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APPLICATIONS OF SOLAR PV SYSTEM USING FUZZY LOGIC CONTROLLER

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Abstract: - photovoltaic systems, whether they are domestic commercial or industrial often incorporate some forms of system production. However, elaborate real time fault detection is not defined for most such system. To address this short fall, a comprehensive photovoltaic installation system fault detection and control strategy is presented in this paper .The design system is made up of fault detection in any of one of the photovoltaic system components that include the solar panel, charge controller, battery and the inverter. The system also includes battery and user load current control. Fuzzy logic principles due to this powerful nonlinear problem solving capabilities is used in formulation of the fault detection and control algorithms as opposed to the classical method. This results in simpler, cheaper and faster hardware. Which in this case is implemented on the using fuzzy logic controller, DC-DC boost power converters play an important role in solar power systems; they step up the input voltage of a solar array for a given set of conditions. This project presents an overview of the variance boost converter topologies. Each boost converter is evaluated on its capability to operate efficient, size, and cost of implementation. In this project, The induction motor was operated by the voltage which is produced from solar photovoltaic. So in this work laboratory type induction motor interfaced SPV generating system is developed to validate its developed model and the fuzzy-based control algorithm.

Keywords: Fuzzy logic control, solar photovoltaic, Second Order Generalized Integrator.

I INTRODUCTION

This section covers the theory and operation of "Maximum Power Point Tracking" as used in solar electric charge controllers. An **MPPT**, or maximum power point tracker is an electronic DC to DC converter that optimizes the match between the solar-array (PV panels), and the utility grid. The most recent and best type of solar charge controller is called Maximum Power Point Tracking or MPPT. MPPT controllers are basically able to convert excess voltage into amperage. This has advantages in a couple of different areas.

II CIRCUIT DESCRIPTION

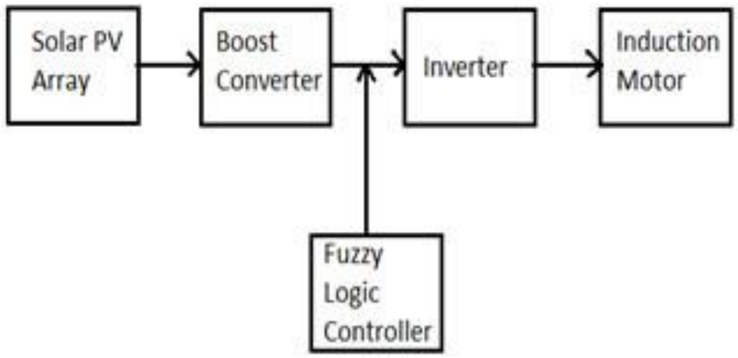

Figure 1: Block diagram of solar PV system using fuzzy logic controller.

From the circuit model of solar pv array connect with motor using fuzzy logic controller.
The solar pv array connecting with the boost converter. The boost converter is connecting with inverter. In this model the DC power is converted to AC power. The DC power is converted to three phase ac power. The ac power is given to the motor. The FUZZY output is given to the Boost converter. The input of the boost converter is solar pv array output.

We are using matlab simulation software to implement the project model.

III SOLAR PV ARRAY

A photovoltaic panel is the complete power-generating unit, consisting of any number of PV modules and panels. Figure 2, Photovoltaic cells, modules, panels and arrays. The performance of PV modules and arrays are generally rated according to their maximum DC power output (watts) under Standard Test Conditions. Solar PV systems use cells to convert sunlight into electricity. The PV cell consists of one or two layers of a semi conducting material, usually silicon. When light shines on the cell it creates an electric field across the layers causing electricity to flow. A complete photovoltaic system uses a photovoltaic panel as the main source for the generation of the electrical power supply. The amount of solar power produced by a single photovoltaic panel or module is not enough for general use. Most manufactures produce standard PV panels with an output voltage of 12V or 24V. A *photovoltaic array* is therefore multiple solar panels electrically wired together to form a much larger PV installation (PV system) called an array, and in general the larger the total surface area of the array, the more solar electricity it will produce.

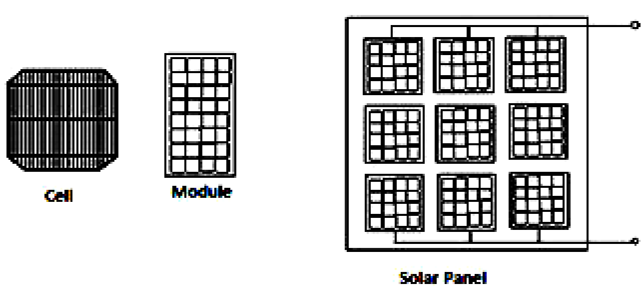

Figure 2: Solar PV cell and solar Panel.

