SPEED CONTROL OF SWITCHED RELUCTANCE MOTOR POWERED BY RENEWABLE ENERGY

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Abstract
The work presented in this paper is speed control of switched reluctance motor (SRM) applied to a SEPIC converter. A PV generator and wind energy is used for energy supply. Fuzzy logic control is been an important methodology in many fields. This paper proposes a Fuzzy Logic Controller (FLC) to control the speed of SRM motor. The primary objective of this work is to compare the operation of P& PI based conventional controller to provide effective performance using Fuzzy Logic Control. The present work concentrates on the design of a fuzzy logic controller for the SRM speed control. Thus the result of applying fuzzy logic controller to the SRM drive gives the best performance and higher robustness than conventional P & PI controller. Simulation is then done using Matlab Simulink.
Keywords: Switched Reluctance Motor (SRM); Photovoltaic's; MPPT control; wind energy; SEPIC converter; fuzzy logic control;

I.INTRODUCTION

Photovoltaic Generators (PV) gives a clean and unlimited source of energy. As part of an ongoing project on low-cost PV powered Electrical Vehicles, a control system is evaluated for required configuration, based on the PV panels that used to power a Switched Reluctance Motor, using independent controllers for maximizing the power supply and optimizing the operation of the SRM motor. In this paper the simulink model for the speed control of switched reluctance motor by use of renewable source is carried out by using different speed controllers. The simulink model is designed for P, PI & Fuzzy logic controller separately and their performance result has been compared. The Switched Reluctance Motor is an electric motor which runs by a reluctance torque. Industrial applications require very high speed of 50,000 rpm motor. The speed controllers applied here are based on conventional P& PI Controller and the other one is AI based Fuzzy Logic Controller. Fuzzy logic is a many valued logic which as much like a human reasoning. In the industrial control of FLC have various applications, particularly where this conventional control design techniques are very difficult to apply. A comprehensive review has done for SRM machine modeling, design, simulation, analysis and control.

The wind energy is a form of solar energy. Wind energy (or wind power) describes the process by which wind is used to produce electricity. Wind turbines are used to convert the kinetic energy into mechanical power. A generator can convert mechanical power into electricity. Electricity from wind is done by using a large wind turbine usually consisting of propellers; the turbine can be given to a generator to generate electricity, or the wind used as mechanical power for applications such as pumping water or grinding grain. As the wind passes the turbines it moves the blades, which spins the shaft. To provide the maximum possible power in varying conditions, the control system aims to obtain the PV generators and wind turbine so that they are always at the Maximum PowerPoint (MPP) (which changes with the sustainable values of solar radiation and panel temperature and with the characteristics of the load connected to the PV and wind). Therefore, a Maximum Power Point Tracking (MPPT) strategy is used to obtain the maximum power from the panel. Many methods have been developed to determine Maximum Power Point Tracking (MPPT): This paper consider the problem of coupling these energy sources to power an electrical motor in a stand alone application. When a SRM load is supplied from the PV generator and wind energy through a SEPIC converter thus the duty cycle is controlled using a specific MPPT controller. In this study, the duty cycle is calculated and adjusted in order to maximize power operation of the whole installation.

II.SYSTEM DESCRIPTION

A Switched Reluctance Motor is a singly excited, doubly- salient pole machine in which the electromagnetic torque is created due to variable reluctance principle. Both stator and rotor consists of salient poles but only the stator carries windings. As in dc motor the SRM has wound field coils for stator windings. However the rotor has been no attached coils or magnets. The projecting magnetic poles of salient pole rotor are made up of very soft magnetic material. When the excitation is given to stator windings, a force is created due to rotor's magnetic reluctance to align the rotor pole with its adjacent stator pole. In order to maintain a sequence rotation, the windings of its stator pole switches in sequential manner by means of electronic control system. So, the magnetic field of the rotor pole was lead by the stator pole, pulling towards in it. The rotor pole is said to be "fully unaligned position" when the rotor pole is equidistant from its two adjacent stator pole. This position is called as maximum magnetic field of reluctance for its rotor pole.

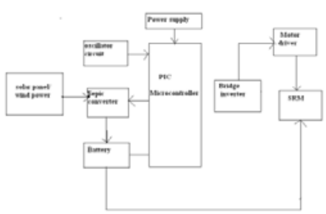

Fig.1. Block Diagram of Proposed System

a.Block Diagram

From the Fig.1 the position of rotor is being sensed by the rotor position sensor and it provides its corresponding output to its error detector. Error detector compares the reference speed with theactual speed to provide error signal which is given to controller block. Thus either fuzzy or the PI controller gives control signal to the converter as per the error signal. The speed of the motor is been controlled by the converter through proper excitation of their corresponding windings.

