SPEED CONTROL OF PNEUMATIC CYLINDER USING ON/OFF VALVE AND PWM

SITI AMIRAH BINTI MOHD PADLI

This report is submitted in partial fulfilment of the requirements for the award of Bachelor of Electronic Engineering (Industrial Electronics) with Honours

Faculty of Electronic and Computer Engineering

University Teknikal Malaysia Melaka (UTeM)

June 2016

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : SPEED CONTROL OF PNEUMATIC CYLINDER USING ON/OFF VALVE AND PWM

Sesi Pengajian :

1	5	/	1	6

Saya SITI AMIRAH BINTI MOHD PADLI mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☐ **SULIT*** *(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐ **HAD**** *(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☐ **TIDAK TERHAD**

Disahkan oleh:

_____ (TANDATANGAN PENULIS)

Tarikh: ……..

_____ (COP DAN TANDATANGAN PENYELIA)

Tarikh: ……..

"I hereby declare that the work in this project is my own except for summaries and quotations which have been duly acknowledge."

Signature : ……..

Name : Siti Amirah Binti Mohd Padli

Date : 10 June 2016

"I acknowledge that I have read this report and in my opinion this report is sufficient in term of scope and quality for the award of Bachelor of Electronic Engineering (Industrial Electronics)* with Honours."

Signature	: ……
Supervisor"s name	: Zulhairi Bin Othman
Date	: 13 June 2016

To my beloved parents, family members and friends;

ACKNOWLEDGEMENTS

I would like to return my gratitude and courtesy to all those that have assisted and encourage me in completing this final year project and thesis. A special thanks to my supervisor Mister Zulhairi Bin Othman for his support, critic and encouragement throughout the project. Besides, thanks to lectures and technicians at the Faculty of Electronic Engineering and Computer Engineering for their valuable comments and knowledge on using machining and equipment at laboratory.

I would like to thanks and appreciation to my faculty for providing the lab to be used and also the library for supplying the relevant literatures. My fellow classmates should be recognized for their support and help during testing my project. I would like to thanks them for their encouragement, views and tips that very useful for this project. Finally, I am grateful to my parents and family members for giving me the support and encouragement in spirit and also the financial to complete this project.

ABSTRACT

Mostly Pulse width modulation (PWM) is the method that commonly used by the researchers on pneumatic project for the improvement in industry. This method will be applied into this project about how to control the speed of pneumatic cylinder with using On-Off solenoid valve. Currently, this method is not applying in the industry yet, however, the component that mostly used in industry is servo valve type. Unfortunately, by using the servo valve is very costly but it has its own advantage such a very long life time. Solenoid valve is implemented for reducing the cost of industry maintenance. Solenoid valve will conduct together with PWM so that, the speed can be control as well as if using servo valve. Besides that, the other components that will use the system are microprocessor bootloader PIC18F4550. The programming of PWM will be program into this microcontroller and the result will obtain by the waveform at oscilloscope and also the timing of movement retracted and extended from pneumatic cylinder.

ABSTRAK

Kebanyakannya kaedah modulasi lebar denyut (PWM) selalu digunakan oleh penyelidik dalam mengkaji pemanbahbaikkan penggunaan sistem pneumatik dalam sektor industri. Kaedah ini (PWM), akan diaplikasikan dalam pempentangan projek ini untuk mengawal kelajuan silinder pneumatik dengan menggunakan sistem On-Off injap solenoid. Pada hari ini, kaedah ini tidak diketengahkan lagi dalam sektor industri, walau bagaimanapun, alatan yang selalu digunapakai dalam industri adalah sejenis injap servo. Malangnya, penggunaan injap servo ini adalah sangat mahal, tetapi ia mempunyai kelebihannya tersendiri iaitu ketahanan yang lama. Injap solenoid ini dilaksanakan adalah untuk mengurangkan kos penyelenggaraan industri. Injap solenoid akan digunakan bersama dengan PWM supaya kawalan kelajuan boleh dicapai seperti mana jika menggunakan injap servo. Selain itu, antara komponen lain yang akan digunakan dalam sistem ini adalah mikropemproses pemuat PIC18F4550. Pengaturcaraan PWM ini akan diprogramkan dalam mikropengawalan ini dan keputusannya akan diperolehi dari bentuk gelombang pada osiloskop dan juga masa pergerakan pelanjutan dan penarik balik dari silinder pneumatic.