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The solar PV cell and solar panel diagram is shown in fig 2,
The combination of solar cell is called Module. And the combination of module is called solar panel. The photo voltaic cell is serially connected in the panel.

IV. FUZZY LOGIC CONTROL

A fuzzy control system is a control system based on fuzzy logic—a mathematical system that analyzes analog input values in terms of logical variables that take on continuous values between 0 and 1, in contrast to classical or digital logic, which operates on discrete values of either 1 or 0. Fuzzy logic is widely used in machine control. The term "fuzzy" refers to the fact that the logic involved can deal with concepts that cannot be expressed as the "true" or "false" but rather as "partially true". Although alternative approaches such as genetic algorithms and neural networks can perform just as well as fuzzy logic in many cases, fuzzy logic has the advantage that the solution to the problem can be cast in terms that human operators can understand, so that their experience can be used in the design of the controller. This makes it easier to mechanize tasks that are already successfully performed by humans. A fuzzy control system is a control system based on fuzzy logic—a mathematical system that analyzes analog input values in terms of logical variables that take on continuous values between 0 and 1, in contrast to classical or digital logic, which operates on discrete values of either 1 or 0. Fuzzy logic control algorithm was applied in voltage source inverter(VSC). The entire simulation diagram was shown in figure 3,

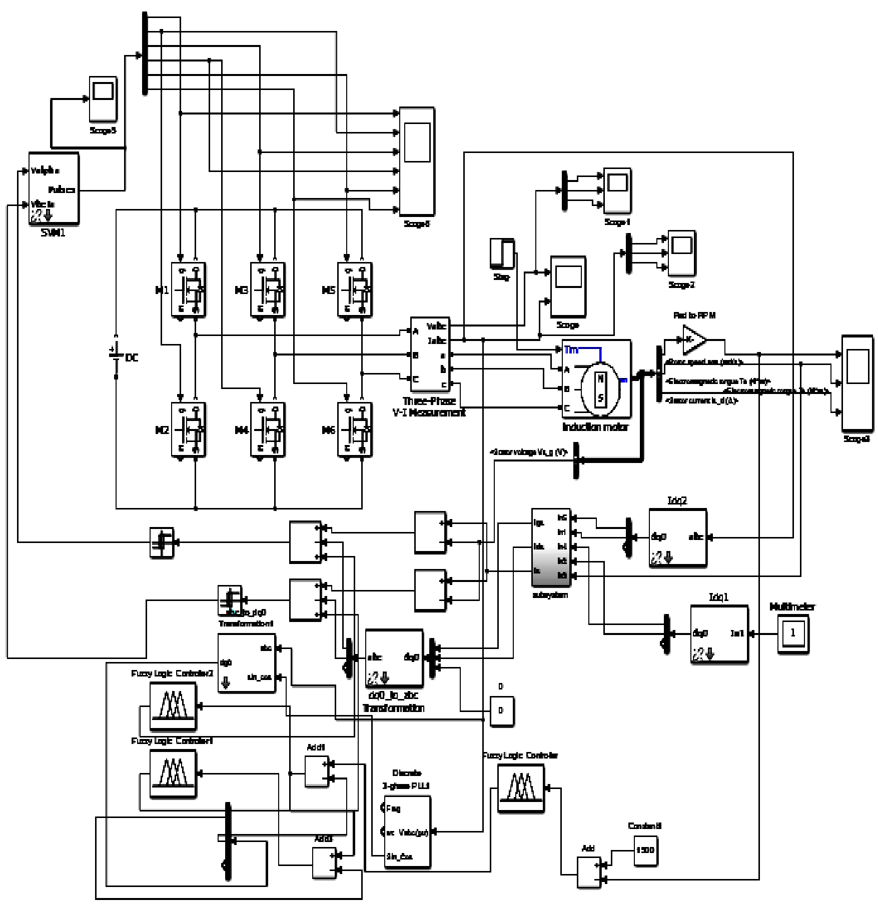

Figure 3: Simulation diagram of solar PV system using fuzzy logic control.

This diagram represents the working of induction motor, by solar PV using fuzzy logic control. When we get the solar power from the sun, that sun light energy was stored in solar panels. And it was converted into DC to AC by using voltage source inverter. Then the supply was applied to the induction motor. Now the motor was in running condition, and we can get the output for speed, torque and current of the induction motor. These whole process are done by the fuzzy logic controller technique. By using the fuzzy logic controller we can get the accurate output when compared to other techniques.

