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FPGA Based Solar Tracking With Backup System

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ABSTRACT

The aim of this projects is to utilize the maximum solar energy through solar panel. For this a FPGA based automatic sun tracking system is proposed. This project helps the solar power generating equipment to get the maximum sunlight automatically thereby increasing the efficiency of the system. The solar panel tracks the sun from east to west automatically for maximum intensity of light. The use of the energy is more demanding as the world population increases day by day. In present time oil and coal which is main resource of energy is about to end up. So, we need a reliable source of energy.

Keywords: **FPGA, Solar panel, Relay, ADC0809.**

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I. INTRODUCTION

The the name of this project is FPGA based solar tracking with backup system. This project is implemented using field programmable gate array. Using the astronomical equations for detecting the position of the sun is difficult so in this project an online sonalr position calculator is being used for making the task easy for the user. The main aim of designing this project is to develop a solar panel which uses sun's rays as energy and generates maximum power out of it, effectively. This design also includes the backup system. As the intensity of sunlight varies throughout the day, output voltage of solar panel may also vary. Thus when voltage level falls backup system provides the voltage supply.

Basically there are two kinds of energy resources i.e. Renewable energy resources and non-renewable energy recourses. As we know that renewable energy can be produced again and again. Renewable source of energy are the natural source of energy. They are the never ending source of energy like the sun, wind, geothermal energy etc. They are the never ending source of energy. These energy sources do not create any type of pollution which can affect the humans as well as the environment.

Whereas the non-renewable resources are the one that cannot be produced again and again. Non-renewable resources are the fossil fuels which are found into the earth's crust such as the coal, oil, petrol, diesel etc. Since these non-renewable resources are being used from a long period of time and also due to the increasing population, the demand for these fossel fuels is increasing day by day hence there is a danger that these non-renewable resources may deplete and completely disappear as they are limited.Hence it is the duty of every individual to save these fossel fuels and preserve them from running out. And at the same time even this should be taken into consideration that these non-renewable resources create a lot of pollution which is bad for the humans and the environment. Hence it is the best option to use the renewable source of energy. There are two problem area's with solar which have been studied before implementing this project. Firstly the problem is that the solar energy is the dilute source of energy. Even in the hottest regions on the earth, the solar radiation flux available rarely exceeds 1kw/m, which is a very low value for technological utilization. Secondly, the solar cannot be available due to the night cycles taking place regularly and seasonally i.e. In the rainy and in the winter season because of the earth's orbit around the sun, which is the main problem domain.

To verify these to problems the solar panel should be such that it always receives maximum intensity of light. The solar panel tracks the sun from east to west for maximum intensity of light. This project helps the solar generating equipment's to get maximum sunlight, thereby increasing the efficiency of the system.

II. LITERATURE SURVEY

Photovoltaic power was first discovered by French scientists Antoinc Becquerel in 1839. The first working solar cell was successfully made by Charles frits in 1882. It was made of thin sheets of selenium and coated with gold. The use of solar panels for generating electricity and heat seems relatively like new development, it has actually been widely used to generate power since early 1900s.

In the late 1900s as awareness grew in the science community about the effects of global warming and the need for renewable energy sources, scientists continued to refine the silicon PV and by early 2000 they were able to make a solar cell with 24% electricity return. By 2007, modern silicon PV solar cells were operating with 28% electricity return. Each photovoltaic cell produces a small amount of electricity so they are wired together into panels to provide enough current (DC) power so it must be converted to alternating current (AC) with the aid of an inverter.

In 1953, an article in a magazine with a title "Why Don't We Have Sun Power" with a statement "Every hour, it floods the earth with a deluge of thermal energy equal to 21 billion tons of coal". In fact according to latest figures published, the surface of the earth receives about 124 exact (1018) Watts or 3,850 zeta (1024) Joules per year of solar power [1].The spectrum of the solar light coming from sun covers from about 250 nm to about 2500 nm in wavelength, ascan be seen in the figure (1). By the way visible light of human beings covers from 400 to 700 nm, at which band the light is very dense, about 1.5 W/m2/nm at 400 nm, going up to about 1.75 W/m2/nm at about 550 nm and then comes back to 1.5 W/m2/nm at 700 nm.

In 2002, researchers in Materials Sciences Division (MSD) in Lawrence Berkeley National Laboratory discovered that the band gap of indium nitride is 0.7eV that means a single system of alloys incorporating indium, gallium and nitrogen can convert virtually the full spectrum of sunlight to electric current [8]. But they discovered too, that lattice matching between the three semiconductors has to be met, otherwise, the system would not work. Later it was discovered that:

- GaInP2 (band gap:1.8 eV) covering wavelength 300-700 nm.
- GaAs (band gap:1.42 eV) covering wavelength 650-900 nm.
- Ge (band gap :0.67) covering wavelength 900-1650 nm.

Which have lattice matching that can cover a large portion of the band. This shows the efficiencies of different types of cells.

III. PROPOSED SYSTEM

Figure 1. shows the block diagram of FPGA based solar tracking with backup system. This block diagram contains FPGA, motor driver IC, stepper motor, solar panel, relay and load. In this design program code is dumped in Spartan-3A FPGA kit using Xilinx ISE 14.2 software. After successful implementation of code in FPGA kit stepper motor moves clockwise or anticlockwise through motor driver IC ULN2003. Operating voltage of FPGA is in the range of 3.5 to 5v whereas stepper motor requires 230V power supply. ULN2003 bridges the stepper motor with FPGA. The tracking system consists of two motors, which control the solar panel position and a control circuit to direct these motors.

