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30/3/2005

THE DESIGN OF SMART MOTOR CONTROLLER


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**This Report Is Submitted In Partial Fulfillment Of Requirements For The
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**Faculty of Electronics And Computer Engineering
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MARCH, 2005

“Hereby, I declare that this report is a result of my own research idea except for works that have been cited clearly in the references.”

Signature : 
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Date : 30/03/2005

Special dedicated to my dearest parent, sisters and brothers

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ABSTRACT

Smart motor controller is build to produce a prototype for close-loop control system. The application of this project is as to resolve the problems facing by the industries and as replacement the pneumatic system operation for such a restricted place and for the short distance track conveyer. This project includes the knowledge of PIC program and the combination of controller circuit, such as the motor speed controller and the sensor. Types of motor used are the stepper motor and the detectors of sensor used are the ultrasonic sensor. Stepper motors are a digital motor that move accurately according to the degree of the rotation after it was set by the motor controller circuit. The project operations are more on the differential control and the movement efficiency with the sensor and the programming control. The motor can move forward and reverse. If they are an obstacle, it will stop after the sensors sense the obstacle more than 10 meter. They will stop at each set point the have been set the by programming in the microcontroller. From the output analysis result, variable resistor on the speed controller circuit proportional with time ($R \propto T$) and inverse with motor speed ($R \propto 1/\text{motor speed}$). Other than that, stepper motor will move imitate by degrees after receive pulse from motor driving circuit about 7.5° per step.

ABSTRAK

Pengawal Motor Pintar dicipta untuk menghasilkan satu prototaip sistem kawalan gelung tutup. Aplikasi projek ini adalah untuk menyelesaikan masalah-masalah industri bagi menggantikan operasi pneumatik untuk tempat-tempat yang terhad dan bergerak di atas landasan penggerak yang pendek. Projek ini menggunakan kawalam mikro PIC untuk mengawal pergerakan motor dan menggunakan alat pengesan bagi mengesan objek atau halangan apabila motor bergerak. Jenis motor yang digunakan adalah motor pelangkah dan alat pengesan yang digunakan pula adalah alat pengesan ultrasonik. Operasi kawalan pergerakan motor adalah untuk mengawal kelajuan motor, pergerakan motor bergerak samaada kehadapan dan kebelakang dan berhenti mengikut jarak yang ditetapkan. Pada masa yang sama, sensor ultrasonik akan beroperasi memberhentikan pergerakan motor dengan serta merta apabila terdapat objek atau halangan ketika motor bergerak pada jarak lebih daripada 10 meter. Pengawal Motor Pintar bukan sahaja dapat beroperasi seperti mana yang dirancang, malah dari hasil projek ini juga dapat mempelajari dan mengkaji secara menyeluruh mengenai operasi, kecekapan dan kaedah kawalan dengan menggunakan aturcara yang telah ditetapkan. Di dalam operasi Pengawal Motor Pintar, rintangan boleh laras pada litar kawalan kelajuan berkadar langsung dengan masa ($R \propto T$) dan berkadar songsang dengan kelajuan motor ($R \propto 1/\text{kelajuan motor}$). Selain itu, motor pelangkah akan bergerak mengikut darjah setelah menerima denyutan dari litar pembawa motor sebanyak 7.5^0 pada setiap langkah.

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ABBREVIATION

A/D	-	Analog to digital
ASM	-	Assembler
BCPL	-	Basic Combined Programming Language
CAD	-	Computer-Aided Design
CADD	-	Computer-Aided Design Directories
CIS	-	Component Information System
DC	-	Direct Current
EMF	-	Electro Motor Force
GPR	-	General Purpose Registers
HB	-	Hybrid
HEX	-	Hexadecimal
I/O	-	Input / Output
IC	-	Integrated Circuit
IDE	-	Integrated Development Environment
KUTKM	-	Kolej Universiti Teknikal Kebangsaan Malaysia
LED	-	Light Emitting Diode
LSI	-	Large Scale Integration
MCU	-	Microcontroller
MPU	-	Microprocessor
MB	-	Mega Bytes
PC	-	Personal Computer
PCB	-	Printed Circuit Board
PIC	-	Peripheral Interface Controller
PM	-	Permanent Magnet
RAM	-	Random Access Memory
RX	-	Receiver

