SINGLE AXIS SOLAR TRACKER

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ABSTRACT

Solar energy is fast becoming a very important means of renewable energy resource. With solar tracking, it will become possible to generate more energy since the solar panel can maintain a perpendicular profile to the rays of the sun. Even though the initial cost of setting up the tracking system is considerably high, there are cheaper options that have been proposed over time. This project discuses the design and construction of a prototype for solar tracking system that has a single axis of freedom. Light Dependent Resistors (LDRs) are used for sunlight detection. The control circuit is based on an ATMega328P microcontroller. It was programmed to detect sunlight via the LDRs before actuating the servo to position the solar panel. The solar panel is positioned where it is able to receive maximum light. As compared to other motors, the dc motors are able to maintain their torque at high speed. They are also more efficient with efficiencies in the range of 80-90%. DC can supply roughly twice their rated torque for short periods. They are also quiet and do not vibrate or suffer resonance issues. Performance and characteristics of solar panels are analyzed experimentally. Silicon solar cells produced an efficiency of 20% for the first time in 1985. Whereas there has been a steady increase in the efficiency of solar panels, the level is still not at its best. Most panels still operate at less than 40%. As a result, most people are forced to either purchase a number of panels to meet their energy demands or purchase single systems with large outputs. There are types of solar cells with relatively higher efficiencies but they tend to be very costly. One of the ways to increase the efficiency of solar panels while reducing costs is to use tracking. Through tracking, there will be increased exposure of the panel to the sun, making it have increased power output. The trackers can either be dual or single axis trackers. Dual trackers are more efficient because they track sunlight from both axes. A single tracking system was used. It is cheaper, less complex and still achieves the required efficiency. In terms of costs and whether or not the system is supposed to be implemented by those that use solar panels, the system is viable. The increase in power is considerable and therefore worth the small increase in cost. Maintenance costs are not likely to be high.

INTRODUCTION

Solar energy is clean and available in abundance. Solar technologies use the sun for provision of heat, light and electricity. These are for industrial and domestic applications. With the alarming rate of depletion of depletion of major conventional energy sources like petroleum, coal and natural gas, coupled with environmental caused by the process of harnessing these energy sources, it has become an urgent necessity to invest in renewable energy sources that can power the future sufficiently. The energy potential of the sun is immense. Despite the unlimited resource however, harvesting it presents a challenge because of the limited efficiency of the array cells. The best efficiency of the majority of commercially available solar cells ranges between 10 and 20 percent.

This shows that there is still room for improvement. This project seeks to identify a way of improving efficiency of solar panels. Solar tracking is used. The tracking mechanism moves and positions the solar array such that it is positioned for maximum power output. Other ways include identifying sources of losses and finding ways to mitigate them. When it comes to the development of any nation, energy is the main driving factor. There is an enormous quantity of energy that gets extracted, distributed, converted and consumed every single day in the global society. Fossil fuels account for around 85 percent of energy that is produced. Fossil fuel resources are limited and using them is known to cause global warming because of emission of greenhouse gases.

There is a growing need for energy from such sources as solar, wind, ocean tidal waves and geothermal for the provision of sustainable and power. Solar panels directly convert radiation from the sun into electrical energy. The panels are mainly manufactured from semiconductor materials, notably silicon. Their efficiency is 24.5% on the higher side. Three ways of

It is a more cost-effective solution than the purchase of solar panels. There are various types of trackers that can be used for increase in the amount of energy that can be obtained by solar panels. Dual axis trackers are among the most efficient, though this comes with increased complexity. Dual trackers track sunlight from box axes. They are the best option for places where the position of the sun keeps changing during the year at different seasons. Single axis trackers are a better option for places around the equator where there is no significant change in the apparent position of the sun. The level to which the efficiency is improved will depend on the efficiency of the tracking

increasing the efficiency of the solar panels are through increase of cell efficiency, maximizing the power output and the use of a tracking system. Maximum power point tracking (MPPT) is the process of maximizing the power output from the solar panel by keeping its operation on the knee point of P-V characteristics. MPPT technology will only offer maximum power which can be received from stationary arrays of solar panels at 2 any given time. The technology cannot however increase generation of power when the sun is not aligned with the system. Solar tracking is a system that is mechanized to track the position of the sun to increase power output by between 30% and 60% than systems that are stationary.

