PROGRAMMABLE PULSE WIDTH MODULATION (PWM) USER INTERFACE FOR H-BRIDGE DRIVER

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PROGRAMMABLE PWM USER INTERFACE H-BRIDGE DRIVER

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May 2009

" I hereby declare that I have read through this report entitle "Programmable PWM User Interface H-Bridge Driver" 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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Date : 20 April 2009

"I declare that this report entitle "Programmable PWM User Interface H-Bridge Driver" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : MOHD IZWANNI BIN SARIMAN

Date : 20 APRIL 2009

For my beloved father and mother

Haji Shariman Bin. Haji Razali and Hajah Rosniah Binti Redzuan

In appreciation of supported and understanding.

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ABSTRACT

A Pulse Width Modulation (PWM) is widely used in different areas of control systems, such as robotics, industrial process control, power control systems, etc. A PWM circuit converts a DC voltage into a series of pulses, so that the pulse duration is directly proportional to the value of DC voltage. There are two of the more popular form PWM techniques which is Simple, locked anti-phase PWM technique and Sign/Magnitude PWM technique. The H-Bridge Driver circuit is to drive the DC motor which is controlled by PWM (Pulse Width Modulation) signal. The interface was used to connect the H-Bridge Driver circuit with PWM signal. On the PC, a graphical user interface (GUI) will be developed which will adjust the value of frequency and the duty cycle for control the position and speed DC motor. The user will be able to enter the desired value of set point on the GUI and the speed for this motor can high or low and the position for DC motor change from counterclockwise or anti clockwise. Overall, this project will provide a user friendly graphical presentation so that the control and monitoring process will be simple and convenient.

ABSTRAK

Pemodulatan Lebar Denyut (PWM) telah digunakan dengan meluas dalam sistem kawalan yang berbeza kawasan seperti robotik, proses kawalan industri, sistem kawalan kuasa, dan sebagainya. Litar PWM boleh menukarkan voltan arus terus kepada nada denyut yang sesiri supaya tempoh nada denyut adalah berkadaran terus dengan nilai voltan arus terus. Terdapat 2 jenis teknik PWM yang popular iaitu teknik PWM yang ringkas dan anti-fasa berkunci dan teknik magnitude PWM. Perkakasan H-Bridge digunakan untuk memacu motor-arus terus yang dikawal oleh isyarat PWM (Pemodulatan Lebar Denyut). Pengantaramukaan digunakan untuk menghubungkan H-Bridge dengan isyarat PWM. Antara muka grafik pengguna (GUI) dibina, untuk mengawal nilai frekuensi dan kitaran masa bagi mengawal arah pusingan dan kelajuan motor arus terus. Pengguna boleh memasukkan sebarang nilai yang dingini pada antaramuka grafik pengguna (GUI) dan kelajuan motor boleh ditinggikan atau direndahkan dan kedudukan motor arus terus akan berubah mengikut pusingan arah jam atau lawan arah jam. Keseluruhan, projek ini menyediakan program yang mesra pengguna,jadi proses kawalan dan pemantauan boleh dilakukan dengan mudah dan cepat.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Pulse-width modulation (PWM) of a signal or power source involves the modulation of its duty cycle, to either convey information over a communications channel or control the amount of power sent to a load. There are many applications of PWM. One particular application of PWM that is common to industrial robotics, industrial process control, power control systems, etc. is in switch-mode servo amplifiers.

Pulse Width Modulation (PWM) technique is employed to control motor speed. A VI (virtual instrument) is developed with LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) that allows the DAQ to read a user selected reference voltage continuously. The VI also generates a suitable triangular wave that with the help of the reference signal produces the desired PWM signal. PWM is an analog signal that switches between two predefined limits. The switching interval of the PWM controlled by the reference signal determines the average power delivered to the motor circuit. The PWM signal is sent through the output port of the DAQ by the VI which in turn controls the motor speed. User from the front panel of the VI may input the duty cycle and the frequency of the square wave, sampling rate of the reference signal, and the desired amplitude of the PWM. As the reference voltage increases, the width of the PWM (duty cycle) increases which in turn. A DC motor position control system is developed using National Instrument's LabVIEW software and Data Acquisition Board. A path generation technique is utilized to compute a speed profile of the motor. The path generation for motor position can be easily adjusted with the software which saves project development time.