SCI	-	Scalable Coherent Interface
SEC	-	Second
SFR	-	Special Function Register
SR	-	Set Reset
SRAM	-	Static Random Access Memory
TMR	-	Timer
TTL	-	Transistor-Transistor Logic
TX	-	Transmitter
UV	-	Ultraviolet
V	-	Voltage
VR	-	Variable-Reluctance
WIN	-	Window

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CHAPTER I

INTRODUCTION

1.1 BACKGROUND

Smart motor controllers will allow easy programmability for individual application [1].

It a soon be possible to construct a low-cost motor control with enough memory to store several built-in motor functions and its control strategies. The end user would simply hook up in a small personal computer to the motor drive's communication port and pick up the appropriate motor control parameters required for a specific application. This would be accomplished with an easy-to-use program with graphics in which would not involved programming languages. Essentially, the user would just click on the appropriate graphic boxes and enter a specific value to program the motor drive. The motor drive would then retain these user-defined variables in a nonvolatile memory and execute its latest program.

In the last decade, progress in microelectronics and very large scale integration (VLSI) technology has fostered the widespread use of computing and electronics devices for commercial use. This has resulted in the development of a

highly integrated microprocessor and microcontroller. Microcontroller is widely used in robotics, motors and electronics devices. They are used in industrial world to control the many types of equipment, ranging from consumer to specialized devices. Also, there is a growing need for off-line support of a computer's main processor.

The user then could customize the controller of each applications, whether it is a temperature-controlled variable-speed fan, or a multiple-speed motor used in a factory tool. Stepper motor is one of the most popular motor uses in the manufacturing area. Thus, stepper motor which provides accurate position control has the requirement needed in this project.

1.2 OBJECTIVES

The objective of this project is specified below:

- a. To design, test and build a prototype module of a microcontroller device that can measure and indicate motor movement using stepper motor and ultrasonic sensor.
- b. At the end of the project, we shall manage to demonstrate on how the Smart Motor Controller operates.
- c. To study how on the stepper motor movement, operation forward and backward by using the speed controller.
- d. To study the variety step of sensor and their operation procedure.
- e. To study the PIC microcontroller and how to program it with the PIC programmer.

1.3 PROJECT SCOPE

Smart Motor Controller refer to three elements such as PIC microcontroller, motor and sensor.

a. PIC microcontroller

PIC microcontroller is a main element for this project because PIC can be controlled others elements. The types of PIC microcontroller used are 16F84A.

b. Motor

Types of motor used are the stepper motor. Stepper motors are a digital motor that move accurately according to the degree of the rotation after it was set by the motor controller circuit.

c. Sensor

Types of sensor used are the ultrasonic sensor. Circuit sensor is added circuit to give a close loop response for order reactions. For example, function motor can be stops after the sensors sense the obstacle.

1.4 PROJECT OVERVIEW

Smart Motor Controller using PIC16F84A is devices that were capable to measure the motor movement efficiency with the sensor and the programming control. In order to get a high accuracy measurement, several condition must be fulfilled which will discuss later.

Basically, this project consist of hardware and software programming. The hardware are such as the PIC microcontroller, stepper motor, ultrasonic transducer and others. The programming language used to programmed the PIC chip was assembly a language.

This project needs on overall understanding regarding of the microcontroller, motor and the sensor. Theoretically, there are many type of stepper motors. Unipolar type, Bipolar type, Single-phase type, Multi-phase type, and the PM type. Single-phase stepper motor is often used for quartz watch. In the PM type stepper motor, a permanent magnet is used for rotor and coils are put on the stator. At the same time, this project also needs to find a suitable circuit to be use in design which is more to process closed-loop (feedback control) system. The generic architecture of a close-loop system Smart Motor Controller is shown in figure. Furthermore, we will discuss it later.