TABLE OF CONTENT

LIST OF TABLES

LIST OF EQUATIONS

LIST OF FIGURES

LIST OF ABBREVIATIONS

PWM	Pulse Width Modulation
PIC	Programmable Interface Controller
PLC	Programmable Logic Converter
CPU	Centre Processing Unit
RAM	Random Access Memory
ROM	Read Only Memory
ADC	Analogue to Digital Converter
DAC	Digital to Analogue
GSR	General Purpose Register
SFR	Special Function Register
PCB	Printed Circuit Board
ISIS	Intelligent Schematic Input System
ARES	Advanced Routing & Editing Software
USB	Universal Serial Bus
RC Servo	Radio Control Servo

LIST OF APPENDIXES

CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

Popular and low cost system makes pneumatics system mostly been located and used in industry. Besides, this system is commonly use because there is no return piping yet the process change is simple and flexible. However, this pneumatics control systems are also have played the important roles in the industrial automation systems owing to the advantages as low cost, ease of maintenance, cleanliness, and a readily available and cheap power source [1].

The application well suited for pneumatic cylinders is the position of robotic manipulators, end effectors and grippers, where stiff and lightweight structures are critical. Then, for the innovation of this system is about to developing in controlling the pneumatics cylinder by using the on-off solenoid valve with pulse width modulation (PWM) system. It has been recognised that the used of pneumatics cylinder is nowadays are common

widely used in industry. However, there is no design for controlling the speed by using on-off valve and PWM unless by using the old way technology such the use mechanical servo valve for controlling the speed of pneumatics.

So, to overcome the solution, the methods about how to implement the speed control is using double acting pneumatic cylinder and solenoid valve along with microcontroller will be used as the method to approaching the PWM for controlling the speed of pneumatics.

1.2 PROBLEM STATEMENT

As for todays, many of industrial sector go toward to the mechanical servo valve types in order controlling the speed for their pneumatics and robotics. The method was applied as for many years ago because of the advantages of long life user for industry. Unfortunately, it involves the use of high cost to procure and be placed into the industry.

Other than that, mostly in industrial automation used the type of servo valve systems rather than proportional valve system is because of their high accuracy and versatility of the position tracking and its control. Then, it was another reason why it made that component is so highly rate to be purchased and be placed in industry.

So, the project propose to use solenoid on-off valve and PWM can be seen for applied and swapped to use for controlling the speed motion of pneumatic cylinder. Yet, it is inexpensive compared to using the servo valve where the cost approximately USD400 whereas on-off valve costly in range USD20, representing a 20:1 reduction in valve, costs, or a savings of approximately 60% on the total cost of the pneumatic actuator [1]. In addition, microcontroller also is used because it is cheaper rather than to use microcomputer.

1.3 OBJECTIVE

The objective of this project is to develop the speed controlling of pneumatics cylinder system with on-off valve and using the PWM method. The controller of speed can be driven by PWM method where it will change the speed of pneumatic to be faster or slower motion of retracted and extended by program it with the code of PWM duty cycle.

Besides that, the second objective of this project is to implement the inexpensive of on-off solenoid valve instead of using the servo valve.

1.4 SCOPE OF WORK

In order to fulfil to achieve the objectives of this project, there are several scope has been outlined. This project involved with the software and hardware way of work. The hardware will works with using the double acting pneumatic cylinder, 5/2 way solenoid valve, switches, Darlington transistor, RC servo and PIC kit. PIC kit is use for boot and reboot the programming to make sure electronic device run well and also to experimenting in troubleshooting the function of system that have been design for run the speed control.

Besides that, software also played as the main role to complete this project. The software consist the use of Proteus 8 Professional and PIC Basic programming where the PWM programming will be code into microcontroller and will be debugging to make sure it may control the speed of pneumatic. Other than that, this Proteus is to design the circuit contains of switches circuit, microcontroller bootloader, and Darlington of transistor circuit.

1.5 PROJECT OVERVIEW

This project is to control the speed of pneumatic cylinder by using the on-off solenoid valve with pulse width modulation (PWM) method. The method that will guide to achieve this project to be success is through the selecting hardware of the actuator and its valve. Since there are much type of actuator and valve in the market, the advantages and the disadvantages need to be made for selecting the equipment that should be use may function or dysfunction.

After the selecting part is done, the setup of the actuator and the valve will then be experiment to see the linearity and non-linearity of the cylinder movement. Then the output will be analysed. After that, the next method will be discussed about the using of microcontroller Programmable Interface Controller (PIC). The uses of PIC microcontroller will lead the project successful depends on its programming to give the signal to valve and PWM in conducting the speed control.

