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SPEED CONTROL OF PMSM USING FUZZY LOGIC AND PID CONTROLLER

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ABSTRACT

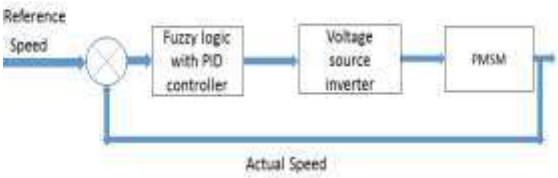
This paper presents the speed control Of permanent magnet synchronous motor. The required speed achieved by the proportional integral derivative[PID] and fuzzy logic controller[FLC]. The PMSM separately simulated with the PID and FLC and the settling time of the speed curve Noted. Which one gives the lesser timing that controller will be implemented. The PMSM has advantages in contrast with the AC induction motor. Because a PMSM achieves higher efficiency and regulation. The speed sense through the proximity sensor is compared with the reference value and the error obtained is given to the specific controller and the process continuous till minimum error is obtained. The output from the controller is converted into corresponding PWM output signal. Depends on the signal given to the inverter the will be controlled. Thus the closed loop speed control of PMSM is achieved by the controller. The proposed concept can be applied to fuzzy logic control system in order to improve the stability of the system by using MATLAB/SIMULATION software and the results are verified.

KEYWORDS—***Permanent magnet synchronous motor, proportional integral derivative [PID], fuzzy logic controller [FLC].***

1. INTRODUCTION

Generally a high performance motor drive system must have good dynamic speed control response. The speed control of permanent magnet synchronous motor is more efficient compared with other motor drives. To improve the reliability and efficiency of production in industries the speed control is required. The project provides efficient method to control speed of permanent magnet synchronous motor using fuzzy logic and proportional integral derivative controller. The motor is driven with the three phase voltage source inverter. The controller gets the reference speed from the user side and it is compare with the actual speed of the motor and difference is calculated as error. The error given to the fuzzy logic and proportional integral derivative controller. The output from the controller is converted in to corresponding pulse width modulation signal. Depends on the signal given to the voltage source inverter the speed of the motor is maintained constant.

2. BLOCK DIAGRAM



The single phase AC supply is given to the AC voltage controller. The voltage controller can be triggered by pulse width modulation technique by changing the firing angle. This varying supply voltage can control the speed of the motor. The speed sensor sends the actual speed of the motor to controller and compared with reference speed. The controller output is given to the ac voltage controller in the form of PWM pulses. Depends on the PWM pulses the voltage applied to the PMSM motor will varied.

3. FUZZY LOGIC CONTROL

Fuzzy set theory has been commonly used in the control area with some application to power system. A simple fuzzy logic control theory is built up by a group of systematic rules based on the human knowledge of system behavior. Matlab/Simulink simulation model is constructed to study the dynamic behavior of converter.

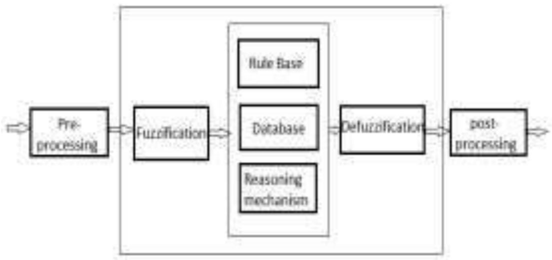


Figure 4.1 Fuzzy logic controller structure

TABLE I
FUZZY LOGIC RULES FOR PRECOMPENSATOR

		$e(k)$						
		NB	NM	NS	ZO	PS	PM	PB
$\Delta e(k)$	NB				NB	NB		
	NM	NB			NB	NB		
	NS	NB			NM	NM	NM	PM
	ZO	NB	NM	NS	ZO	PS	PM	PB
	PS	NM		PS	PS	PM		
	PM				PM	PB	PB	
	PB			PM	PM	PB		

4. PROPORTIONAL INTEGRAL DERIVATIVE (PID) CONTROLLER

Many industrial controllers employ a proportional, integral plus differential PID regulator arrangement that can be tailored to optimize the particular control system. The PID controller is most commonly used algorithm for controller design and it is most widely used controller in industry. The basic types of PID controller are parallel controller, serial controller and mixed controller. In most of the industry PID controllers are the most common control methodology to use in real applications. PID controllers has all the necessary dynamics: fast reaction on change of the controller input (D mode), increase in control signal to lead error towards zero(I mode) and suitable action inside control error area to eliminate the oscillations(P mode).