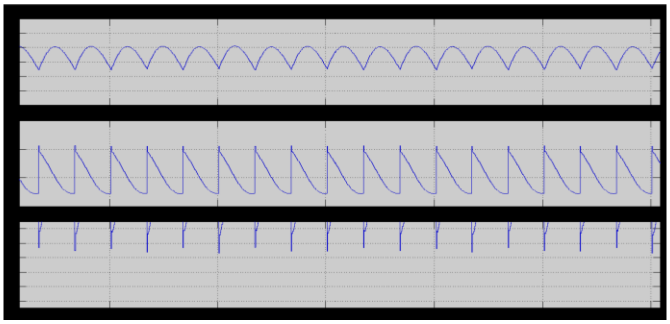

Figure 4: Output of Speed, Torque, and the Current of the Induction motor

V. BOOST CONVERTER

Boost converter is a one type of converters which is mostly used in industries, motors and generators. Boost converter is used to boost up the given input. Our input is increased by using this boost converter. If we put a input like 12 volt, we can establish this input as a 400 volt by using this boost converter. One of the best advantages is in simulation result, there is no any losses in outputs. When compared to hardware system. In hardware system many types o losses where occur. During the uses of boost converter we can get the more output than the hardware sections. Which is the best advantages of simulation result, in boost converter. A **boost converter** is a DC to DC **converter** with an output **voltage** greater than the source **voltage**. A **boost converter** is sometimes called a **step-up converter** since it "steps up" the source **voltage**. Since power ( ) must be conserved, the output current is lower than the source current.

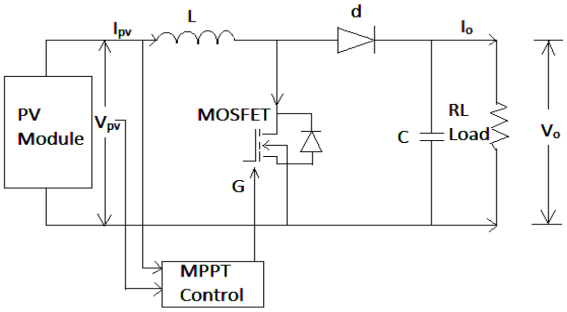

Figure 5: Circuit of Boost converter

The above figure explains the working of boost converer.

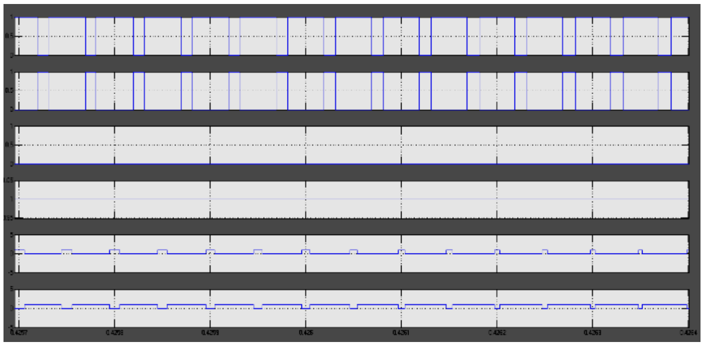

Figure 6: Simulation output of boost converter

In this above waverform represents the output of six pulses of boost converter. Which is connected with solar panel. This device is a three-phase device. It is used in both the inverter and the rectifier and for the first time we are introduced to firing angle alpha (ά). The 6-pulse bridge has a pulse number of 6 and can be thought of as a 6 phase, half wave circuit.

A three-phase diode rectifier converts a three-phase AC voltage at the input to a DC voltage at the output. To show the working principle of the circuit the source and load inductances (L_s and L_d) are neglected for simplicity.

VI. VOLTAGE SOURCE INVERTER (VSI)

Inverter is a one type of converting device, which is mainly used to convert the DC supply voltage into AC supply voltage.

This converting supply voltage is given to the induction motor for the running of motor.

The AC supply provides the required active power and the capacitor of active power filter provides the reactive power for the load. In the proposed work, a fuzzy-logic based PWM control technique is used to generate the gating signals. The DC link capacitor voltage is maintained constant by a fuzzy logic controller.