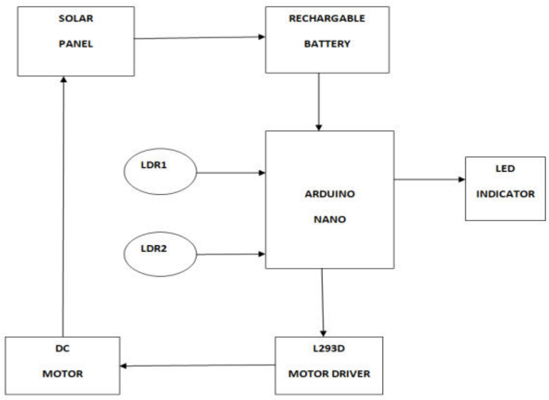

Fig 1 BLOCK DIAGRAM

system and the weather. Very efficient trackers will offer more efficiency because they are able to track the sun with more precision. There will be bigger increase in efficiency in cases where the weather is sunny and thus favorable for the tracking system.

LITERATURE SURVEY

The photovoltaic effect was experimentally demonstrated first by French physicist Edmond Becquerel. In 1839, at age 19, he built the world's first photovoltaic cell in his father's laboratory. Willoughby Smith first described the "Effect of Light on Selenium during the passage of an Electric Current" in a 20 February 1873 issue of Nature. In 1883 Charles Fritts built the first solid state photovoltaic cell by coating the semiconductor selenium with a thin layer of gold to form the junctions; the device was only around 1% efficient. In 1888 Russian physicist Aleksandr Stoletov built the first cell based on the outer photoelectric effect discovered by Heinrich Hertz in 1887.

Albert Einstein explained the underlying mechanism of light instigated carrier excitation—the photoelectric effect—in 1905, for which he received the Nobel Prize in Physics in 1921. Russell Ohl patented the modern junction semiconductor solar cell in 1946 while working on the series of advances that would lead to the transistor.

The first practical photovoltaic cell was publicly demonstrated on 25 April 1954 at Bell Laboratories. The inventors were Daryl Chapin, Calvin Souther Fuller and Gerald Pearson.

Solar cells gained prominence when they were proposed as an addition to the 1958 Vanguard I satellite. By adding cells to the outside of the body, the mission time could be extended with no major changes to the spacecraft or its power systems. In 1959 the United States launched Explorer 6, featuring large wing-shaped solar arrays, which became a common feature in satellites. These arrays consisted of 9600 Hoffman solar cells.

Improvements were gradual over the next two decades. The only significant use was in space applications where they offered the best power-to-weight ratio. However, this success was also the reason that costs remained high, because space users were willing to pay for the best possible cells, leaving no reason to invest in lower-cost, less-efficient solutions. The price was determined largely by the semiconductor industry; their move to integrated circuits in the 1960s led to the availability of larger boules at lower relative prices. As their price fell, the price of the resulting cells did as well. These effects lowered 1971 cell costs to some $100 per watt.

In late 1969, Elliot Berman was investigating organic solar cells, when he joined a team at Exxon SPC who were looking for projects 30 years in the future. The group had concluded that electrical power would be much more expensive by 2000, and felt that this increase in price would make alternative energy sources more attractive, finding solar the most interesting. He conducted a market study and concluded that a price per watt of about $20/watt would create significant demand.

The first improvement was the realization that the standard semiconductor manufacturing process was not ideal. The team eliminated the steps of polishing the wafers and coating them with an anti-reflective layer, relying on the rough-sawn wafer surface. The team also replaced the expensive materials and hand wiring used in space applications with a printed circuit board on the back, acrylic plastic on the front, and silicone glue between the two, "potting" the cells. Solar cells could be made using cast-off material from the electronics market.

Navigation market

SPC convinced Tideland Signal to use its panels to power navigational buoys, after finding that Automatic Power, the market leader, had purchased and shelved a solar navigation aid prototype from Hoffman Electronics to protect its battery business. Tideland's solar-powered buoy quickly overtook Automatic.

The rapidly increasing number of offshore oil platforms and loading facilities led Arco to buy Solar Power International (SPI), forming ARCO Solar. ARCO Solar's factory in Camarillo, California was the first dedicated to building solar panels, and was in continual operation from its purchase by ARCO in 1977 until 2011 when it was closed by Solar World.

Following the 1973 oil crisis oil companies used their higher profits to start solar firms, and were for decades the largest producers. Exxon, ARCO, Shell, Amoco (later purchased by BP) and Mobil all had major solar divisions during the 1970s and 1980s. Technology companies also participated, including General Electric, Motorola, IBM, Tyco and RCA.