Derivative mode improves stability of the system and enables increase in gain K and decrease in integral time constant Ti, which increase speed of controller response. PID controllers are the most often used controllers in the process industry. The majority of the control systems in the world are operated PID controllers. PID controller combines the advantage of proportional, derivative and integral action. The control signal is proportional to the error signal and the proportional gain Kp.

If an integrator is added, the control signal is proportional to the integral of error and the integral gain Ki. In integral control will have the effect of reduced the error, in principle, to zero value. Derivative control is used to anticipate the future behaviour of the error signal by using corrective actions based on the rate of change in the error signal. The control signal is proportional to the derivative of the error and Kd is the derivative gain. Derivative control will have the effect of increasing the stability of the system, reducing the overshoot, and improving the transient response. In derivative control action can never be used alone because this control action is effective only during transient periods. The combined action has the advantage of the three individual control actions.

5. SIMULATION RESULTS

For consistent speed operation, the reference speed is set as 1500 rpm. Figure 5.1and figure 5.2 shows the respective simulation for the proportional integral derivative and fuzzy logic controller. Which has oscillations or vibrations during starting but attains steady state within negligible time. The simulation results of the developed simulation model is compared with the mat lab/simulink model of the system. The simulation circuits are designed using the fuzzy logic controller and proportional integral derivative. When compare the simulation results of both the controllers" fuzzy system having the lower settling time than the proportional integral derivative. The simulation results of the simulation system model and the developed simulation model is shown in fig 5.1 and fig 5.2 respectively. It can be observed from, the simulation results of the developed system simulation model and the circuit simulation model well coincides with each other, which shows the exactness of the developed model.

5.1. MATLAB SIMULATION FOR PID CONTROLLER

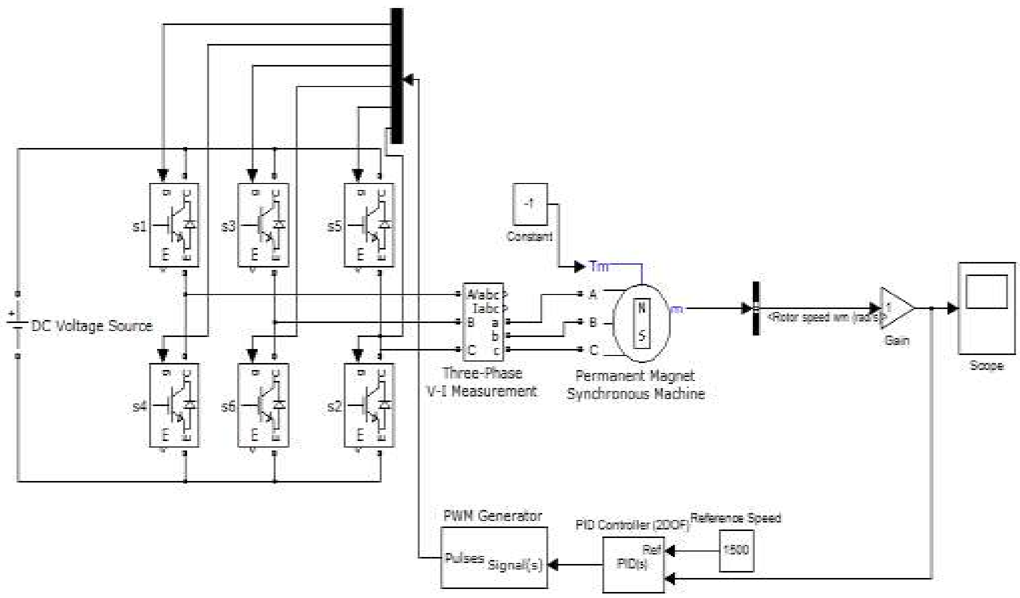


Fig.5.1. Circuit Simulation Model of PMSM using matlab /simulink with Fuzzy Controller

