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Dual Axis Maximum Power tracking solar Energy using Arduino

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Abstract: The goal of this thesis was to develop a laboratory prototype of a solar tracking system, which is able to enhance the performance of the photovoltaic modules in a solar energy system. The operating principle of the device is to keep the photovoltaic modules constantly aligned with the sunbeams, which maximizes the exposure of solar panel to the Sun's radiation. As a result, more output power can be produced by the solar panel. The work of the project included hardware design and implementation, together with software programming for the microcontroller unit of the solar tracker. The system utilized an ATmega328P microcontroller to control motion of two servo motors, which rotate solar panel in two axes. The amount of rotation was determined by the microcontroller, based on inputs retrieved from four photo sensors located next to solar panel. At the end of the project, a functional solar tracking system was designed and implemented. It was able to keep the solar panel aligned with the sun, or any light source repetitively. Design of the solar tracker from this project is also a reference and a starting point for the development of more advanced systems in the future.

Index Terms **– Solar, Arduino, Solar Tracking, Dual Axis**

I. INTRODUCTION

Hospital With the unavoidable shortage of fossil fuel sources in the future, renewable types of energy have become a topic of interest for researchers, technicians, investors and decision makers all around the world. New types of energy that are getting attention include hydroelectricity, bioenergy, solar, wind and geothermal energy, tidal power and wave power. Because of their renewability, they are considered as favourable replacements for fossil fuel sources. Among those types of energy, solar photovoltaic (PV) energy is one of the most available resources. This technology has been adopted more widely for residential use nowadays, thanks to research and development activities to improve solar cells' performance and lower the cost. According to International Energy Agency (IEA), worldwide PV capacity has grown at 49% per year on average since early 2000s. Solar PV energy is highly expected to become a major source of power in the future. However, despite the advantages, solar PV energy is still far from replacing traditional sources on the market. It is still a challenge to maximise power output of PV systems in areas that don't receive a large amount of solar radiation. We still need more advanced technologies from manufacturers to improve the capability of PV materials, but improvement of system design and module construction is a feasible approach to make solar PV power more efficient, thus being a reliable choice for customers. Aiming for that purpose, this project had been carried out to support the development of such promising technology. One of the main methods of increasing efficiency is to maximise the duration of exposure to the Sun. Tracking systems help achieve this by keeping PV solar panels aligned at the appropriate angle with the sun rays at any time. The goal of this project is to build a prototype of light tracking system at smaller scale, but the design can be applied for any solar energy system in practice. It is also expected from this project a quantitative measurement of how well tracking system performs compared to system with fixed mounting method

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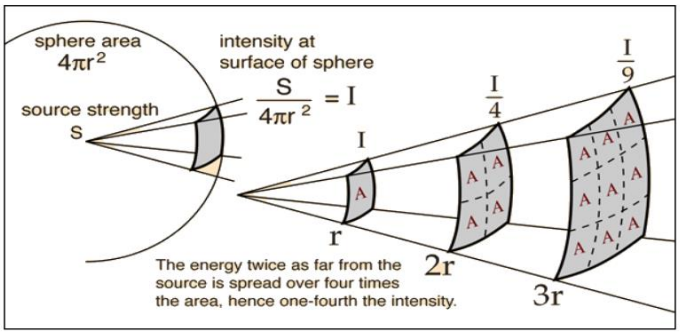
II. MATHEMATICAL MODEL

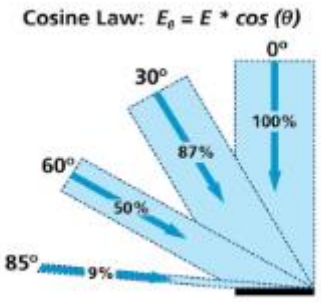
2.1 Inverse square law

The illumination upon a surface varies inversely as the square of the distance of the surface form the source. Thus, if the illumination at a surface 1 metre from the source is I units, then the illumination at 2 metres will be I/4, at 3 metres will be I/9 and so on. In fact inverse square law operates only when the light rays are from a point source and are incident normally upon the surface. Thus illumination in lamberts/m2 on a normal plane= Candle power/ (Distance in metres)2



2.2 Lambert's Cosine Law

The illumination received on a surface is proportional to the cosine of the angle between the direction of the incident light rays and normal to the surface at the point of incidence. This is mainly due to the reduction of the projected area as the angle of incidence increases.