1.Photovoltaic Generator:

The PV generator has many photovoltaic modules adequately connected in series and parallel and to provide its desired voltage and current obtained by the system. The specific cha) and parallel (np), that has been selected according to type of the solar modules have been used and the expected solar radiation, and ambient temperature of the location where the PV generator has be used. Cell characteristics of the PV generator depends on the number of modules connected in series (ns The equivalent circuit for each solar module, internally arranged in np parallel and Ns series.

2.Wind energy:

It is a source of renewable energy which means it can be produced again and again. Unlike fossil fuels that are being depleted in years to come, wind energy has immense potential and can be used to produce free source of power as like solar and hydro power. It is cleanest form of renewable energy and is being used in many leading and developing nations to fulfill their demand for electricity.

3.MPPT Control Strategy:

MPPT is essentially a real time process to provide the combination of current and voltages at the output of the PV generator that give the maximum possible power that can be produced from the PV under given operating conditions .Although there are several MPP tracking methods, the most frequent is the P&O algorithm. The principle of this control algorithm is to create small disturbances on by decreasing or increasing the duty cyclic and observing the effect on the power output of PV generator.

III.SPEED CONTROL OF SRM USING FUZZY LOGIC CONTROLLER

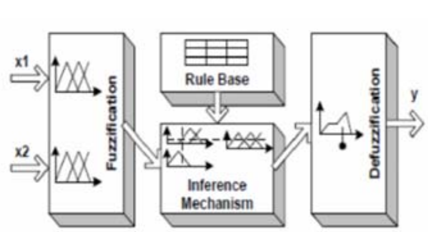

Fig 2. Structure of fuzzy logic controller.

The merits of fuzzy logic controller are the clarification for a problem is a very easy task and the design of the controller can be easily implemented. The design of fuzzy logic system is not based on its mathematical model of process. The four main category in fuzzy logic controller (Figure 2): fuzzification, rule base, inference mechanism and the defuzzification as shown in the Figure 3. The surface view of FLC is shown in Figure 4. Thus the fuzzification is very easy but it comprises the process of transpose crisp values into the grades of membership for linguistic terms of fuzzy sets. The transpose from the fuzzy set to a crisp number is called the defuzzification. The inference engine and its knowledge base were the components of an expert system. This knowledge base stores the factual knowledge of the operation of being used . Fuzzy inference engine is the best process for calculating a given input to an output using fuzzy logic. In inference engine, If Then type fuzzy rules converts the fuzzy input ovear all to its output.

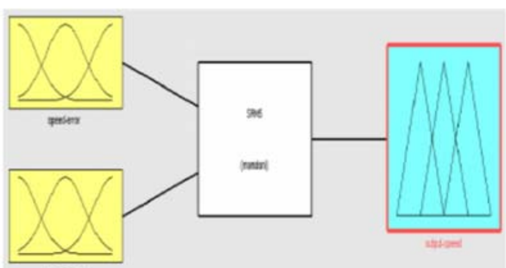

Fig 3. Fuzzy Inference System of SRM

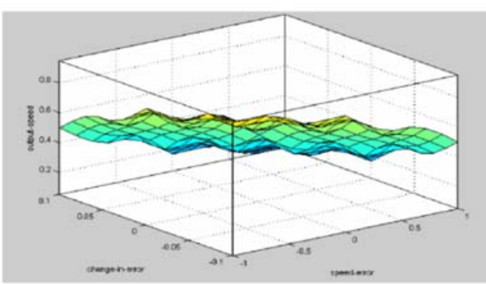

Fig 4. Surface view of FLC

	e						
Δe	NL	NM	NS	ZR	PS	PM	PL
NL	PL	PL	PM	PM	PS	PS	ZR
NM	PL	PM	PM	PS	PS	ZR	NS
NS	PM	PM	PS	PS	ZR	NS	NS
ZR	PM	PS	PS	ZR	NS	NS	NM
PS	PS	PS	ZR	NS	NS	NM	NM
PM	PS	ZR	NS	NS	NM	NM	NL
PL	ZR	NS	NS	NM	NM	NL	NL

Table 1. FLC Rule Table

Mamdani type fuzzy logic controller is the most commonly used in a closed loop control system, because it reduces the steady state error has finally to zero. The designed fuzzy rules based used in this research are given in Table 1. The fuzzy logic sets have been defined as: the negative large (NL), the negative medium (NM), the negative small (NS), zero (ZR), and positive small (PS), positive medium (PM) and the positive large (PL) respectively. Many research papers have developed SRM models been based on the fuzzy logic, hybrid fuzzy and neural techniques2–4. The simulink model is designed for the speed control of Switched Reluctance Motor by using Fuzzy logic controller using renewable energy and their corresponding waveform is shown in Figures 5-9.