5.1.1PID SIMULATION OUTPUT

Figure5.1.1 Output for PID controller

5.2. MATLAB SIMULATION FOR FUZZY CONTROLLER

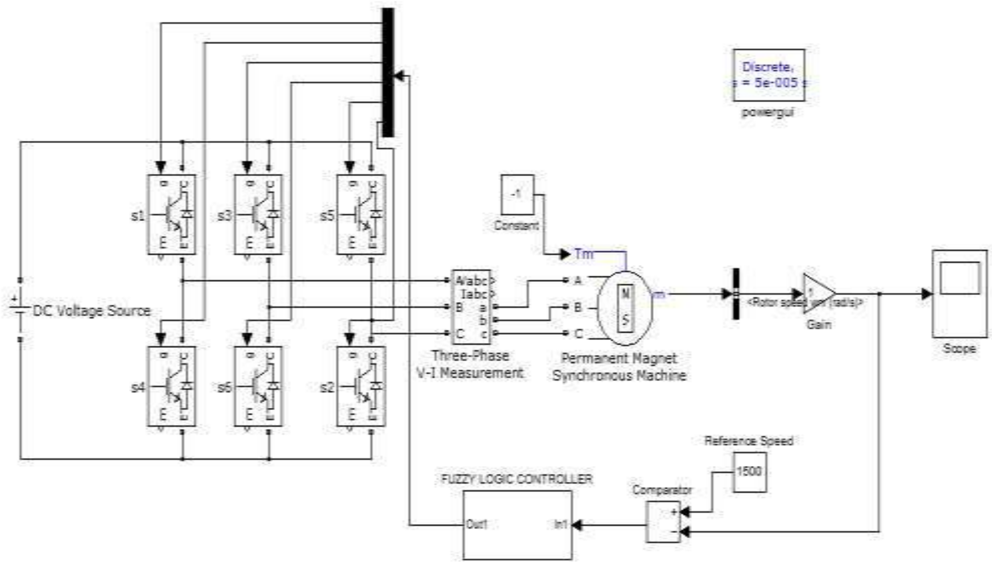


Figure 5.2 Simulation of Fuzzy controller

5.2.1.FUZZY SIMULATION OUTPUT

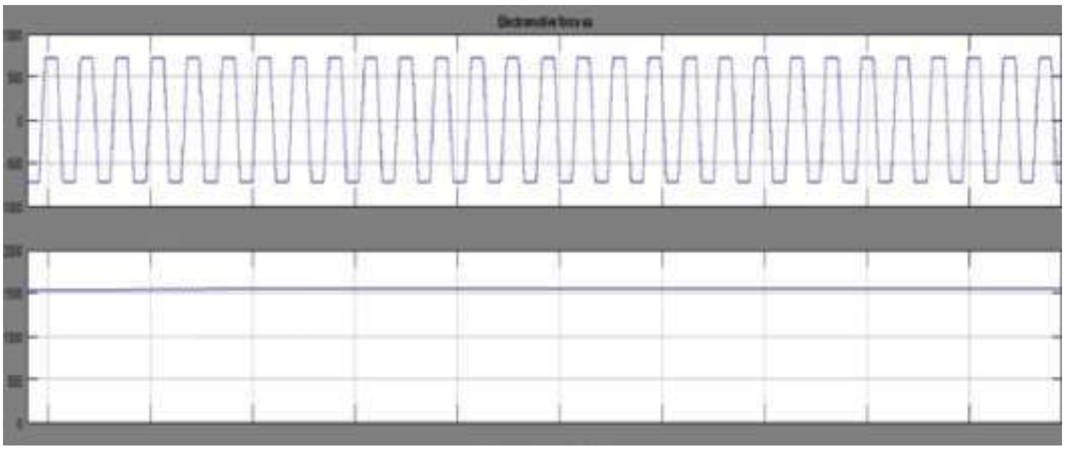


Figure 5.2.1 Output of Fuzzy controller

Table 5.1 Output parameters of PID and fuzzy

Parameter	PID	Fuzzy
Rise time	0.05 sec	0.03 sec
Settling time	0.15 sec	0.1 sec

6. HARDWARE COMPONENTS

6.1. PIC MICROCONTROLLER (16F877A)

PIC 16F877A is one of the most advanced microcontroller from Microchip. This controller is widely used for experimental then modern applications because of its low price, wide range of applications, high quality, ease of availability. It is ideal for applications like machine control applications, measurement devices, study purpose. and so on. The PIC 16F877A features all the components which modem micro controllers normally have.

6.2. PROXIMITY SENSOR

Inductive proximity sensors are used in various applications to detect metal devices. They can be used in various environments (industry, workshop, lift shaft...) and needs high reliability.

Inductive proximity sensors generate an electromagnetic field and detect the eddy current losses induced when the metal target enters the field. The field is generated by a coil, wrapped round a ferrite core, which is used by a transistorized circuit to produce oscillations. The target, while entering the electromagnetic field produced by the coil, will decrease the oscillations due to eddy currents developed in the target. If the target approaches the sensor within the so-called "sensing range", the oscillations cannot be produced anymore: the detector circuit generates then an output signal controlling a relay or a switch.

