PULLEY SYSTEM DESIGN

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28 MARCH 2006

"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 (Industrial Power)."

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Date : 4/5/06

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This Report Is Submitted In Partial Fulfillment of Requirements For The Degree of Bachelor In Electrical Engineering (Industry Power)

Faculty of Electrical Engineering
Kolej Universiti Teknikal Kebangsaan Malaysia

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"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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Name : MOHAMAD NAZEEB B. BOLHASSAN

Date : 4.05.06

Special dedication goes to my mother Puan Siti Mawar Binti Aliman, my father Bolhassan Bin Putit, my brothers and sister, my kind hearted supervisor En Fariz Bin Ali @ Ibrahim and all my supportive friends.

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ABSTRACT

A pulley system is design that can be controlled by a microcontroller (PIC). The cable of the pulley system can be positioned up and down with a few sensors to limit its maximum and minimum positions. In this new technology era, manpower is very important in all industries. Although it is important, it can cause problem to the industries especially in handling machine and discipline. Unfortunately for the companies, so much time and money are wasted due to the error, absent and less concentration from the employees. Thus, technologies improvement is important. By implementing the microcontroller replacing human can improve the accuracy, reducing the operating problem and saving more time and money for the industries. In this project, the pulley system consists of a design circuit with microcontroller, push-pull switch, Dc motor, gear, pulley, a few sensors, magnet and the body. A set of program code are programmed using MPLAB for the PIC which enable it to control the pulley system operation. A bidirectional Dc motor allows the pulley cable to be positioned up and down due to the maximum and minimum limit set by the sensors. The Dc motor will move right (clockwise) when the switch is on, simultaneously the cable of the pulley start to go down until it reaches the load. It will stop a moment before the Dc motor start to move left (anti-clockwise) causing the cable to move up again toward its minimum position. As a spin-off benefit, hopefully this project can be applied to improve the existing pulley system in the industries.

ABSTRAK

Kabel sistem takal dikawal oleh *microcontroller* (PIC) dan kabel nya boleh digerakkan ke atas dan ke bawah dimana kedudukan maksimum dan minimumnya akan dihadkan oleh beberapa pengesan. Pada masa sekarang, tenaga manusia adalah suatu aspek penting dalam sesebuah industri. Walaupun begitu, banyak kesilapan berlaku akibat daripada kecuaian pengendalian oleh pekerja-pekerja terutama sekali dalam mengendalikan mesin. Oleh itu, banyak masa dan wang telah banyak dihabiskan akibat daripada kesilapan pengendalian mesin atau mesin rosak dan pekerja yang ponteng kerja. Jadi, kemajuan teknologi amat penting dalam menangani masalah ini. Penggunaan *microcontroller* sebagai pengganti kepada manusia dalam mengendalikan mesin boleh mempertingkatkan lagi kejituan dan mengurangkan risiko kerosakan pada mesin sekaligus dapat mengelakkan pembaziran wang dan masa. Sistem takal ini terdiri daripada gabungan litar bersama *microcontrolle*r, suis, Dc motor, gear, kabel, takal, pengesan, roda dan struktur badan. Kod-kod program akan dihasilkan menggunakan *MPLAB* bagi membolehkan PIC mengawal operasi sistem takal ini. Dc motor pula digunakan untuk menarik atau menurunkan kabel berdasarkan kepada paras maksimum dan minimum yang telah dihadkan oleh beberapa pengesan. Dc motor akan berputar kehadapan apabila suis dihidupkan menyebabkan kabel turun sehingga ke paras maksimum. Setelah itu, putaran motor akan berubah ke belakang menyebabkan kabel tertarik keatas semula sehingga ke paras minimum iaitu paras asal. Sistem takal ini berupaya mengangkat beban yang diperbuat daripada besi. Diharapkan agar sistem takal ini dapat diaplikasikan bagi membantu mempertingkatkan lagi sistem takal yang ada sekarang.

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CHAPTER 1

INTRODUCTION

1.1 Project Objective

The objective of this project is to design a pulley system that can be controlled by a microcontroller. The cable of the pulley system can be positioned up and down with a few Infrared sensors to limit its maximum and minimum positions.