1.2 Problem Statement

Basically the DC motor was control using manually of function generator or Pulse Width Modulation (PWM) generator circuit. Generating pulse width modulation signal using 555 integrated circuit (IC) is also very popular. So that, the power losses more highly and not efficiency. To overcome this problem, the Programmable Pulse Width Modulation (PWM) user interface was developed. In this project the pulse width modulation is easily obtained with the LabVIEW software. The major hardware component, pulse width modulator, of the motor speed control system can thus be eliminated. The software also allows adjusting the performance characteristics of the signal with little effort. This project can be providing interactive learning for student on learning the concept of PWM.

1.3 Project Objectives

The main objectives of this project can be described as:

1) To develop user interface of PWM signal in PC for H-Bridge driver that can be used to drive an electric motor.
2) To control the frequency, amplitude and duty cycle of Pulse Width Modulation (PWM) in software environment.
3) To develop monitoring and controlling system to drive an electric motor by implementing the Graphic user interface (GUI).
4) To improve the controlling system in drive the electric motor which is varies speed, rotational and direction with database system.

1.4 Project Scope

This project will focus on the design and development circuit and graphical user interface (GUI) to interconnect an H-bridge driver and a dc motor to a single personal computer. The method to interface the circuit to the personal computer will be studied and developed. Thus the scopes are:

1) GUI–Generate PWM user interface using Labview 7.1 software (Visual Programming Language).
2) Interface Module – Used NI USB 6009 Data acquisition card (DAQ) that most compatible with Labview software.
3) Used DMOS H-Bridge driver to control the speed of DC Motor.
4) In this project a VI developed with LabVIEW software generates the PWM signal.
5) Control the duty cycle in the range of 0 to 100%

1.5 Literature Review

In this section, analyze an impressive list of earlier works about Programmable PWM interface H-Bridge Driver. It is also include the review, and summarized related previous project in term of programmable Width Modulation (PWM), interface module control method and Labview software. All the sources are from the books, internet and also the journal.

1.5.1 Programmable Width Modulation (PWM)

PWM is the factor industrial standard for high efficiency power transfer in a variety of high performance applications, which include motor speed drives, dc to ac inverters and switch mode Power Supply. Previous study [1]-[10], Pulse Width Modulation (PWM) technique is employed to control motor speed. It can be also generated using software alone,

by hardware alone or by using both. Many micro controllers such as AT Mega series and some PICs today have in built PWM channels which are fully software independent based on [4].

Three commonly used PWM techniques are Sinusoidal PWM technique, Space Vector PWM technique and Hysteresis (bang-bang). The pulses of a symmetric PWM signal are always symmetric with respect to the center of each PWM period. The pulses of an asymmetric PWM signal always have the same side aligned with one end of each PWM period as in [7]. Figure 1.1 that obtained from [5], show that the output of pulse width modulation

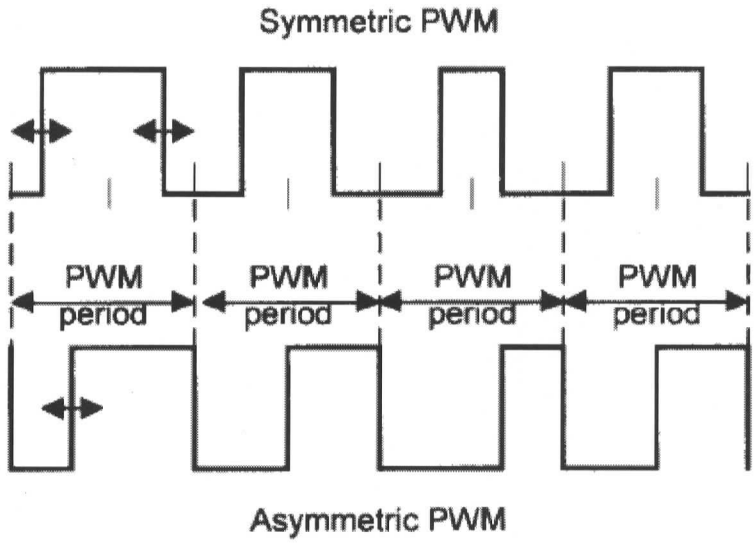

Figure 1.1: Output of Pulse Width-Modulation

The most efficient method of controlling the output voltage is incorporate PWM control within the inverters. In this method, a fixed DC input voltage is supplied to the inverter and controlled AC output voltage is obtained by adjusting the on and off periods of the inverter devices. According to [6], the PWM control has the following advantages:

i. The output voltage control can be obtained without any additional components.
ii. With this type of control, lower order harmonics can be eliminated or minimized along with it output voltage control. Therefore the filtering requirements are minimized as higher order harmonics can be filtered easily.