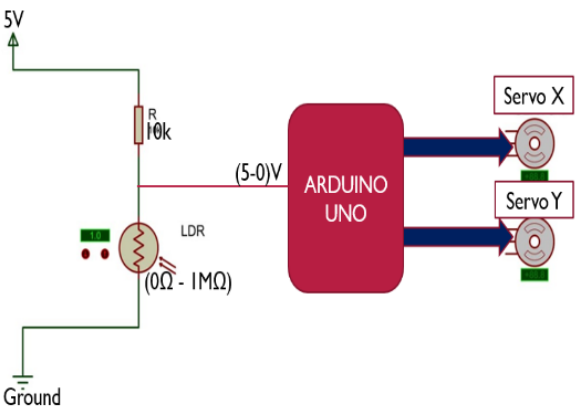
$$E_\theta = E\cos\theta = \frac{I\cos\theta}{D^2}$$

where,
Eθ= illumination on horizontal plane
E= illumination due to light normally incident
θ= the angle of incidence
D= distance from the surface

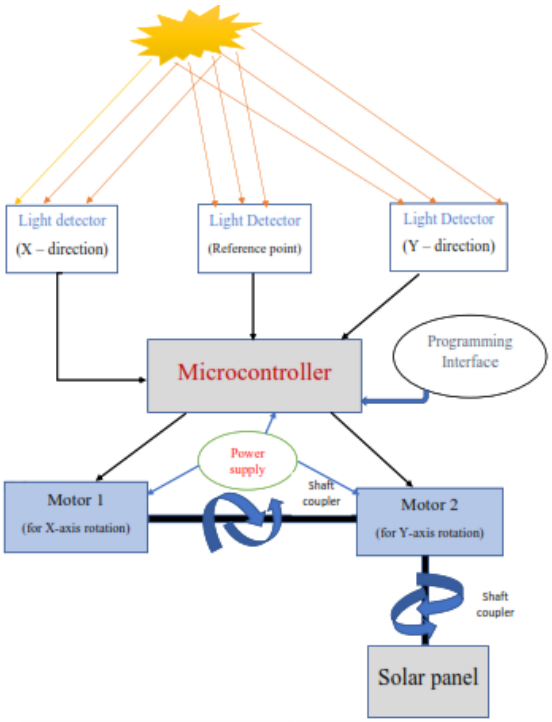
III. PROPOSED METHODOLOGY

3.1 Proposed System Design

Resistance of LDR depends on intensity of the light and it varies according to it. The higher is the intensity of light, lower will be the LDR resistance and due to this the output voltage lowers and when the light intensity is low, higher will be the LDR resistance and thus higher output voltage is obtained. A potential divider circuit is used to get the output voltage from the sensors(LDRs).The circuit is shown here.The LDR senses the analog input in voltages between 0 to 5 volts and provides a digital number at the output which generally ranges from 0 to 1023.Now this will give feedback to the microcontroller using the arduino software(IDE).The servo motor position can be controlled by this mechanism which is discussed later in the hardware model. The tracker finally adjusts its position sensing the maximum intensity of light falling perpendicular to it and stays there till it notices any further change.The sensitivity of the LDR depends on point source of light. It hardly shows any effect on diffuse lighting condition.



3.2 Block Diagram of Proposed system



As we see in the block diagram, there are three Light Dependent Resistors (LDRs) which are placed on a common plate with solar panel. Light from a source strikes on them by different amounts. Due to their inherent property of decreasing resistance with increasing incident light intensity, i.e. photoconductivity, the value of resistances of all the LDRs is not always same. Each LDR sends equivalent signal of their respective resistance value to the Microcontroller which is configured by required programming logic. The values are compared with each other by considering a particular LDR value as reference. One of the two dc servo motors is mechanically attached with the driving axle of the other one so that the former will move with rotation of the axle of latter one. The axle of the former servomotor is used to drive a solar panel. These two-servo motors are arranged in such a the solar panel can move along X-axis as well as Y-axis.The microcontroller sends appropriate signals to the servo motors based on the input signals received from the LDRs. One servo motor is used for tracking along x-axis and the other is for y-axis tracking.In this way the solar tracking system is designed.