6.2.1. CIRCUIT DESCRIPTION

The wheel type metal rod is fixed in motor shaft. The proximity sensor is placed near shaft. When the shaft is rotating, the metal rod is crossed proximity sensors sequentially. So the sensor gives pulse to the microcontroller. Now the microcontroller starts to counts the pulse. By using pulse count we can find revolution per minute which is equal to speed of the microcontroller.

6.3. STEPDOWN TRANSFORMER

A step down transformer has more turns of wire on primary coil and less turns of wire on the secondary coil. This takes a smaller included voltage in the secondary coil. Compare it with a step up transformer. It is called step down transformer because the output voltage is smaller than the input voltage. If the secondary coil has half many turns of wire then the output voltage will be half the input voltage. Decreasing the voltage does not decrease power. As the voltage goes down, the current moves up. Here the 230 volts input voltage converted to 18 volts.

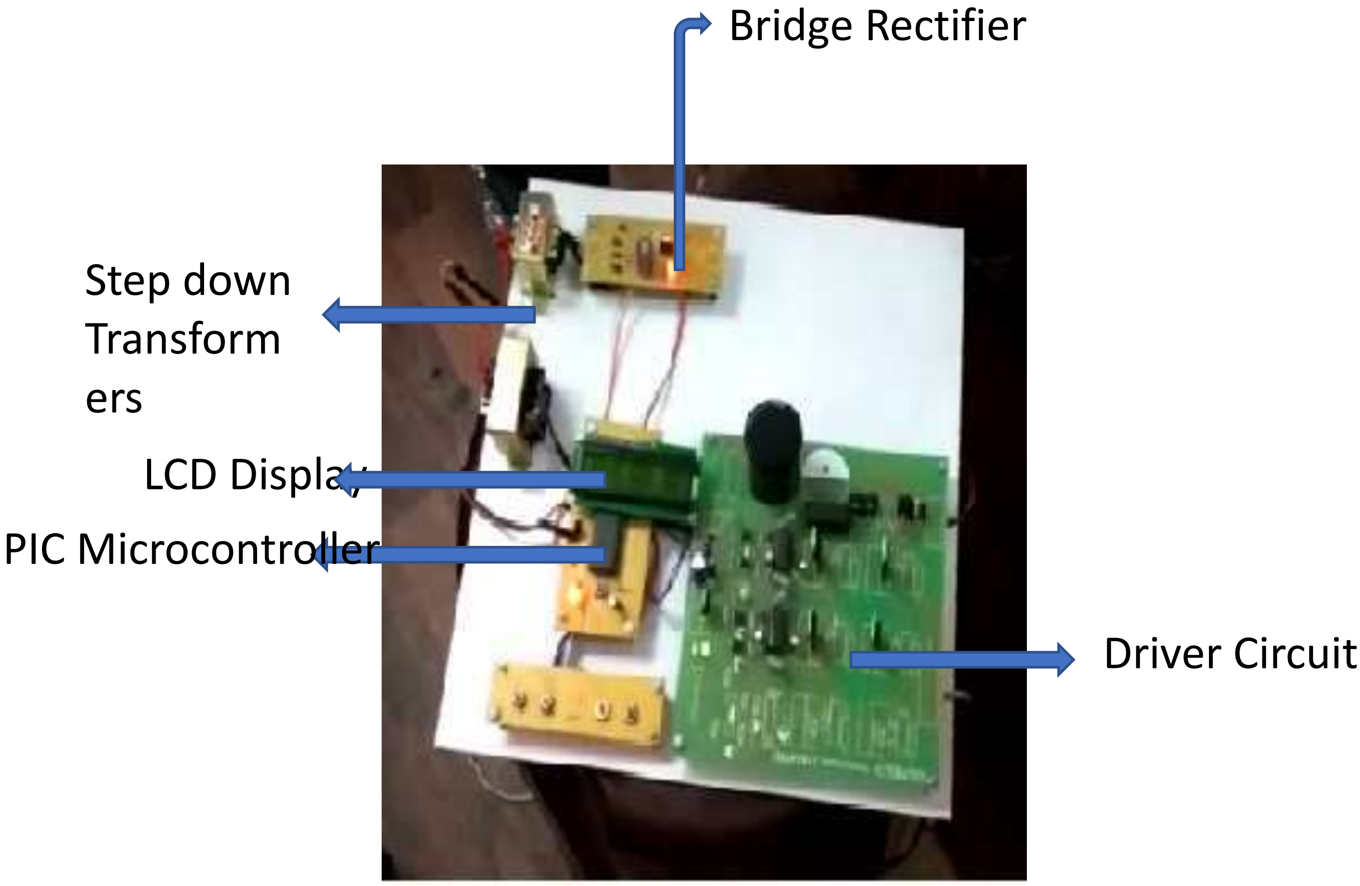
6.4.OPTOCOUPLER

Optocoupler or optical isolator, is a component that transfers electrical signals between two isolated circuits by using light. Opto-isolators is prevent high voltages from affecting the system receiving the signal. Commercially available opto-isolators withstands input-to-output voltages up to 10 kV and voltage transients with speeds up to 10 kV/10-6s. A common type of opto- isolator consists of an LED , a phototransistor in the same opaque package. Other types of source-sensor combinations include LED-photodiode, LED-LASCR, and lamp photo resistor pairs. Usually opto-isolators transfer digital (on-of) signals, but some techniques allow them to be used with analog signals. Fig 4.5 showing the source of light (LED) on the left, dielectric barrier in the centre and the sensor(phototransistor) on the right.

