FPGA BASED SUN TRACKING SYSTEM USING FUZZY LOGIC

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ABSTRACT

A solar tracking system of power generation is implemented and designed. To increase the energy generation efficiency of solar cells a FPGA board, solar panel, sensors and input/output interface are integrated with a solar tracking mechanism light dependent resistor are used in order to track the sun. To achieve optimum solar tracking, development of logical fuzzy algorithm is done to design the controller FPGA is applied in such a way that the solar cells are always facing the sun in most of the day span.

Keyword :- *solar tracking, solar panel, field programmable gate array (FPGA) , fuzzy logic for control*

1. INTRODUCTION

There are various renewable sources which are used for electric power generation, such as solar energy, geothermal, wind energy, etc. In electric power generation renewable energy sources play an important role. As we know solar energy is a good choice of electric power generation, since the solar energy is directly converted into electrical energy by solar photovoltaic segments. These segments are made up of silicon cells. We get a solar PV module when much such kind of cells is connected in series. When the area of the individual cells is increased, the current rating of the modules increases, and vice versa. We get a solar PV array when many such PV modules are connected in series and parallel combinations, that's suitable for obtaining expected power output.

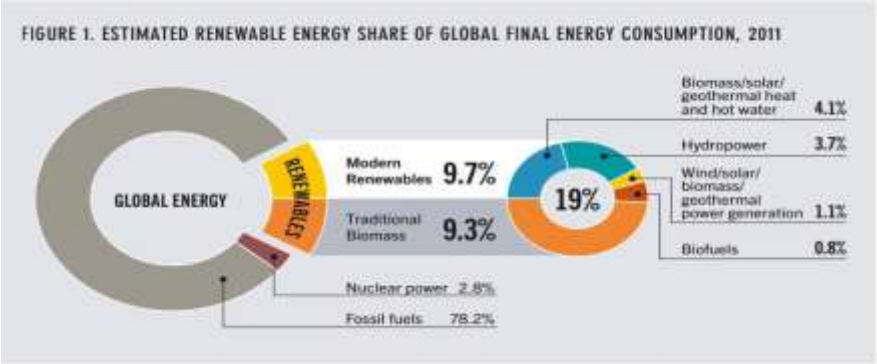


Fig. 1.1: appropriate and estimated renewable energy share

The main factor that it causes effects on the efficiency of the collection process are intensity of storage techniques and source radiation, solar cell efficiency.Implementation of fuzzy controller by using a general-purpose microprocessor or microcontroller is the most popular method these days.

The FPGA can be programmed to do any type of digital functions which is suitable for fast implementation controller. An FPGA has the operating ability is faster than a microprocessor chip. Because of the additional functionality, flexibility of the FPGA and user interface controls can be assimilated into the FPGA minimizing the additional external component requirement. Programming of the FPGA is done using VHDL that is Very High Speed Integrated Circuit hardware description languages. Programming of the FPGA is done while they run, because reprogramming of it is done in the order of microseconds.

1.1 BASIC CONCEPT:-

Fuzzy logic controllers have an effectual performance over the traditional controller researches especially in nonlinear and complex model systems. motivated me to implement FLC on FPGA techniques. In Gaza Strip we have a big problem in electrical power generation, since our sources don't cover all people requirements, electrical power hasa high cost and many daily interruptions, so we need clean, renewable energy sources that do not depend on others, such as solar energy since Gaza Strip is 360 km2 and an excellent solar location with 2750 kWh/m2/year irradiation. The electrical problem Gaza has motivated me to investigate Solar Energy as an application toapply my fuzzy controller.Modern manufactures began to apply these technologies in their applications instead of the traditional once , due to the low cost and features available in this controller. This

