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Research Article

Design of Fuzzy Logic Controller for Controlling Physical Parameter

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A B S T R A C T

In this paper the design and development of a fuzzy logic controller for controlling physical parameters is presented. The duty cycle of the DC motor is taken as a prime variant of the system to control the parameters. ATmega16 Microcontroller based system is designed and presented. This technique may find its applications in the systems which need control of physical parameters as a vital factor.

Keywords: Fuzzy Logic, Microcontroller, DC Motor, Physical Parameter

Introduction

Automatic controllers require a precise mathematical model for the given system to be controlled. In many complex industrial processes, the construction of mathematical model is too difficult and very complex and nonlinear. In such situations, Fuzzy Logic Controllers (FLC) are most appropriate. In order to improve the performance of the system, one has to apply FLC technique because they give high stability, more robust control, more accuracy and higher flexibility.

The brushed DC motor was invented in 1856 by Werner Von Siemens in Germany. Variable speed by armature voltage control was first used in the early 1930s using a system involving a constant speed AC motor driving a D.C. generator in the design and implementation. DC motors are widely used in industry applications, robotics and domestic appliances because of their low cost and less complex control structure and wide range of speed and torque.

The present study is to design and develop fuzzy logic controllers for control of physical parameters. Researcher highlighted an insight into design and development of fuzzy logic controller for control of physical parameters like temperature, pressure, humidity, speed, motion, position, vision etc. using micro controllers. Hence, in the present project the researcher used the speed as main parameter using microcontroller ATmega16.

ATmega16 Microcontroller: The AT mega 16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

DC Motor Driver: L 293D is a dual H-bridge motor driver Integrated Circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher current signal. This higher current signal is used to drive the motors. An H- bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. These circuits are often used in robotics and other Applications to allow DC motors to run forwards and backwards. Most DC-to-AC converters (power inverters), most AC/ AC converters, the DC-to-DC push-pull converter, most motor controllers, and many other kinds of power electronics use H bridges.

Objectives

Design and develop the hardware for control of speed parameters using fuzzy logic controllers. Design and develop the software for control of Physical Parameters using fuzzy logic controllers. Study the designed hardware and software for control of Physical Parameters using fuzzy logic controllers.

Methodology

The Methodology used with complete system is shown in Figure 1. The hardware system has been developed and tested under laboratory conditions. It consists of ATmega16 the 8 bit microcontroller programmer. This device is interfaced to the Liquid Crystal Display (LCD) for display of speed of the motor. The Opto-Isolator is included to provide isolation between control unit and power driving unit of the whole system. The MOSFET Driver circuit is used to provide necessary voltage and current to the H-bridge circuit. The Separate power supply unit is incorporated to energize the H-bridge. The differential amplifier, F-V converter and the I.R Sensors are used to generate and condition the signal.

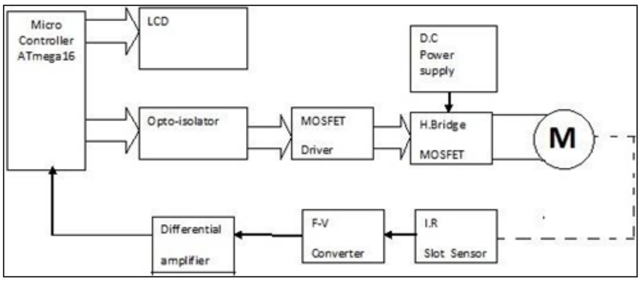

Figure 1.Methodology of the System

Result and Discussion

Response of the pulse width in respect to the change in rpm of the motor when rotated in clockwise and counter clockwise direction.

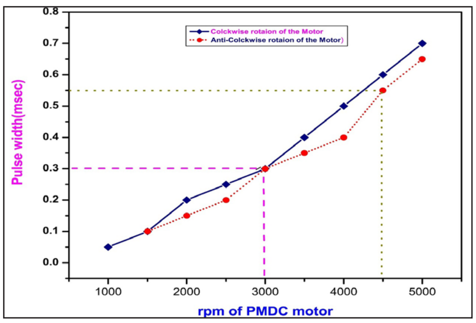

Figure 2.Variation of the Pulse Width against rpm of the PMDC Motor

In this graph it is clear that, by moving the PMDC motor is rotated in clockwise and counter clockwise direction. The rpm of the motor is kept as independent variable. The speed of PMDC motor is increased by applying the suitable voltage to get fixed rpm in clockwise and counterclockwise direction. With respect to this speed the change in pulse width is observed. Pulse width changes nonlinearly from 1000 to 3000 rpm of the PMDC motor when rotated in clockwise direction. Further, when the rpm of the motor attains the value of 4000 to 5000 the pulse width increases linearly. From the same graph it is clear that, when the motor is rotated in counter-clockwise direction, the non linearity of the pulse width is achieved between 1000 to 4500 rpm of the motor. Later, the pulse width becomes linear from the rpm value of 5000. The major advantage is seen from 1500 to 3000 rpm that, the pulse width shows dip and rise at around 2000 rpm. This feature is very useful in control system in maintaining balanced control of the physical parameters.

