Intelligent Solar – Tracking System for Efficiency Maximization of Solar Panel Energy

[1] Mr.Sutar Shahaji S., [2] Mr.Yadav Suhas, [3]Santosh Kamble
[1]Lecturer, [2]Lecturer, [3]Design Engineer
[1] Electronics and Telecommunication Dept
[1] Bharati Vidyapeeth Institute of Technology, Kharghar, Navi Mumbai

Abstract : — This paper focuses on the optimization of the electric energy production by photovoltaic cells through the development of an intelligent solar-tracking system. The developed tracking system is innovative. The developed solution has many advantages in relation to similar existing devices, as this system is autonomous regarding the information needed to process the optimal orientation and is intelligent in a way that it performs on-line monitoring of the photovoltaic energy production. An experimental prototype was built and field results have proven the good performance of the developed tracking system.

Keywords: Solar Panel, Motor, Relays,microcontroller

I. INTRODUCTION

According to market economy, the increasing worldwide demand for energy, forces a continuous rise on the price of fossil combustibles. In fact, it is expected in the near future, that the demand for energy will grow faster than the finding out of new available fossil resources. This market behavior brings a positive challenge to the scientific community as more funds are allocated for the research and development of new alternatives to the usual main energetic sources (fossil combustibles). In this context we have assisted, in the last decades, to a concentrated focus on renewable energy research.

Among these renewable energetic sources, the international scientific community has devoted intense efforts to wind, solar photovoltaic and biomass. In this paper an intelligent sun-tracking system for efficiency maximization referring photovoltaic energy production is developed.

This Paper presents a model of power generation by using solar cell and gives a power generating method from sunlight. This method of power generation is simple and is taken from natural resource. This needs only sunlight to generate power. This project helps for power generation by setting the equipment to get maximum sunlight automatically.

This system is tracking for maximum intensity of light. When there is decrease in intensity of light, this system automatically changes its direction to get maximum intensity of light.

Here we are using three sensors in three directions to sense the direction of maximum intensity of light. The difference between the outputs of the sensors is given to the microcontroller unit. Here we are using the microcontroller for tracking and generating power from sunlight. It will process the input voltage from the comparison circuit and control the direction in which the motor has to be rotated so that it will receive maximum intensity of light from the sun. The power generated from this process is then stored in a lead acid battery and is made to charge an emergency light and is made to glow during night.

II. HISTORICAL BACKGROUND:

Energy is the key input to drive and improve the life cycle. Primarily; it is the gift of the nature to the mankind in various forms. The consumption of the energy is directly proportional to the progress of the mankind. With ever growing population, improvement in the living standard of the humanity, industrialization of the developing countries, the global demand for energy is expected to increase rather significantly in the near future. The primary source of energy is fossil fuel, however finiteness of fossil fuel reserves and large scale environmental degradation caused by their widespread use, particularly global warming, urban air pollution and acid rain, strongly suggest that harnessing of non-conventional, renewable and environment friendly energy resources is vital for steering the global energy supplies towards a sustainable path.

Nuclear deal is going to help our power sector. We need lots of power to keep the momentum of growth going to realize the dream of our more than one billion people. It will not readily solve our energy problems. We need to tap other sources of power as well, like the renewable sources such as wind power, hydel-power, tidal power etc. It needs a lot of vision. Though, participation of youth is happening but it requires more intensity. Some 20 years ago, the Atomic Energy Commission had laid down a target of 10,000 MW of electricity generation by the end of the 20th century. Today, in 2008 our capacity is about 4,000 MW and due to shortage of uranium many of these plants are operating at much below their capacity. Therefore there is need of non-conventional energy in large amount still now.

III. SOLAR ENERGY

Solar cells convert sunlight directly into electricity. Solar cells are often used to power calculators and watches. They are made of semi-conducting materials similar to those used in computer chips. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light (photons) to electricity (voltage) is called the photovoltaic (PV) effect.