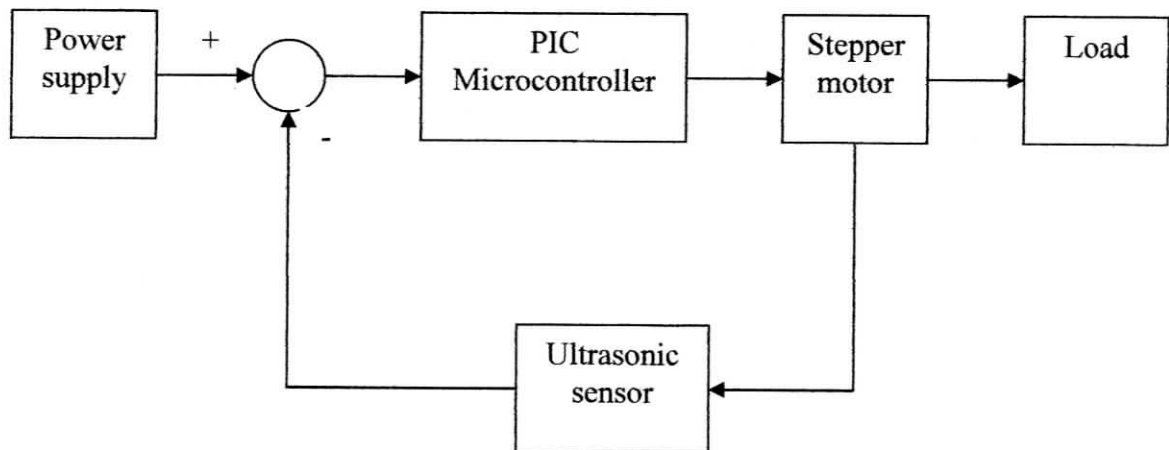


Figure 1.1: Process closed-loop

Structurally, types of motor used are the stepper motor and the detectors of sensor used are the ultrasonic sensor. Stepper motors are a digital motor that move accurately according to the degree of the rotation after it was set by the motor controller circuit. The degrees of the rotation control the speed of the motor.

Lastly, the result from this project is the PIC microcontroller will be able to control the motor movement and the sensor detection. In the motor controller section, the motor can move forward or reverse depending on the distances that have been program. Meanwhile, the motor speed can be controlled manually by the variable resistor. The sensor can be operated as a safety control in which when the sensor sense an obstacle in front, it when the motor is running.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

Smart Motor Controller refers to three elements; PIC microcontroller, Motor and Sensor. PIC microcontroller is the main element in this project because the PIC can controlled the next elements. The types of PIC microcontroller used are 16F84A. Types of motor used are the stepper motor. Stepper motors are a digital motor that move accurately according to the degree of the rotation after it was set by the motor controller circuit. Types of sensor used are the ultrasonic sensor. Circuit sensor is circuit to give a close loop response for the in order reactions. For example, function motor can be stops after the sensors senses on obstacle.

2.2 WHAT IS A MICROCONTROLLER?

A computer revolution in the last 15 years has produced computer with a very high speeds and a computing power while keeping their sizes compact. This revolution has occurred as a result of a development of Large-scale Integration (LSI)

and Very Large-scale integration (VLSI) technologies, which contents thousands of transistor on a single chip. This has made possible to fabricate the heart of a microcomputer as a single chip called a microprocessor (MPU). This chip, with an additional auxiliary chips called peripherals, constitutes 'a microcomputer'. Such peripherals are I/O ports, memories, timers and others.

The new technology has also made it possible to integrate this microprocessor and its peripherals in a single chip called a microcontroller (MCU) That is the reason a microcontroller is called a *single-chip microcomputer*.

2.3 WHY USE A MICROCONTROLLER?

Microcontroller is inexpensive. It's ability to store and run unique programs make it extremely versatile. For example, we can program a microcontroller to make a decision (perform functions) based on the predetermined situations (I/O line logic) and selections. The microcontroller's ability to perform math and logic functions allows it to mimic sophisticated logic and electronic circuit.

Others program can make the microcontroller behave like a neural circuit or a fuzzy logic controller. Microcontroller is responsible for the "intelligence" in the most smart devices in market.

There are literally hundreds of microcontrollers on the market. Listed here are some of the popular 8-bit microcontroller and their features [2]. These devices are the lowest cost representative devices from respective manufactures.