System designed to deliver alternating current (AC), such as grid connected applications need an inverter to convert the direct current (DC) from the solar modules to AC Grid connected inverters must apply AC electricity in sinusoidal form, synchronized to the grid frequency, limit feed in voltage to know higher than the grid voltage and disconnect from the grid if the gird voltage is turned off. Islanding inverter need only reduce regulator voltages and frequency in a sinusoidal wave shape as no synchronization are coordination with grid supplies is required.

The Inverter is the power electronic circuit, which converts the DC voltage into AC voltage. The DC source is normally a battery or output of the controlled rectifier. ... The pulse width modulation techniques are most commonly used to control the output voltage of inverters. Such inverters are called as PWM inverters. In such inverter units, battery supply is used as the input dc voltage source and the inverter circuit converts the dc into ac voltage of desired frequency.

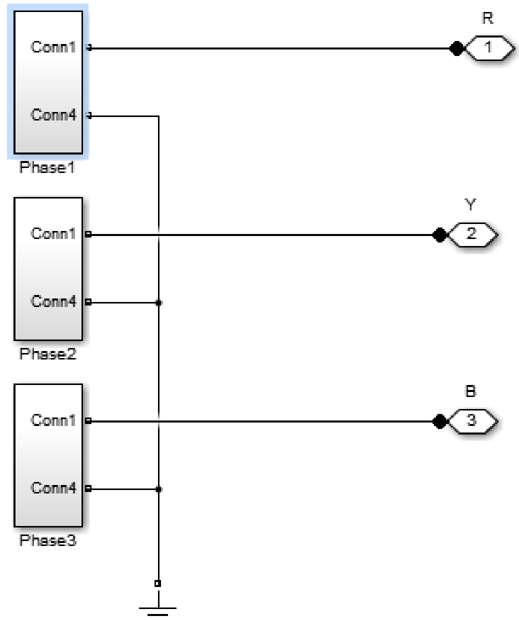

Figure 7: Simulation diagram of Voltage Source Inverter.

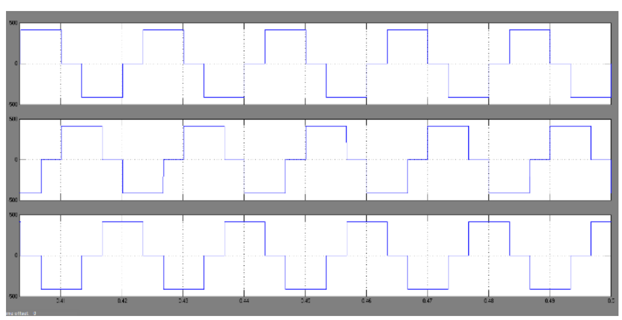

Figure 9(a): Simulation waveform of voltage source inverter for voltage.

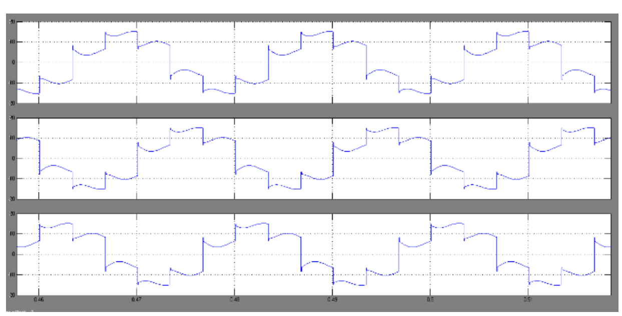

Figure 9(b): Simulation waveform of voltage source inverter for current.

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This waveform represents the voltage level of Voltage Source Inverter in matlab. The AC supply provides the required active power and the capacitor of active power filter provides the reactive power for the load. In the proposed work, a fuzzy-logic based PWM control technique is used to generate the gating signals. The DC link capacitor voltage is maintained constant by a fuzzy logic controller.

VII. INDUCTION MOTOR

Induction motor was run by the AC output voltage which is get from voltage source inverter. An induction motor or asynchronous motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding. An induction motor can therefore be made without electrical connections to the rotor. we can say that a three-phase induction motor works on the principle of electromagnetic. induction where the relative motion between the flux and the rotor caused. by the rotating magnetic field. induces a current in the rotor forcing it to rotate in the same direction related.