PROPOSED SYSTEM WORKING

1. There is input of the voltages from the two LDRs.
2. The inputs are analog. They are converted to digital values that range between 0-1023.
3. The two digital values are compared and the difference between them obtained.
4. The difference between the values obtained is the error proportional angle for the rotation of the dc motor.
5. If the LDR voltages are the same, the motor stops. Otherwise, the motor rotates until the difference is the same.

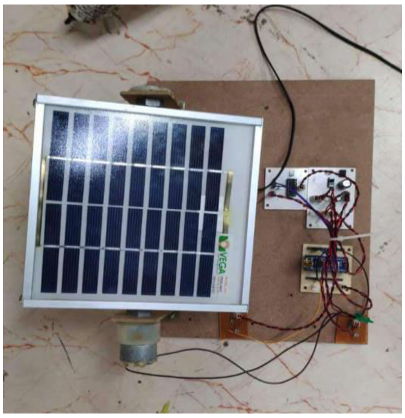

Fig 2 Proposed system prototype

The project is built using a balanced concept which is three signals from the different sensors are compared. Light Dependent Resistor (LDR) as a light sensor has been used. The three light sensors are separated by divider which will create shadow on one side of the light sensor if the solar panel is not perpendicular to the sun. For the controlling circuit, microcontroller acts as a brain that controls the movement of the motor via relay. Data received from the sensors and processed by the microcontroller. The microcontroller will send a data to the Bi-directional DC-geared motor via relay to ensure solar panel is perpendicular towards the Sun. Relay controls the rotation of the motor either to rotate clockwise or anticlockwise. The solar panel that attached to the motor will be reacted according to the direction of the motor.

CONCLUSION

This was achieved using a system with three stages or subsystems. Each stage has its own role. The stages were;

An input stage that was responsible for converting sunlight to a voltage.

A control stage that was responsible for controlling actuation and decision making

A driver stage with the motor. It was responsible for actual movement of the panel

A solar panel that tracks the sun was designed and implemented. The required program was written that specified the various actions required for the project to work. As a result, tracking was achieved. The system designed was a single axis tracker. While dual axis trackers are more efficient in tracking the sun, the additional circuitry and complexity was not required in this case. This is because Kenya lies along the equator and therefore there are no significant changes in the apparent position of the sun during the various seasons. Dual trackers are most suitable in regions where there is a change in the position of the sun. This project was implemented with minimum resources. The circuitry was kept simple, while ensuring efficiency is not affected.

FUTURE WORK

With the available time and resources, the objective of the project was met. The project is able to be implemented on a much larger scale. For future projects, one may consider the use of more efficient sensors, but which are cost effective and consume little power. This would further enhance efficiency while reducing costs. If there is the possibility of further reducing the cost of this project, it would help a great deal. This is because whether or not such projects are embraced is dependent on how cheap they can be. Shading has adverse effects on the operation of solar panels. Shading of a single cell will have an effect on the entire panel because the cells are usually connected in series. With shading therefore, the tracking system will not be able to improve efficiency as is required.

REFERNCES

[1] A.K. Saxena and V. Dutta, “A versatile microprocessor based controller for solar tracking,” in Proc. IEEE, 1990, pp. 1105 – 1109.

[2] T.A. Papalias and M. Wong, “Making sense of light sensors,” http://www.embedded.com, 2006.

[3] R. Condit and D. W. Jones, “Simple DC motor fundamentals,” Texas Instruments. Publication AN907, pp. 1 – 22, 2004.

[4] S. J. Hamilton, “Sun-tracking solar cell array system,” University of Queensland Department of Computer Science and Electrical Engineering, Bachelors Thesis, 1999.

[5] M. F. Khan and R. L. Ali, “Automatic sun tracking system,” presented at the All Pakistan Engineering Conference, Islamabad, Pakistan, 2005.

[6] “Fabrication of Dual-Axis Solar Tracking Controller Project”, Nader Barsoum, Curtin University, Sarawak, Malaysia, Intelligent Control and Automation, 2011, 2, 57-68.

[7]Antonio L. Luque; Viacheslav M. Andreev (2007). Concentrator Photovoltaics. Springer Verlag.

[8]David Cooke, "Single vs. Dual Axis Solar Tracking", Alternate Energy eMagazine, April 2011.