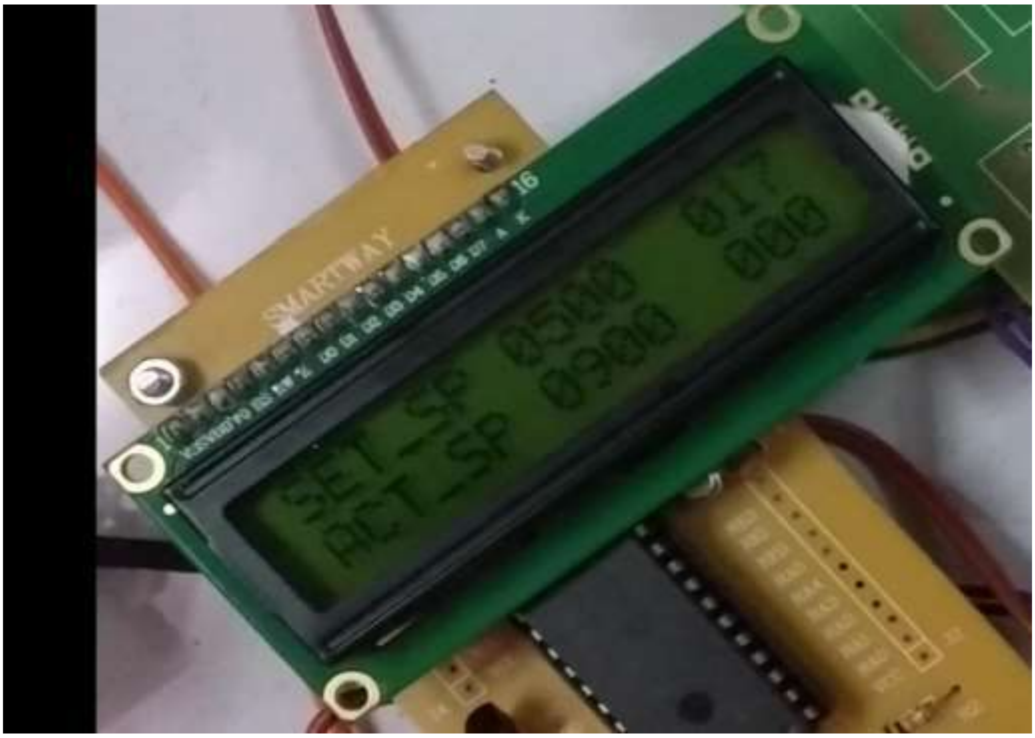
6.5.LCD DISPLAY

LCD (Liquid Crystal Display) screen is an electronic display module used here. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In that LCD each character is displayed in 5x7 pixel matrix. That LCD has two registers, namely, Command and Data. The command register stores the command instructions given to that LCD. A command is an instruction given to LCD to do predefined task like initializing it, clearing its screen and setting the cursor position, controlling display etc. The data register stores the data to be displayed on that LCD. The data is the ASCIl value of the character to be displayed on the LCD.

6.6. HARDWARE IMPLEMENTATION



RESULT:



7. CONCLUSION

In this project the speed of control permanent magnet synchronous motor is achieved by using the fuzzy logic and proportional integral derivative controller. The comparison of fuzzy logic and proportional integral derivative controller is done by using the MATLAB Simulink. The settling time of the fuzzy logic controller is 0.1sec and the proportional integral derivative controller is 0.15sec. If compares these two controllers the speed curve settling time of the fuzzy logic controller is lesser than the proportional integral controller. So that the speed control of permanent magnet synchronous motor is achieved faster than the PID controller by using fuzzy controller.

9. REFERENCE

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