1.2 Scope of Project

In this project, there are three main characteristic that is pulley system controlled by microcontroller, cable can be positioned up and down and its maximum and minimum position is limited by a few Infrared sensors. In order to reach the objectives of the project, the project scope is specified.

i. The physical design of the pulley system.

ii. Pulley system controlled by microcontroller.

iii. Cable can be positioned up and down.

vi. Maximum and Minimum of the cable is limited by a few Infrared sensors.

1.3 Problem Statement

Now a day, technology is a leading subject in all sorts of industries. As we know, machineries such as pulley machines are widely used in car industry, shipping industry and many more. Many companies have to hire a lot of manpower just to handle all sorts of machines. In order to do that, a lot of money needed to pay them just to handle small machines. Sometimes breakdown could happen to the machines because of some small conducting error done by the employees. Problem can also happen if the worker that in charge of the machine is absent for work. All of this can cause a big loss of money and time to the industries. So as a method of solving this problem, an advance pulley system is design, so that it can be controlled by a microcontroller. The microcontroller is use to replace human in conducting the machine whereby it work automatically. With this, the conducting of the machine will be more accurate and the ensure safety of the machines. As a result, the companies can save money and time during their production time.

CHAPTER 2

PROJECT BACKGROUND

Nowadays technology is one of the most important aspects to improve industrial production. One of them is pulley system. In this chapter, the history of pulley system is described.

2.1 Project Background

A machine is a device that helps people doing their work against some resistive force. Some machines are powered by engines, motors and even animals, while many others simply use human power. The basis of all complex machines comes from their simple components. When these components are by themselves, they are called simple machines. The most common simple machines are the lever, rollers, the ramp, and the pulley [8].

2.1.1 Pulley System

Before engines and motors were invented, people had to do things like lifting heavy loads by hand. Using an animal could help, but what they really needed is some clever ways to either make work easier or faster. Ancient people invented, simple machines that would help them overcome resistive forces and allow them to do the desired work against those forces. A pulley is a way to use your own weight to lift an object to another height. The same force must be used, but it simply changes direction. You pull down and the weight goes up [7].

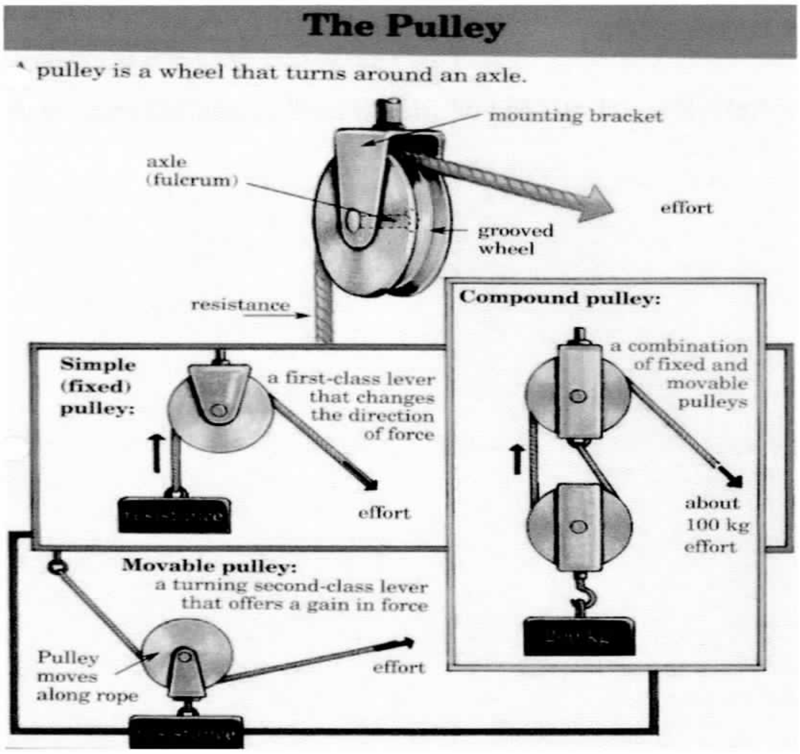

Figure 2.1: The Pulley [8].

