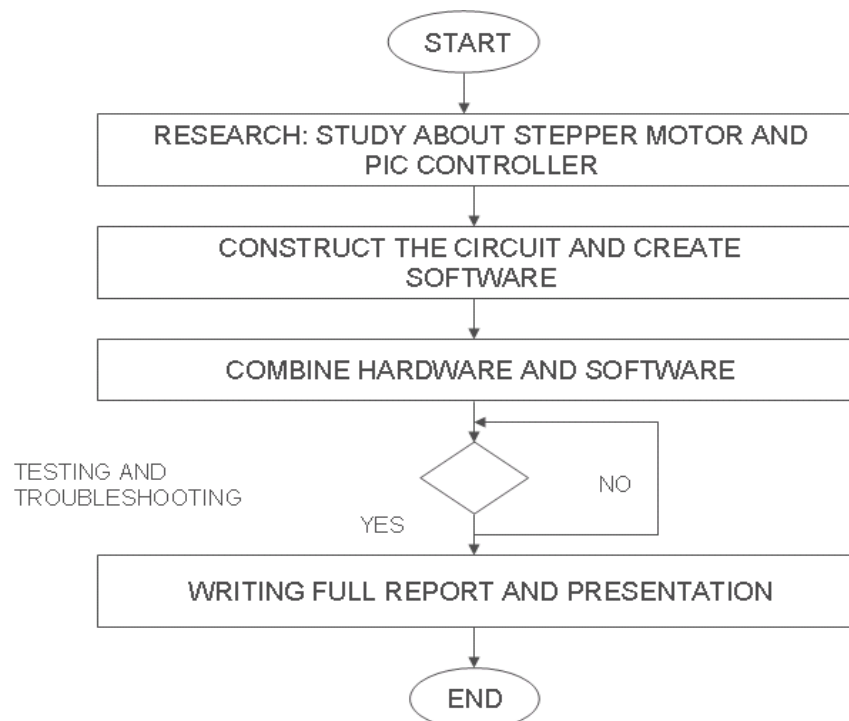


Figure 1.1 Flow chart for the project methodology

1.6 Thesis Outline

This final report consists of five chapters. First chapter explain about project background including objectives of the project, scope of the project, problem statement, and methodology. Literature Review about the stepper motor and microcontroller are explained in chapter two. Chapter three consists about theory and design of the component and software. Result and discussion are explained in chapter four. Lastly, conclusion and recommendation of the project were explained in chapter five.

1.7 Summary

This chapter is described about objectives, scope of the project, problem statement and methodology and also thesis outline described about all chapters which included in this final report. The literature review about stepper motor, microcontroller and C programming language will be discussed in next chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Before starting for the development project, the research in literature review are been done to improve the knowledge about the project. In this process, all the resources are referred from the books, internet and human resources.

2.2 Stepping System

Stepping systems have been used in industrial automation for many years to accurately position machine tools, x-y tables, feeders, and others. Unlike typical AC variable speed drives (used for velocity control), a stepping drive and Stepper Motor are used primarily for position control. A typical single axis Stepping system consists of a Stepper Motor controller/ indexer, a motor drive, a motor (with or without gearbox), and a power supply. A stepper is typically commanded by two digital inputs: a digital pulse train and a direction bit. A single pulse on the pulse input moves the motor one step increment in the direction (CW or CCW) set by the direction bit. [1].

2.2.1 Stepper Power Supply

The power supply plays a dual role: it supplies the main power to the motors as well as the power to optically-isolated digital inputs. The motor power is typically provided by a linear non-regulated power supply. Also, the digital interface between the drive and the controller should be powered by the isolated +5 VDC (500 mA max) regulated output. The motor power and the digital interface power are typically isolated since the motor power source is extremely noisy when loaded. Using the motor power for the interface might lead to false pulse commands thereby creating undesired system movement.

2.2.2 Stepper Drive

The drive translates the pulse and direction commands from the controller and converts them into actual motor movement. For each pulse from the controller, the drive will move the motor "one step" in the direction indicated by the direction command. The drive provides 4 different step resolutions for use in a wide range of applications. This drive enables an on-board indexer that moves the motor 1/2 revolution back and forth in half-step mode so the user can easily move the system while troubleshooting. An idle current cutback feature can be used to save power and reduce heat by cutting the power to the motor by 50% if no step pulses are received for 1 second. No software or external resistors are required to configure the drive.

2.2.3 Stepper Motor

The motor converts the power from the drive into rotational movement. Unlike AC motors, Stepper Motors have 100% current (idle-current cutback disabled) applied to them all the time regardless of load on the motor. The motor is moved in "steps" (one per command pulse) and will hold at its present position if no command pulses are received. The stepper motor has 4 lead which it easy to connect to driver. Another stepper motor also has 6 or 8 leads, which can cause confusion while wiring the system.