IV. HADWARE IMPLEMENTATION

4.1 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328. Arduino is an opensource,prototyping platform And its simplicity makes it ideal for hobbyists to use as well as professionals.The Arduino Uno has 14 digital input/output pins(of which 6 can be used as PWM outputs), 6 analog inputs,a 16MHz crystal oscillator,a USB connection, a power jack,an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-toDC adapter or battery to get started. The Arduino Uno differs from all preceding boards in that it does not use the FTDI USB-toserial driver chip.Instead,it features the Atmega8U2 microcontroller chip programmed as a USB-to-serial converter."Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Arduino Uno and version 1.0 will be the reference versions of Arduno, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

4.2 LDR

It is a photo-resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance.LDR works on the principle of photo conductivity.Photo conductivity is an optical phenomenon in which the material's conductivity is increased when light is absorbed by the material.The most common type of LDR has a resistance that falls with an increase in the light intensity falling upon the device (as shown in the image above). The resistance of an LDR may typically have the following resistances.

4.3 Servo Motor

A DC servo motor consists of a small DC motor, feedback potentiometer, gearbox, motor drive electronic circuit and electronic feedback control loop. It is more or less similar to the normal DC motor.The stator of the motor consists of a cylindrical frame and the magnet is attached to the inside of the frame.A brush is built with an armature coil that supplies the current to the commutator. At the back of the shaft, a detector is built into the rotor in order to detect the rotation speed.With this construction, it is simple to design a controller using simple circuitry because the torque is proportional to the amount of current flow through the armature.

4.4 Solar Panel and Connected Load

Solar panel is placed at the top and connected to a load directly. The load may a led or a voltmeter which could be connected to get the exact voltage which depends on the intensity of light falling on the panel and the position of the tracker. Concentrated

solar photo voltaic and have optics that directly accept sunlight, so solar trackers must be angled correctly to collect energy. All concentrated solar systems have trackers because the systems do not produce energy unless directed correctly toward the sun. The solar panel is just a mere device to accept the light radiation which is purely controlled by LDR sensors and the load connected depends upon the rating of the panel used.

V. RESULTS AND DISCUSSION

In this Dual Axis Solar Tracker, when source light falls on the panel, the panel adjusts its position according to maximum intensity of light falling perpendicular to it. The objective of the project is completed. This was achieved through using light sensors that are able to detect the amount of sunlight that reaches the solar panel. The values obtained by the LDRs are compared and if there is any significant difference, there is actuation of the panel using a servo motor to the point where it is almost perpendicular to the rays of the sun.This was achieved using a system with three stages or subsystems. Each stage has its own role.The input stage is designed with a voltage divider circuit so that it gives desired range of illumination for bright illumination conditions or when there is dim lighting. The potentiometer was adjusted to cater for such changes. The LDRs were found to be most suitable for this project because their resistance varies with light. They are readily available and are cost effective. Temperature sensors for instance would be costly.The control stage has a microcontroller that receives voltages from the LDRs and determines the action to be performed. The microcontroller is programmed to ensure it sends a signal to the servo motor that moves in accordance with the generated error.The final stage was the driving circuitry that consisted mainly of the servo motor. The servo motor had enough torque to drive the panel. Servo motors are noise free and are affordable,making them the best choice for the project.