In [4], [6] and [7] studies, Pulse Width Modulation (PWM) is widely used in different areas of control systems, such as robotics, industrial process control, power control systems. A PWM circuit converts a DC voltage into a series of pulses, so that the pulse duration is directly proportional to the value of DC voltage.

Basically, the majority of applications use a 555 IC timer as pulse-width modulator in. [4], [6] and [7]. The concept of PWM inherently requires timing. The classic 555 timer chip and some potentiometers can be used to generate PWM. The pots are manually adjusted for the desired duty cycle. However, if used a PC, it can automatically change the duty cycle and PC can control motor's speed [4].

As discussed and mentioned in [3]-[5], the switching control of the PC's fan motor is fairly conventional pulse-width-modulation (PWM) technology for a single-phase, non-reversing motor. While the control of the motor is rather straightforward, the system aspects of cooling can be quite complex. In PC applications, the motor has a two-, three-, or four-wire connector from the processor. The fan connector provides both an interface and a barrier. In [4], the prevalent method currently used for controlling fan speed in PCs is low-frequency PWM control. In this approach, the voltage applied to the fan is always either zero or full-scale avoiding the problems experienced in linear control at lower voltages. Figure 1.2 that obtained from [4], show that he low-frequency PWM fan-drive circuit.

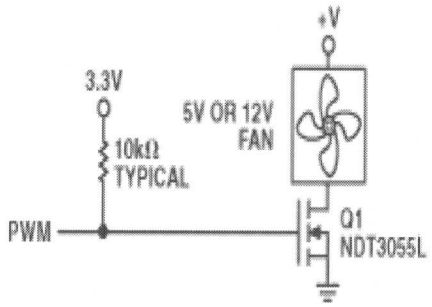

Figure 1.2: A low-frequency PWM fan-drive circuit.

The PWM signal is sent through the output port of the DAQ by the Virtual Instrument (VI) which in turn controls the motor speed as discussed [1] and [2].

1.5.2 Interface Module

As discussed and mentioned in [11]-[15], the interfaces from PWM with another component from PC have several types:

i. Serial Port
ii. Parallel Port
iii. USB Port

1.5.2.1 Serial Port

As discussed in [11] and [12]. Serial refers to data sent over a single wire, with each bit lining up in a series as the bits are sent. This type of communication is used over the phone system, because this system provides one wire for data in each direction. Add-on serial ports for the PC are available from many manufacturers. Usually these ports can be finding on one of the multifunction boards available or on a board with at least a parallel port. Serial ports may connect to a variety of devices such as modems, plotters, printers, other computers, bar code readers, scales, and device control circuits. Basically, anything that needs a two-way connection to the PC uses the industry-standard reference Standard number 232 revision c (RS-232c) serial ports. This device enables data transfer between incompatible devices as in [11]. Figure 1.3 shows that the serial port diagram.

Figure 1.3: Serial Port

In computing, a serial port is a serial communication physical interface through which information transfers in or out one bit at a time (contrast parallel port). Throughout most of the history of personal computers, data transfer through serial ports connected the computer to devices such as terminals and various peripherals, based on [11] and [12].

1.5.2.2Parallel Port

From the previous works [14] and [15], a parallel port is a type of interface found on computers (personal and otherwise) for connecting various peripherals. It is also known as a printer port or Centronics port. The IEEE 1284 standard defines the bi-directional version of the port.

Parallel port has eight lines for sending all the bits that comprise 1 byte of data simultaneously across eight wires. This interface is fast and has traditionally been used for printers. However, programs to transfer data between systems have always used the parallel port as an option for transmitting data because it can do so 4 bits at a time rather than 1 bit at a time with a serial interface. The only problem with parallel ports is that their cables cannot be extended for any great length without amplifying the signal, or errors occur in the data based on [13]. Figures 1.4 show below that the parallel port.

Figure 1.4: Parallel Port