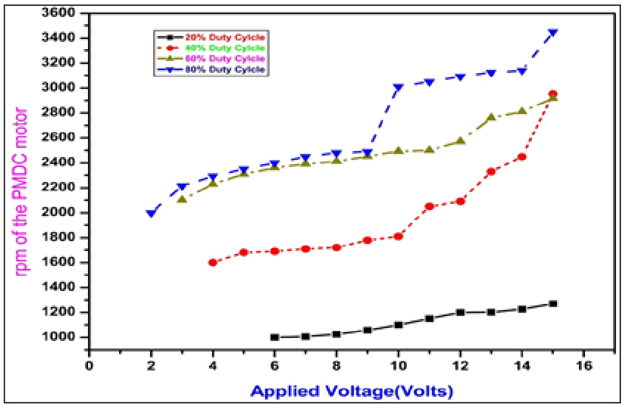

Figure 3.Variation of rpm of the PMDC Motor against Applied Voltage

Response of the PMDC motor for varying applied voltage of the MOSFET Driver IR 2110 under variable duty cycle of the pulse are represented in below Figures 4-6.

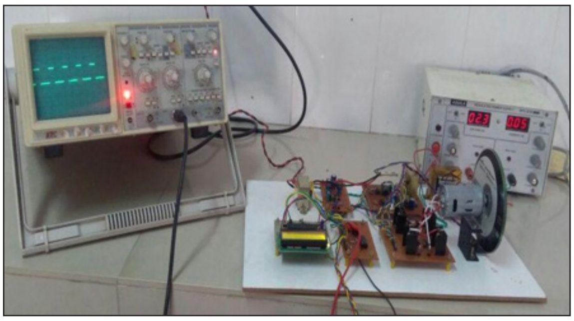

Figure 4.The Variation of Speed of Motor for 20% Duty Cycle

From Figure 4-6, the overall response of the PMDC motor is seen when the duty cycles are set as 20%, 40%, 60% and 80%. It is observed that, the rpm of the motor is directly proportional to the pulse width of the signal applied. When the duty cycle of the pulse is fixed at 20%, the motor shown the constant speed of about 1100 rpm. Further, when the duty cycle is set at 40% the PMDC motor attained the rpm of 1600 and remained constant over the voltage range of 4 to 10 volts. In the next, study when the duty cycle is increased to 60%, the speed of the motor raised to around

2050 rpm and took the constant values over the voltage range of 2 to 9 volts. Finally, when the duty cycle is taken as 80%, the motor shown regular rise. Also, when the pulse voltage is between 9-14 volts the rpm of the motor shoot-up drastically and later, beyond 14V of the pulse voltage the rpm of the motor shown linearly increasing speed. The variation of speed of motor with respect to change in duty cycle is shown in the above photographs.

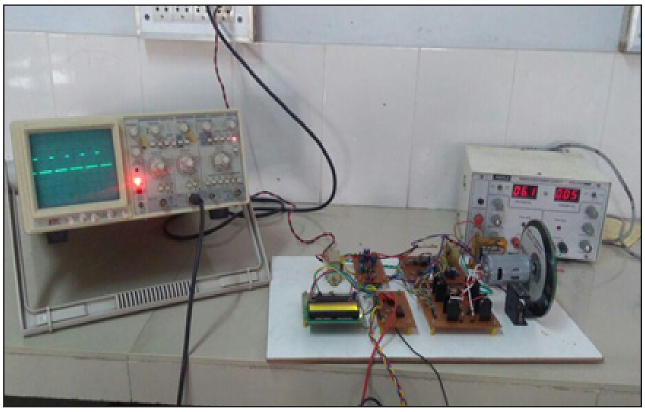

Figure 5.The Variation of Speed of Motor for 40% Duty Cycle

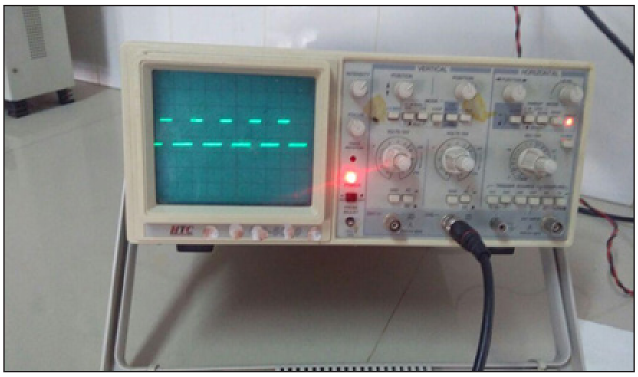

Figure 6.The Variation of Speed of Motor for 80% Duty Cycle

Conclusion

This work laid the new era of in modern control system. The linear and non linear control of the PMDC motor showed the light in many industrial and R and D applications. The control of speed of motor using the set of duty cycle variation made the robotic application in hand to achieve tasks where human hazard is observed.

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