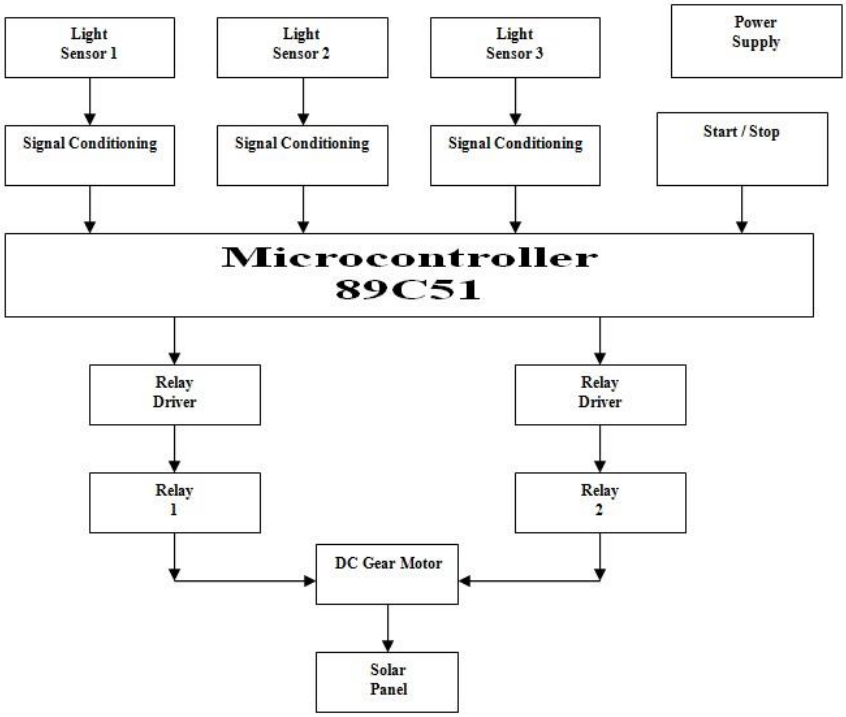
Solar cells are typically combined into modules that hold about 40 cells; a number of these modules are mounted in PV arrays that can measure up to several meters on a side. These flat-plate PV arrays can be mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture the most sunlight over the course of a day. Several connected PV arrays can provide enough power for a household; for large electric utility or industrial applications, hundreds of arrays can be interconnected to form a single, large PV system.

Thin film solar cells use layers of semiconductor materials only a few micrometers thick. Thin film technology has made it possible for solar cells to now double as rooftop shingles, roof tiles, building facades, or the glazing for skylights or atria. The solar cell version of items such as shingles offer the same protection and durability as ordinary asphalt shingles.

Some solar cells are designed to operate with concentrated sunlight. These cells are built into concentrating collectors that use a lens to focus the sunlight onto the cells. This approach has both advantages and disadvantages compared with flat-plate PV arrays. The main idea is to use very little of the expensive semi-conducting PV material while collecting as much sunlight as possible. But because the lenses must be pointed at the sun, the use of concentrating collectors is limited to the sunniest parts of the country. Some concentrating collectors are designed to be mounted on simple tracking devices, but most require sophisticated tracking devices, which further limit their use to electric utilities, industries, and large buildings.

The performance of a solar cell is measured in terms of its efficiency at turning sunlight into electricity. Only sunlight of certain energies will work efficiently to create electricity, and much of it is reflected or absorbed by the material that make up the cell. Because of this, a typical commercial solar cell has an efficiency of 15%-about one-sixth of the sunlight striking the cell generates electricity. Low efficiencies mean that larger arrays are needed, and that means higher cost. Improving solar cell efficiencies while holding down the cost per cell is an important goal of the PV industry, NREL researchers, and other U.S. Department of Energy (DOE) laboratories, and they have made significant progress. The first solar cells, built in the 1950s, had efficiencies of less than 4%.

IV. BLOCK DIAGRAM:



V. BLOCK DIAGRAM DESCRIPTION

Solar Tracking system has following blocks

1. Light sensor
2. Signal Conditioning
3. Microcontroller 89C51
4. Relay Driver & Motor
5. Solar panel
6. Start / stop switch

7. Power supply

1..Light Sensor:

This is one of the main part of our project. The main intention of this block is to sense the light. For this purpose we are using here the Light Dependent Register (LDR).

If light is present then its resistance is low and if light is absent its resistance is high.

2. Signal Conditioning:

Output of light sensor is given to signal conditioning block. Signal conditioning means converting input according to requirement of next stage. The next stage is microcontroller. Its requirement is either logic 0 signals or logic 1 signals.