1. A Pulley is a Grooved Wheel that turns around an Axle (Fulcrum), and a rope or a chain is used in the grove to lift heavy objects.

2. A Pulley changes the direction of the Force – Instead of lifting up, you can pull down using your body weigh against the Resistance (load, what you are lifting).

3. A Pulley may be Fixed, Moveable, or used in combination.

4. The Simple Pulley gains nothing in Force, Distance or Speed, but it changes the Direction of the Force.

5. A Fixed Pulley (attached to something that doesn't move such as the selling or wall) acts as a First Class Lever with the Fulcrum located at the Axis, instead of a bar the Pulley uses a Rope.

6. A Moveable Pulley acts as Second Class Lever, the Load (Resistance) is between the Fulcrum and the Effort.

7. Samples of Pulleys in use – On Top of the Flag Pole to Raise and Lower the Flag, To Hoist a Sail, to Open Curtains or Mini Blinds, To Lift Hay into a Hayloft [8].

CHAPTER 3

LITERATURE REVIEW

In this chapter, theories that support the project are presented.

3.1 Introduction

To understand this project, some research has been done throughout making this a successful project. The research includes the hardware and software.

3.2 Microcontroller

Microcontroller is the main part of this project. Referring to the objective, microcontroller is used to control the pulley system. In this project, microcontroller PIC16F877a is used. A PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I^2C™) bus and a Universal Asynchronous Receiver Transmitter (USART). All of these features make it ideal for more advanced level A/D applications in automotive, industrial, appliances and consumer applications [5]. Beside that, it consists of many electronic circuits which can decode written instructions and convert them into electrical signals. A PIC microcontroller includes timers, synchronous/asynchronous serial transmission, analog-to-digital converters, voltage comparators, capture/compare/PWM modules, ROM, RAM, EPROM,

PROM, I/O,LCD driver, I2C and SPI peripheral Bus Support, Motor Control Kernels and USB interfacing support.

There are some factors to be considered in order to choose a microcontroller such as the input, output, control, size of program memory storage, number of interrupts, how much data EPROM is needed and etc. there are 105 types of microcontroller at present and they include devices for all kind of applications [4].

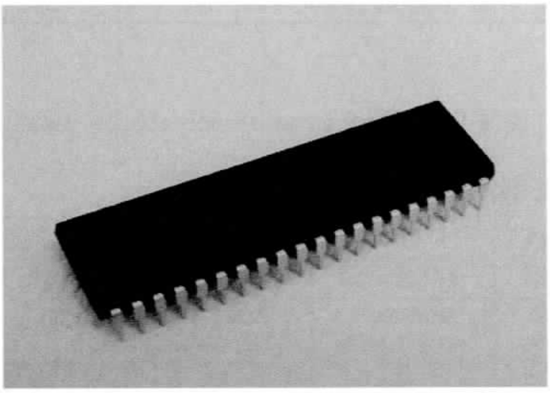

Figure 3.2: Microcontroller PIC16F877A

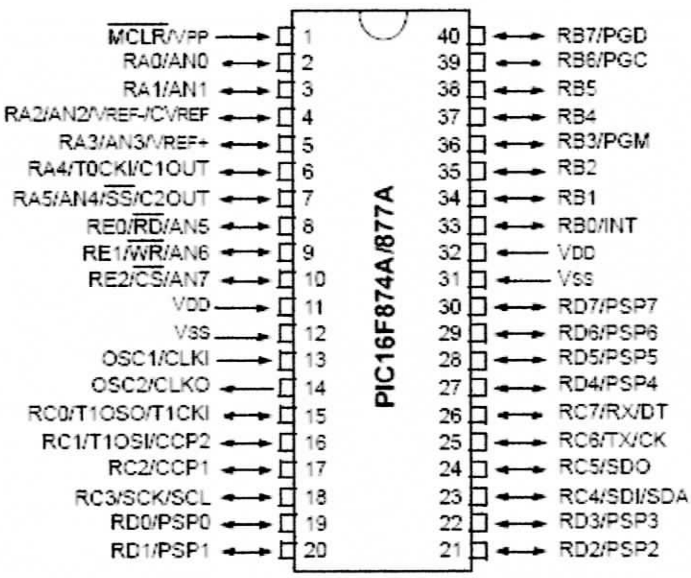

Figure 3.3: PIC16F877 Pin Diagram [4].