VI. CONCLUSION

In this 21st century, as we build up our technology, population & growth, the energy consumption per capita increases exponentially, as well as our energy resources (e.g. fossils fuels) decrease rapidly. So, for sustainable development, we have to think alternative methods(utilization of renewable energy sources) in order to fulfil our energy demand. In this project, Dual Axis Solar Tracker, we've developed a demo model of solar tracker to track the maximum intensity point of light source so that the voltage given at that point by the solar panel is maximum. After a lot of trial and errors we've successfully completed our project and we are proud to invest some effort for our society. Now, like every other experiment, this project has couple of imperfections. Our panel senses the light in a sensing zone, beyond which it fails to respond.If multiple sources of light (i.e. diffused light source) appear on panel, it calculates the vector sum of light sources & moves the panel in that point. This project was implemented with minimal resources. The circuitry was kept simple,understandable and user friendly.

REFERENCES

[1] Juang, J.N. and Radharamanan, R., 2014. Design of solar tracking system for renewable energy. In proceedings of the 2014 Zone 1 conference of the American society for engineering education (pp. 1-8). IEEE.

[2] Pradeep, K., Reddy, K.S.P., Mouli, C.C and Raju, K.N., 2014. Development of dual-axis solar tracking using Arduino with lab view. International Journal of Engineering Trends and Technology, 17(7), pp.321-324.

[3] Kaur, T., Mahajan, S., Verma, S. and Gambhit, J., 2016. Arduino based low cost active dual axis solar tacker. In 2016 IEEE 1st International conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES) (pp. 1-5). IEEE.

[4] Das, S., Chakraborty, S., Sadhu, P.K. and Sastry, O.S., 2015. Design and experimental execution of a microcontroller (μC)-based smart dual-axis automatic solar tracking system. Energy Science & Engineering, 3(6), pp.558-564.

[5] Catarius, A.M. and Christiner, M.P., 2010. Azimuth - altitude dual axis solar tracker.

[6] Sidek, M.H.M., Azis, N., Hasan, W.Z.W., Ab kadir, M.Z.A., Shafie, S. and Radzi, M.A.M., 2017. Automated positioning dual-axis solar tracking system with precision elevation and azimuth angle control. Energy, 124, pp.160-170.

[7] Vieira, R.G., Guerra, F.K.O.M.V., Vale, M.R.B.G. and Araujo, M.M., 2016. Comparative performance analysis between static solar panels and single-axis tracking system on a hot climate region near to the equator. Renewable and Sustainable Energy Reviews, 64, pp.672-681.

[8] Reddy, J.S., Chakraborti, A. and Das, B., 2016. November. Implementation and practical evaluation of an automatic solar tracking system for different weather conditions. In 2016 IEEE 7th Power India International Conference (PIICON) (pp. 1-6). IEEE.

[9] Hoffmann, F.M., Molz, R.F., Kothe, J.V., Nara, E.O.B. and Tedesco, L.P.C., 2018. Monthly profile analysis based on a two-axis solar tracker proposal for photovoltaic panels. Renewable energy, 115, pp.750-759.

[10] Singh, P., Pahuja, R., Karwasra, M., Beniwal, S., Bansal, M. and Dadhich, A., 2016. Dual Axis Solar Tracking System for Solar panel. Bulletin of Electrical Engineering and Informatics, 5(4), pp.403-411.

[11] Das, A. and Swthika, O.V., 2016. Arduino Based Dual Axis Sun Tracking System. Advanced Science Letters, 22 (10), pp.2837-2840.

[12] Fuentes, M., Vivar, M., Burgos, J.M., Aguilera, J. and Vacas, J.A., 2014. Design of an accurate, low-cost autonomous data logger for PV system monitoring using Arduino that complies with IEC standards. Solar Energy Materials and Solar Cells, 130. Pp.529-543.

[13] Rosenblatt, A. and Aaron, N., 2014. Solar Tracking System (2014).

[14] Barsoum, N., Nizam, R. and Gerard, E., 2016. New approach on development a dual axis solar tracking prototype. Wireless Engineering and Technology, 7(1), pp. 1-11.

[15] Vit, J. and Krejcar, O., 2016. Smart solution of alternative energy source for smart houses. In International conference on Industrial, Engineering and Other Applications of Applied Intelligent Systems (pp. 830- 840). Springer, Cham.s.