So this block will convert low resistance i.e light condition into logic 1 and high resistance i.e dark condition into logic 0. For this purpose we are using IC555 in Schmitt trigger mode.

3. Microcontroller 89C51:

It is a low-power, high-performance CMOS 8-bit micro-computer with 4K bytes of Flash Programmable and Erasable Read Only Memory PEROM). The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the MCS-51™ instruxtion set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a con-ventional nonvolatile memory programmer.

4.Relay Driver and Motor:

This block has the potential to drive the various controlled devices. In this block mainly we are using the transistors and the relays. Total 2 relay driver circuits we are using to control the direction of DC gear motor.

Output signal from 89C51 are given to base of transistor, which we are further energizing the particular relay. Because of this appropriate device is selected and it do its allotted function. Relay 1 and 2 are used to control the direction of the DC motor.

If relay 1 is turned On then DC motor will rotate in clock wise direction. And if relay 2 is turned ON then DC motor will rotate in Anti-Clockwise direction.

5.Solar Panel:

Solar cells convert sunlight directly into electricity. Solar cells are often used to power calculators and watches. They are made of semi-conducting materials similar to those used in computer chips. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light (photons) to electricity (voltage) is called the photovoltaic (PV) effect.

6. Start / Stop Switch :

These switches are used to start the project and stop the project. These are push to ON switches. Normally it gives logic 1. And when it is pressed it gives logic 0.

7.Power supply :

Here we used the +12v and +5v dc power supply. The main function of this block is to provide the required amount of voltage to essential circuits.

+5 Vdc is given to Light sensor, signal conditioning, microcontroller, start / stop button etc. and +12 V is given to relay driver, relay and DC gear motor.

VI. BRIEF OPERATION

Here we are using three sensors in three directions to sense the direction of maximum intensity of light. The difference between the outputs of the sensors is given to the microcontroller unit. Here we are using the microcontroller for tracking and generating power from sunlight. It will process the input voltage from the comparison circuit and control the direction in which the motor has to be rotated so that it will receive maximum intensity of light from the sun. The power generated from this process is then stored in a lead acid battery and is made to charge an emergency light and is made to glow during night.

VII. ADVANTAGES AND DISADVANTAGES

Advantages:

1. The efficiency increases by 30-40%
2. The space requirement for a solar park is reduced, and they keep the same output
3. The return of the investment timeline is reduced
4. The tracking system amortizes itself within 4 years (on average)

Disadvantages:

1. Solar energy is not available in night.
2. At high altitudes with substantial cloud cover, efficiency decreases.

VIII APPLICATIONS

Improving solar cell efficiencies while holding down the cost per cell is an important goal of the PV industry, NREL researchers, and other U.S. Department of Energy (DOE) laboratories, and they have made significant progress.

Photovoltaic system of about 83 MW aggregate capacity have been installed including 3,85,000 solar lanterns;1,80,000 home lighting system; 41,000 street lighting systems, 4204 water pumping systems.

IX CONCLUSION

By using this movable solar panel arrangement we can get the maximum output. So the return of the investment timeline is reduced.

X Some Implementation Photos

Two solar trackers POULEK SOLAR, Ltd. (1 kW system) installed on Canaria Islands.

Back wiev of the tracker. (U.K)

2 kW solar system with ridge concentrator (Luxembourg)

Solar tracking system 500W POULEK SOLAR, Ltd. (Malta).

500W solar ridge concentrator system in Spain (courtesy Steve Jasper)

Solar pumping system 3kW (U.K.).

New TRAXLE arrangement with soft concentrator.

Solar tracking system 1.4 kW POULEK SOLAR, Ltd. (Czech Republic)

Solar tracker POULEK SOLAR, Ltd. - 150 W.

New TRAXLE arrangement with soft concentrator installed at Czech Univ. of Life Sciences Prague.

Photovoltaic power station 4 MW with tracking stands TRAXLE installed in Spain.

Solar tracker POULEK SOLAR, Ltd. - 150 W.

REFERENCES

1. Microcontroller 89C51 data Manual -Intel

2. Embedded systems -Mazidi And Mazidi
3. Web site: www.solar-tracking.com/
www.newgenerationenergy.co.uk/solar-pv.htm
www.solarnavigator.net/solar_cells.htm
www.herald-journal.com/profiles/design-homes/
www.pvpumps.com/pictures.htm
www.google.com