Other than that, the link between the using of valve and the PWM is to determine for the suitable coding and how its connection in order to achieve the speed control of pneumatic cylinder. The result will depends on the duty cycle of PWM. Based on the increment and decrement of speed will influenced its duty cycle. In other words, the speed control is depends on its duty cycle of PWM by controlling with its switch (as input).

As the summary, the PIC is the main part in order to control the speed by give a programming code of PWM into microcontroller. Then it will connect to the valve where function to drive the pneumatic cylinder for extended and retracted motion. The speed can be control as its requirement and can be change the speed by changing of duty cycle in PWM.

CHAPTER II

LITERATURE REVIEW

2.1 PNEUMATIC CYLINDER

Pneumatic cylinder is mechanical devices that can be explain as air cylinder which use the source of air compressor or known as a gas in producing a force in a reciprocating linear motion. In performing the function, pneumatic cylinders has force impart by the air compression to converting the potential energy into kinetic energy.

The air compressor has the greater pressure than atmospheric pressure, so it can be able to expend without the external energy input due to the gradient of the pressure. This means that the air expansion may force pneumatic cylinder to move the rod in the extended or retracted direction.

In generally, pneumatic cylinder works by air compressor will compressed by flowing the gas into the tube of piston at one end, hence the air of compressor will

give impacts force on the piston. Therefore, this air compressed will extending the piston that be moved in aiming to reach at atmospheric pressure.

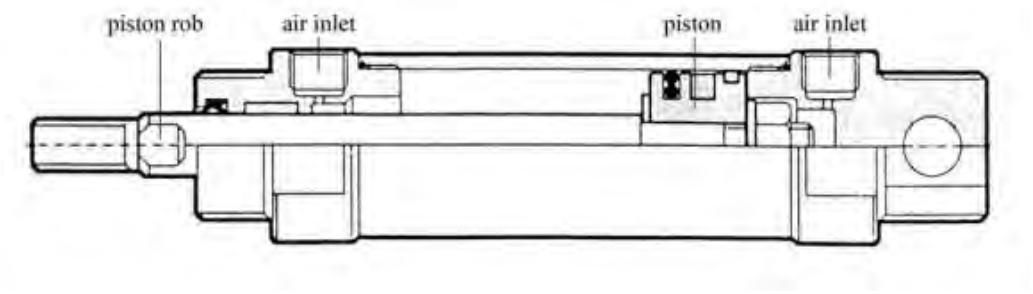

Figure 2.1: Cross section of pneumatic cylinder

The type that use in the experiment was use the double acting cylinder instead of single acting cylinder. Double acting cylinder may apply the air pressure alternately to the piston and will producing the extended force and retracted force.

Figure 2.2: Double acting cylinder and its symbol

2.2 5/2 DIRECTIONAL CONTROL SOLENOID VALVE

Solenoid valve is used to control the flow of the gas from air compressor in a positive, fully closed or in fully open mode. The use of valve is also generally to

replace the manual of valve where desirable use of remote control. The basic operation of solenoid is, it works with opening and closing the orifice in a valve body. So that it will allows and prevent the air flowing through the valve.

Figure 2.3: 5/2 way solenoid valve

For 5/2 way solenoid valve, it is operate when the pressure pulse from air compressor is flow into the pressure control as at „P" figure below, the spool will transfer to the left by connecting the inlet P and work passage „B". As for work passage A then will release pressure whether through air exhaust in R1 or R2. Therefore, the operation position of this directional valve will remain until it get the instruction in opposite. At the same time, it is call this operation have the function of memory.

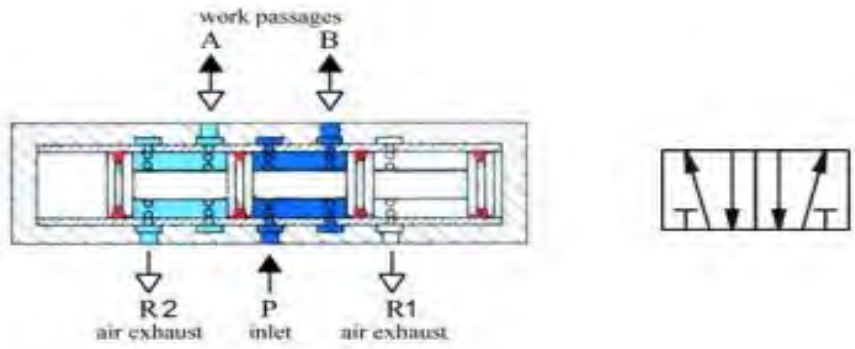

Figure 2.4: The cross section of 5/2 way solenoid valve and its symbol.