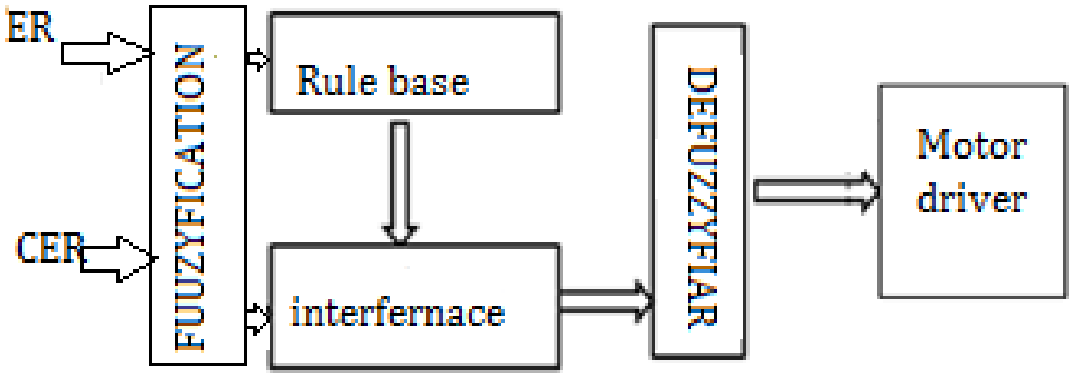
2 SYSTEM STRUCTURE:

2.1 Sun Tracking System :-

Two LDR's (Light Dependant Resistor) are mounted on the panel which are used to coverts light energy into analog voltage and placed in an enclosure as shown in above figure. It has a response which is similar to the human eye. The both LDR sensors compare the intensity of receiving light in the either side i.e. on east and west. The light source intensity received by the sensors are not same, the system obtains signals from the sensor output voltage in the four orientations. The sensor output voltage value inferred by voltage type A/D converter, in this work is used ADC0804 and given to FPGA kit. According to fuzzy logic processing FPGA Provides signal DC motor via motor driver for the current driving purpose. The motor will rotate & it fixed the position of panel towards the sun.

2.2 FLC Design:-

Every FLC has three parts that are, Fuzzification, Rule base, Difuzzification. Error and change in the error are the inputs to the fuzzy logic controller. The output of the fuzzy logic controller is fed to the stepper motor driver. FLC for sun tracking system mainly consists of three basic part and these are discussed as fol



Here the inputs error (ER) and change in the error (CER) getting from the sensor. This inputs converted into the fuzzy input and output will get later on fuzzification. Afterword the output fed to the motor to control it.

2.2.1 Fuzzification:

Fuzzification is the process that transforms numerical values into the grades of membership of fuzzy set members. For each input and output variable are get selected, we define two or more membership functions. The fuzzy set of the change of the error input which contains 7 triangular memberships.

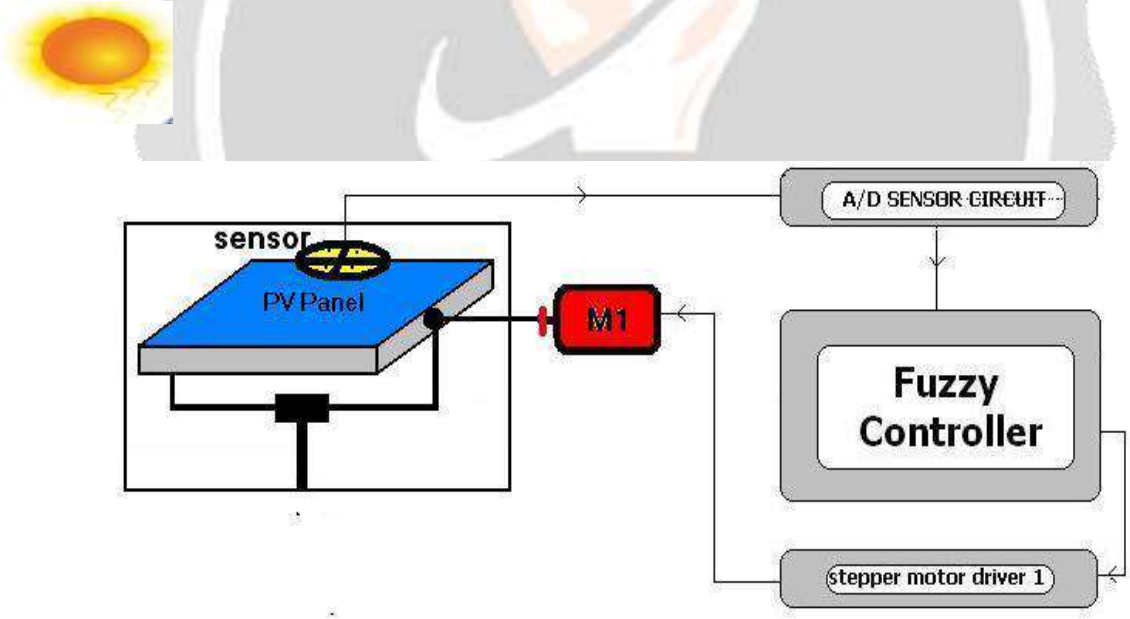
2.2.2 Control Rule Base:

As the input and output variables and MF are defined, we have to design the rule-base composed of expert IF previous circumstances after that conclusions rules. Those rules convert the input variables into an output that will tell us the risk of operational problems. Depending on the number of membership functions for the input and output variables, we can be able to define more or less potential rules. The easiest case is a rule base having only single input and output variable.

2.2.3 Defuzzification:

Reverse of fuzzification is Difuzzification. Difuzzification converts fuzzified output into the normal crisp output. Various methods for Difuzzification are available such as middle of maxima (i.eMOM), first of maxima(i.e.FOM), last of maxima, centre of gravity etc. In this paper centre of gravity method is used for Difuzzification.

3 BLOCK DIAGRAM : -



3.1 Block Diagram Description –

The above figure shows the block diagram of FPGA based sun tracking system using fuzzy logic controller. It describes how the system is implemented the real time application.

Block diagram consists of Following Blocks:
1. Solar Panel (PV panel)

2. Xilinx Spartan-3AN FPGA Board

3. Stepper Motor& Stepper motor Driver

4. Photo Sensor& Position Sensor

5. Analog to Digital converter (ADC)

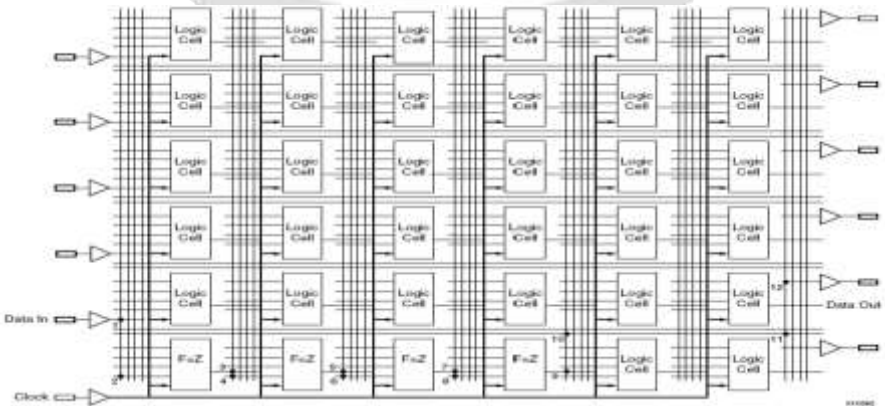
3.1.1 Solar Panel:

Photovoltaic systems employ semiconductor cells generally several square centimetres in size. Semiconductors have four electrons in the outer shell, or orbit, on average. These electrons are called valence electrons. As the sunlight give hit to the photovoltaic cells, some portion of the energy is absorbed into the semiconductor. When that happens the energy loosens the electrons which let them flow freely. Flow of these electrons are a current and when you put metal on the top as well as on the bottom of the photovoltaic cells, we can draw that current to use it externally, Numerous cells are assembled in a module to generate required power. When many such cells are connected in series we can have a solar PV module, the current rating of modules depends on the area of the individual cells. For obtaining higher power output solar PV modules are associated in series and parallel combinations forming solar PV arrays.

3.1.2 FPGA:

An FPGA is an integrated circuitwhich consists of an array of logic blocks that can be configured after it is manufactured by the user to implement digital logic functions of varying complexities.