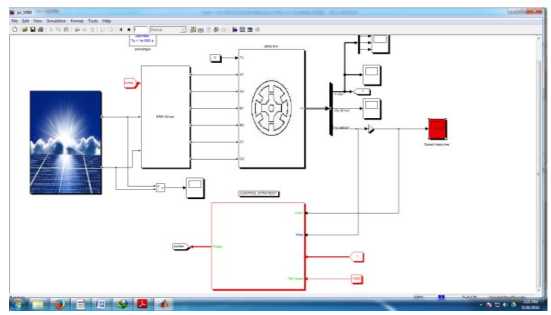

Fig.5 Simulink Model of FLC System in solar

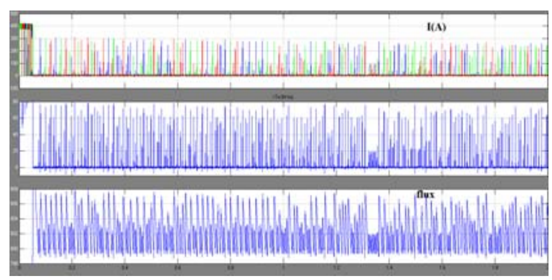

Fig.6 output waveforms of current, flux and torque.

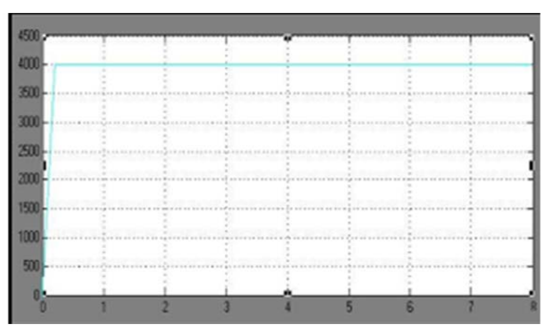

Fig.7 output waveforms of speed

If set speed is 4000, the actual speed displayed is 4000 and the settling time is 0.2. From speed waveform, it can be notified that the fuzzy logic controller increases the speed regulation and it is a perfect speed tracking without overshoot. For reference speed 4000, the following actual speed and settling time were obtained.

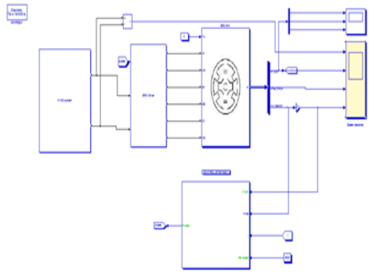

Fig.8 Simulink Model of FLC System in wind

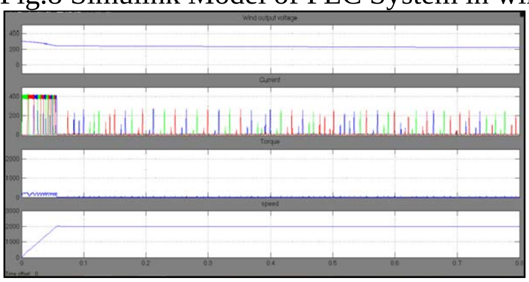

Fig.9 output waveforms of current,flux,torque and speed.

If set speed is 2000, the actual speed displayed is 2000 and the settling time is 0.05. From speed waveform, it can be notified that the fuzzy logic controller enhances the speed regulation and it is a best speed tracking without overshoot. For reference speed 2000, the following actual speed and settling time were obtained.

IV.CONCLUSION

Thus the SRM dynamic performance is forecasted and by using MATLAB/simulink the model is simulated. SRM has been designed and implemented for its speed control by fuzzy logic controller in solar and wind power. We can conclude from the simulation results that when compared with wind and solar power outputs, settling time is less in wind power system. This paper presents a fuzzy logic controller to ensure best reference tracking of switched reluctance motor drives. The fuzzy logic controller gives a perfect speed tracking without overshoot and enhances the speed regulation.

S.NO	TORQUE (N-M)	FLUX (Φ)	CURRENT (A)	SPEED (rpm)	SPEED SETTING TIME (sec)
SOLAR POWER	80	808	400	4000	0.2
WIND POWER	100	800	400	2000	0.05

Table2. Comparison table of solar and wind power.

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