Three-Phase Induction Motor: These motors are self-starting and use no capacitor, start winding, centrifugal switch or other starting device. Three-phase AC induction motors are widely used in industrial and commercial applications. These are of two types, squirrel cage and slip ring motors. The power factor at no load is low because the magnetizing component of input current is a large part of the total input current of the motor. ... The power factor of the induction motor is always lagging because the rotor and the stator winding have inductive impedance. The slip of the motor is more at low load
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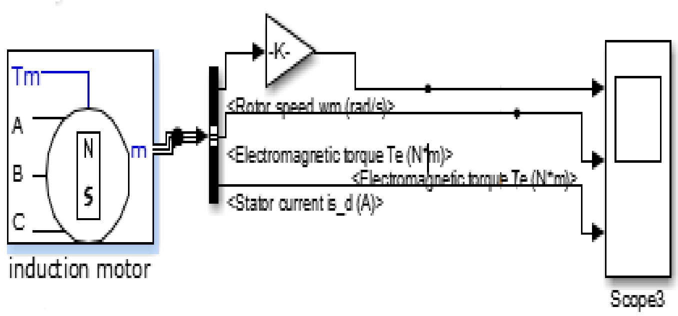

Figure 10: Simulation diagram of induction motor.

This is the simulation diagrammatic representation of a induction motor, which gives the outputs of speed, torque and current values in their scope.

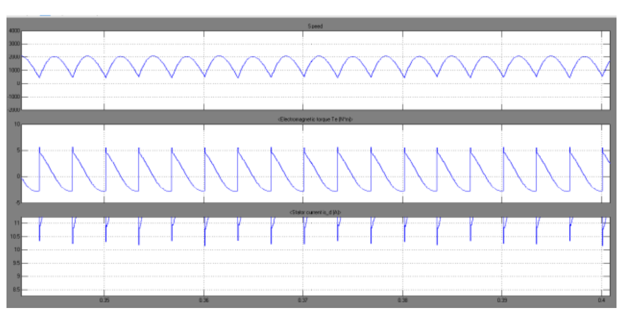

Figure 12: Simulation output of speed, torque and current of the induction motor.

VIII. PI CONTROLLER

A variation of Proportional Integral Derivative (PID) control is to use only the proportional and integral terms as PI control. The PI controller is the most popular variation, even more than full PID controllers. The value of the controller output u(t) is fed into the system as the manipulated variable input.
A PID controller is an instrument used in industrial control applications to regulate temperature, flow, pressure, speed and other process variables. PID (proportional integral derivative) controllers use a control loop feedback mechanism to control process variables and are the most accurate and stable controller. A variation of Proportional Integral Derivative (PID) control is to use only the proportional and integral terms as PI control. The PI controller is the most popular variation, even more than full PID controllers. The value of the controller output u(t)u(t) is fed into the system as the manipulated variable input.

The ubiasubias term is a constant that is typically set to the value of u(t)u(t) when the controller is first switched from manual to automatic mode. This gives "bump less" transfer if the error is zero when the controller is turned on. The two tuning values for a PI controller are the controller gain, KcKc and the integral time constant τIτI. The value of KcKc is a multiplier on the proportional error and integral term and a higher value makes the controller more aggressive at responding to errors away from the set point. The set point (*SP*) is the target value and process variable (*PV*) is the measured value that may deviate from the desired value. The error from the set point is the difference between the *SP* and *PV* and is defined as

e(t)=SP−PVe(t)=SP-PV

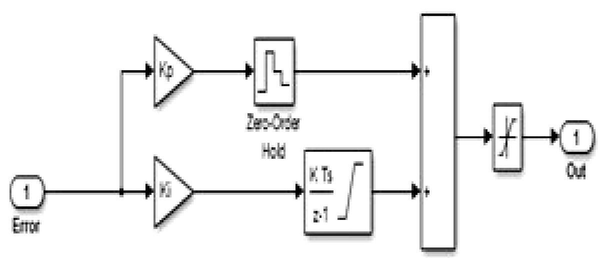

Figure 13: Simulation diagram of PI controller.

This simulation diagram represents the working of Proportional Integral (PI) controller.

IX. FILTER

The LCR filter smoothes inverter output current and voltage waveforms and reduces vibrations in the motor, noise from the motor, and radiated noise from the wires. The LCR filter suppresses a voltage surge that occurs at the motor terminals when driving a 400V class motor.

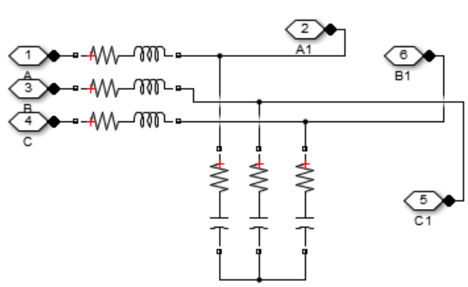

Figure 14: Simulation diagram of filter.

This simulation diagram of filter is represents the working of filter which is connected with inverter.

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