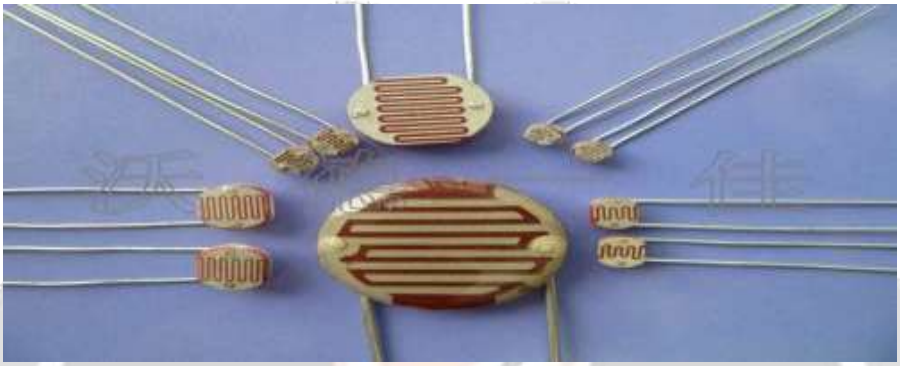
FPGAs come in a wide variety of sizes and with numerous different arrangements of internal and external features. What they have in common is that they are composed of comparatively small blocks of programmable logic.The blocks, each of which typically contains few registers and few low-level configurable logic elements are arranged in a grid and tied together using programmable interconnections.



3.1.3 SENSORS:

3.1.3.1 Photo Sensor:

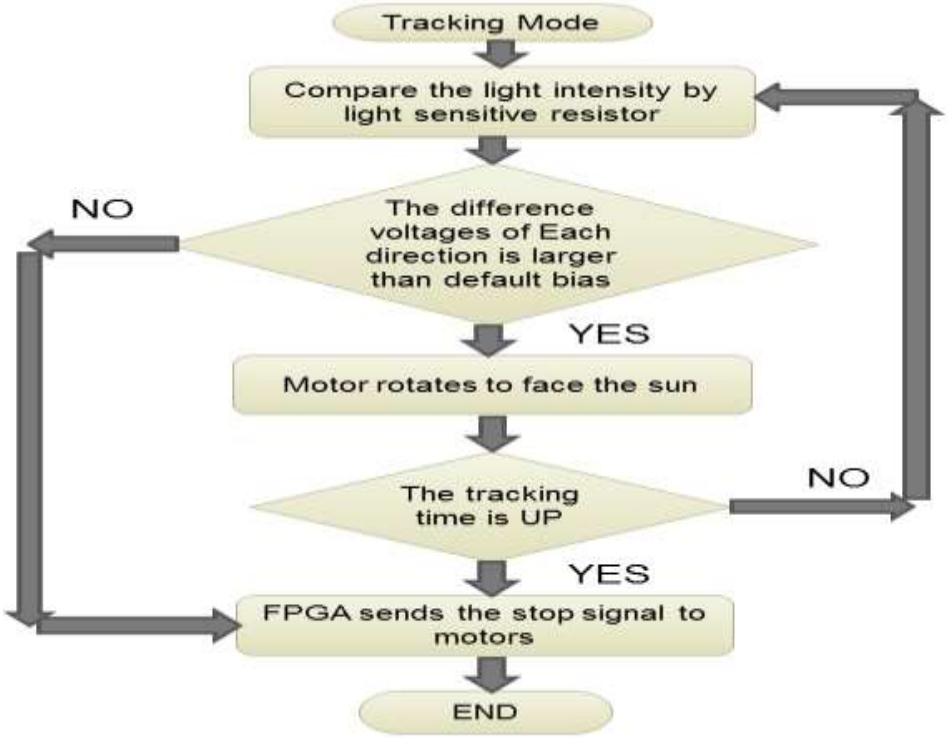
Light dependent resistor (LDR) are used to as the sensor, because it is the most reliable sensor that can be used for sensing the light. Light dependent resistor is mainly a resistor whoseresistance varies with intensity of light, so more intensity will give low resistance. Various LDR sensors are available in the market are shown in Figure. The biggest size is used to build the sensor cause more the area of the sensor mean more its sensitivity or less time taken for output to change when input changes.



3.1.3.2 Position Sensor:

Position sensor is use to decide the place of the PV panel to prevent the panel from the impact when it reach the edges and to get the PV panel to the initial point at the night. This sensor used a variable resistor (potentiometer) located on the rotor of motor and rotate with it. The value of the resistor (R) varies with the rotation.

.4 PROJECT FLOW CHART: -



CONCLUSION : -

Here, the main purpose behind implementation of this project is to improve the efficiency of PV panel. Effectiveness can be amplified by developing automatic sun tracking panel. FPGA based sun tracking system tracks the sun whole day and rotates the motor towards the sun direction hence obtains maximum sun radiation throughout the day. Hence sun tracking system is having maximum efficiency than fixed position PV panel.

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