2.3 About The Stepper Motor



Figure 2.1 The stepper motor

2.3.1 History of Stepper Motor

A Stepper motors were developed in the early 1960's as a low cost alternative to position servo systems in the emerging computer peripheral industry. A stepper motor operates as a result of electromagnetism. [12]. Magnets are assembled in a stepper motor in pairs that will create two poles of magnetic attraction. If a wire is coiled around a magnet and current is induced, two magnetic poles will be created (Figure 2.2). The pole which has 5 volts applied to it will create the "north" pole and the "south" pole will be created at the end which is grounded.

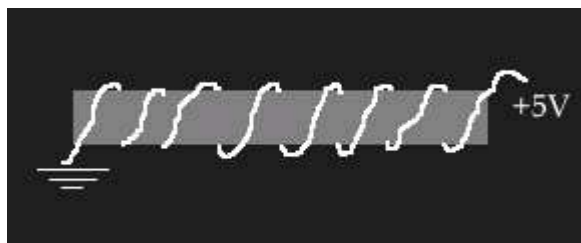


Figure 2.2 Two magnetic poles created when a wire coil around a magnet

The two magnets that shown below are electrically connected with a wire "A1" and "A2". Figure 2.3 shows the magnetic properties of the pair if 5V is applied to A1 and A2 is grounded.



Figure 2.3 The magnetic properties of the two magnets

If the signal is reversed, and "A2" has 5V applied to it while "A1" is grounded then opposite poles will be created. This is shown in Figure 2.4.



Figure 2.4 The opposite poles created when the signal is reversed

A1 and A2 can either be at 5V or ground. This gives us four possible combinations of signals. Table 2.1 shows the combinations and the effect that they have on the magnetic properties of the two poles.

Table 2.1 Combinations and the effect on the magnetic properties of the two poles

A1	A2	
0	0	No magnetic poles
1	0	A1 = North A2 = South

0	1	A1 = South A2 = North
1	1	No magnetic poles

There is no reason to ever use the combination of A1 and A2 both being on at the same time. The same net result can be obtained by both poles being grounded.

A stepper motor is a digitally controlled motor that has non-accumulative rotational error. This means that the number of rotations that the motor turns can be accurately controlled and measured. The motor will rotate one step per digital signal change. A step is a fraction of a rotation (resolution) that can be calculated by the $1 / (\text{no. of magnetic poles})$. An illustration of a 4 pole stepper motor is displayed in Figure 2.5.

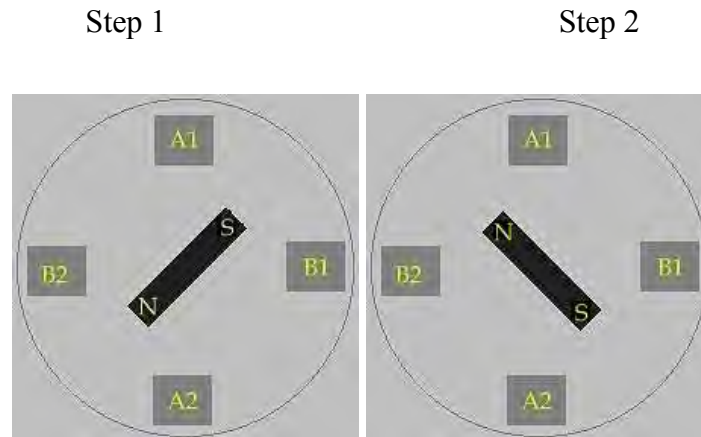


Figure 2.5 Four pole stepper motor

Current will be supplied from a 5V signal that is generated at one pole of the magnet. For example in Figure 2.5 (Step 1), a 5V signal is being applied to both A1 and B1. In this situation, the opposite pole will be connected to ground and the current will flow through the wire and create the opposite magnetic poles. The magnet that is represented in the middle will be the magnet that is connected to the shaft of the motor.

If 5V is next applied to A2 and B1, the magnet connected to the shaft will rotate 90° (Step 2). This sequence can be repeated for the next step, the next one after that, and so on. In this example there are four poles and the motor will rotate 25 percent, or 90 degrees, for every step. The sequence for switching the poles is displayed in Table 2.2 below.

Table 2.2 The Sequence for Switching the Poles

A1	A2	B1	B2
1	0	1	0
0	1	1	0
0	1	0	1
1	0	0	1

This is the illustration of a motor operating in a full step mode. Greater resolution can be gained if the motor is rotated half a step at a time. If this mode is selected less torque is generated by the motor. There is less torque because for every half step only one magnet pair is attracting the magnet connected to the shaft. Half steps are created by turning off one pair of poles in between transitions from one step to another. The sequence for switching the poles in a half step mode is displayed in Table 2. 3. Figure 2.6 is an illustration of a stepper motor operating in half step mode.

Step 1

Step 2