Table 3.2: Microcontroller Features [4].

Device	Program Memory		Data SRAM (Bytes)	EEPROM (Bytes)	I/O	10-bit A/D (ch)	CCP (PWM)	MSSP		USART	Timers 8/16-bit	Comparators
	Bytes	# Single Word Instructions						SPI	Master I^2C			
PIC16F873A	7.2K	4096	192	128	22	5	2	Yes	Yes	Yes	2/1	2
PIC16F874A	7.2K	4096	192	128	33	8	2	Yes	Yes	Yes	2/1	2
PIC16F876A	14.3K	8192	368	256	22	5	2	Yes	Yes	Yes	2/1	2
PIC16F877A	14.3K	8192	368	256	33	8	2	Yes	Yes	Yes	2/1	2

Table 3.3: Device Features for PIC16F87X [4].

Key Features	PIC16F873A	PIC16F874A	PIC16F876A	PIC16F877A
Operating Frequency	DC – 20 MHz	DC – 20 MHz	DC – 20 MHz	DC – 20 MHz
Resets (and Delays)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)
Flash Program Memory (14-bit words)	4K	4K	8K	8K
Data Memory (bytes)	192	192	368	368
EEPROM Data Memory (bytes)	128	128	256	256
Interrupts	14	15	14	15
I/O Ports	Ports A, B, C	Ports A, B, C, D, E	Ports A, B, C	Ports A, B, C, D, E
Timers	3	3	3	3
Capture/Compare/PWM modules	2	2	2	2
Serial Communications	MSSP, USART	MSSP, USART	MSSP, USART	MSSP, USART
Parallel Communications	—	PSP	—	PSP
10-bit Analog-to-Digital Module	5 input channels	8 input channels	5 input channels	8 input channels
Analog Comparators	2	2	2	2
Instruction Set	35 Instructions	35 Instructions	35 Instructions	35 Instructions
Packages	28-pin PDIP 28-pin SOIC 28-pin SSOP 28-pin QFN	40-pin PDIP 44-pin PLCC 44-pin TQFP 44-pin QFN	28-pin PDIP 28-pin SOIC 28-pin SSOP 28-pin QFN	40-pin PDIP 44-pin PLCC 44-pin TQFP 44-pin QFN

The data memory of PIC16F877a is positioned into multiple banks which contain the General Purpose Registers and the Special Functions Registers. Bits RP1 (Status<6>) and RP0 (Status<5>) are the bank select

Table 3.4: Microcontroller Banks [4].

RP1:RP0	Bank
00	0
01	1
10	2
11	3

Each bank extends up to 7Fh (128 bytes). The lower locations of each bank are reserved for the Special Function Registers. Above the Special Function Registers are General Purpose Registers, implemented as static RAM. All implemented banks contain Special Function Registers. Some frequently used Special Function Registers from one bank may be mirrored in another bank for code reduction and quicker access.