Load is driven by the dc voltage generated by the solar panel. As intensity of sunlight varies in day time voltage produced by solar panel also varies. These variations may create problem to drive the load. ADC0809 receives the intensity of sunrays in the form of analog signals. If the intensity of rays goes below the fixed value then dc generator is get connected to load through relay. At normal condition when intensity of sunlight is high the load is directly driven through solar panel.

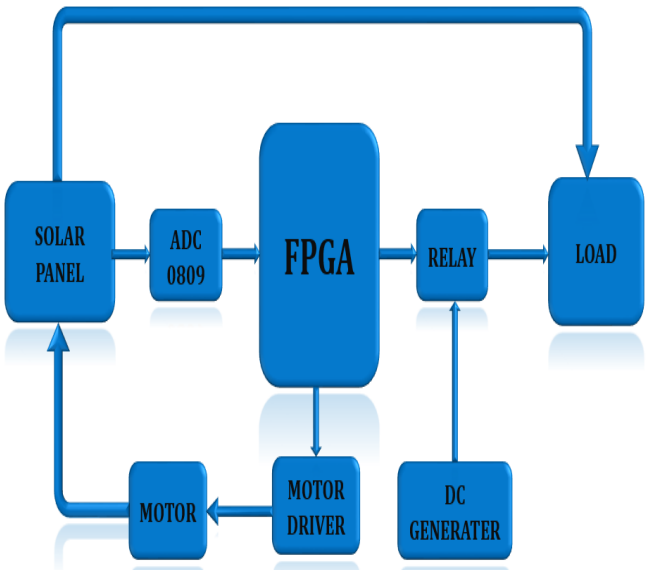

Fig 1: Block diagram of FPGA based solar tracking with backup system

Design of Tracking System:

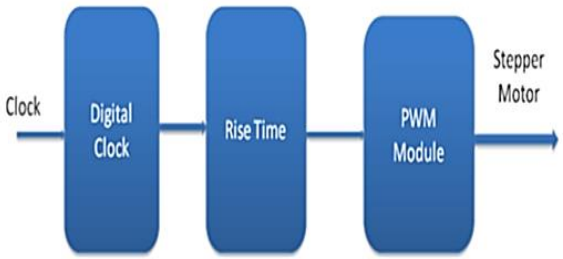

Fig 2: Design of tracking system

Digital Clock Module:

This design contain four modules are clock module, sunrise module and two PWM generator module. These have been implemented on FPGA kit. This design is cost effective. Figure 6.5 shows Design of Tracking System. When I turn on the tracking circuit clock starts. Clock module used in the tracker provides outputs in second, minute, hour,day and day5.day5 is the output which contains 5 days. To make my calculation easier I divide 365days in 73group.For this counter is used like second counter when it reaches 59 then

minute output increase by 1.If second and minute counter exceed 59 then hour has increased by 1 and hour counter reaches 24 then day increased by 1 and so on.

Sun Rise Time Module

This module gives rise time for each group. When it goes high then stepper motor set for azimuth angle start rotating from east to west and when it goes low then west to east.

PWM generator modules

There is basically Pulse generator module is design to send the pulses to stepper motor, for rotation of motor in both directions.

Working Principle of Solar Tracking System

There are various ways from which we can find the position of the sun. Implementation of astronomical equations for calculating azimuth angle is quiet difficult and takes more time. To tackle this problem, I have used online sun position calculator to calculate the azimuth angle value of sun for the year of 2015. I gathered the data containing values of azimuth angle for location Ahmadabad city in India for 2015.

TIME	AZIMUTH
7 to8	6^0
8 to 9	7^0
9 to 10	11^0
10 to 11	13^0
11 to 12	16^0
12 to13	19^0
13 to 14	18^0
14 to 15	15^0
15 to16	12^0
16 to17	8^0
17 to18	7^0

Table 1: Angles of sun rotation with delay

The whole problem is divided into three parts.

a. There is almost negligible variations in degree of azimuth for 5 days, so to make calculations easier take 5 days as one group thus there are total 73 groups means 1st to 5th day be the 1st group and 360th to 365th become the 73rd group.
b. The data is taken online contains values for azimuth angle for every group with delay of 60 minute.
c. Calculate angle changes after every 60 minute of delay from sunrise time to sunset time for every group of the year. Table 6.1 lists the change in azimuth angle for the 1st group after a delay of one hour. For instance time from 7 to 8 the value of azimuth angle varies by 6°.

IV. ADVANTAGES AND APPLICATION

Advantages:

- Solar tracker system generates more electricity than their stationary counterparts due to an increased direct exposure to solar rays.
- They are useful as the sun's position in the sky alters gradually during the day as well as over the season throughout the year.
- Needs no fuel hence fossel fuels are saved on a large scale
- As solar energy is a natural source of energy it does not create any pollution. Hence solar tracker system is Non-Pollutant.
- Easy maintenance and can be integrated with other renewable energy sources.
- Dual-axis tracker tracks the position of sun from all directions.
- It is simple, efficient and it is easy to use.
- Backup system prevents the device from damage due to variations in sunlight.
- Due to backup system, device can be operated without any interruption.

Applications:

- Useful in irrigation systems in farms.
- Used in domestic purposes.
- Used in industries in large scale.
- Used in solar power plants.
- Used in solar vehicles and callbox for emergency calls.

V. CONCLUSION

Solar panel efficiency was substantially improved with a sun tracker. Timing based controlling is an attractive feature. In this design totally depends on time rather than use of light sensor. Timing base control system is advantageous because tracking system lead to no error in partially cloudy weather. Because using light sensor if there is less or no light strike on sensor then you will not get satisfied result. Thus this design is facing the sun even in cloudy weather.

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