Table 3.5: PIC16F87XA Register File Map

Bank 0	File Address	Bank 1	File Address	Bank 2	File Address	Bank 3	File Address
Indirect addr.(*)	00h	Indirect addr.(*)	80h	Indirect addr.(*)	100h	Indirect addr.(*)	180h
TMR0	01h	OPTION_REG	81h	TMR0	101h	OPTION_REG	181h
PCL	02h	PCL	82h	PCL	102h	PCL	182h
STATUS	03h	STATUS	83h	STATUS	103h	STATUS	183h
FSR	04h	FSR	84h	FSR	104h	FSR	184h
PORTA	05h	TRISA	85h		105h		185h
PORTB	06h	TRISB	86h	PORTB	106h	TRISB	186h
PORTC	07h	TRISC	87h		107h		187h
PORTD(1)	08h	TRISD(1)	88h		108h		188h
PORTE(1)	09h	TRISE(1)	89h		109h		189h
PCLATH	0Ah	PCLATH	8Ah	PCLATH	10Ah	PCLATH	18Ah
INTCON	0Bh	INTCON	8Bh	INTCON	10Bh	INTCON	18Bh
PIR1	0Ch	PIE1	8Ch	EEDATA	10Ch	EECON1	18Ch
PIR2	0Dh	PIE2	8Dh	EEADR	10Dh	EECON2	18Dh
TMR1L	0Eh	PCON	8Eh	EEDATH	10Eh	Reserved(2)	18Eh
TMR1H	0Fh		8Fh	EEADRH	10Fh	Reserved(2)	18Fh
T1CON	10h		90h		110h		190h
TMR2	11h	SSPCON2	91h		111h		191h
T2CON	12h	PR2	92h		112h		192h
SSPBUF	13h	SSPADD	93h		113h		193h
SSPCON	14h	SSPSTAT	94h		114h		194h
CCPR1L	15h		95h		115h		195h
CCPR1H	16h		96h		116h		196h
CCP1CON	17h		97h	General Purpose Register 16 Bytes	117h	General Purpose Register 16 Bytes	197h
RCSTA	18h	TXSTA	98h		118h		198h
TXREG	19h	SPBRG	99h		119h		199h
RCREG	1Ah		9Ah		11Ah		19Ah
CCPR2L	1Bh		9Bh		11Bh		19Bh
CCPR2H	1Ch	CMCON	9Ch		11Ch		19Ch
CCP2CON	1Dh	CVRCON	9Dh		11Dh		19Dh
ADRESH	1Eh	ADRESL	9Eh		11Eh		19Eh
ADCON0	1Fh	ADCON1	9Fh		11Fh		19Fh
General Purpose Register 96 Bytes	20h	General Purpose Register 80 Bytes	A0h	General Purpose Register 80 Bytes	120h	General Purpose Register 80 Bytes	1A0h
			EFh		16Fh		1EFh
		accesses 70h-7Fh	F0h	accesses 70h-7Fh	170h	accesses 70h - 7Fh	1F0h
	7Fh		FFh		17Fh		1FFh
Bank 0		Bank 1		Bank 2		Bank 3	

▢ Unimplemented data memory locations, read as '0'.
* Not a physical register.

Note 1: These registers are not implemented on the PIC16F876A.
2: These registers are reserved; maintain these registers clear.

3.3 DC Motor

DC motors are widely used, inexpensive, small and powerful for their size. Reduction gearboxes are often required to reduce the speed and increase the torque output of the motor. Unfortunately more sophisticated control algorithms are required to achieve accurate control over the axial rotation of these motors. Although recent developments in stepper motor technologies have come a long way, the benefits offered by smooth control and high levels of acceleration with DC motors far outweigh any disadvantages.

Several characteristics are important when selecting DC motors and these can be split into two specific categories. The first category is associated with the input ratings of the motor and specifies its electrical requirements, like operating voltage and current. The second category is related to the motor's output characteristics and specifies the physical limitations of the motor in terms of speed, torque and power.

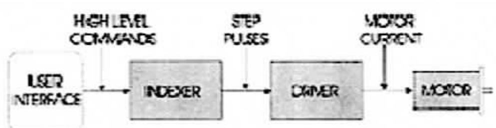

Figure 3.4: A DC Motor System Basic Elements

The Indexer (or Controller) is a microprocessor capable of generating step pulses and direction signals for the driver. In addition, the indexer is typically required to perform many other sophisticated command functions.

The Driver (or Amplifier) converts the indexer command signals into the power necessary to energize the motor windings. There are numerous types of drivers, with different current/amperage ratings and construction technology. Not all drivers are suitable to run all motors, so when designing a Motion Control System the driver selection process is critical.