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DUAL AXIS SOLAR TRACKER

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Abstract: The energy crisis has become a major issue in the world developing country, like India. The Energy crisis has shocked India. Nearly 13% of the Indian population has no Electricity and the Rest 87 % of the population is facing energy cutoffs because of coal shortage. India generates about 70% of its total power from thermal power plants by burning coal. The coal shortage has led to the energy crisis in India.

Renewable energy is the only answer to solve this issue. Solar energy is one of the most effective resources of renewable energy which could play a significant role to solve this crisis. This research presents a performance analysis of the dual-axis solar tracking system using Arduino. The main objective of this research is whether a static solar panel is better than a solar tracker or not. This work is divided into two parts hardware and software system. In the hardware part, four light dependent resistors (LDR) is used to detect the utmost light source from the sun. Two gear motors are conjointly used to move the solar panel to the maximum light source location perceived by the LDRs. In the software part, the code is written using C programming language and has targeted the Arduino UNO controller. The outcome of the solar tracker system has been analyzed and compared with the fixed or static solar panel found better performance in terms of voltage, current, and power. Therefore, the solar tracker is proved more practical for capturing the maximum sunlight supply for star harvesting applications. The result showed dual-axis solar tracking system produced extra 10.53-watt power compared with a fixed and single axis solar tracking system.

Keywords—solar tracking; single axis; dual axis; light depending resistor (LDR), Gear motor, Arduino, altitude, azimuth, charge controller.

I. INTRODUCTION

Electrical energy from solar panels is derived by converting energy from the sun rays into electrical current. The main challenge is to maximize the capture of the sun rays upon the solar panels, which in turn maximizes the output of electricity. There are two possible ways to enhance output power from solar energy based systems. Either one can use an efficient material in the manufacturing of the photo voltaic cell or use a solar tracker to follow the sun.

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. Dual Axis Tracker follows the sun much better as compared to single axis tracker.

It consists of two motors, one for X-axis rotation and other for Y-axis rotation. The microcontroller is programmed to controls the motors such that all LDRs receive maximum amount of light which ensures that solar panel is also receiving maximum sunlight for maximum power generation. 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 dual-axis solar system will be more advanced systems in the future.

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 maximize 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 maximize the duration of exposure 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.

II. INTERNET OF THINGS

In the new era of communication and technology, the explosive growth of electronic devices, smart phones and tablets which can be communicated physically or wirelessly has become the fundamental tool of daily life. The next generation of connected world is Internet of Things (IoT) which connects devices, sensors, appliances, vehicles and other "things". The things or objects may include the tag, mobile phones, sensors, actuators and much more. With the help of IoT, we connect anything, access from anywhere and anytime, efficiently access any service and information about any object. The aim of IoT is to extend the benefits of Internet with remote control ability, data sharing, constant connectivity and so on. Using an embedded sensor which is always on and collecting data, all the devices would be tied to local and global networks. The term IoT, often called Internet of everything, was 1st introduced by Kevin Ashton in 1999 who dreams a system where every physical object is connected using the Internet via ubiquitous sensors. The IoT technology can provide a large amount of data about human, objects, time and space. While combining the current Internet technology and IoT provides a large amount of space and innovative service based on low-cost sensors and wireless communication. IPv6 and Cloud computing promote the development of integration of Internet and IoT. It is providing more possibilities of data collecting, data processing, port management and other new services. Every object which connects to IoT requires a unique address or identification with IPv6. There are so many people in the world whose health may suffer because they do not have proper access to hospitals and health monitoring. The Internet of things (stylized Internet of Things or IoT) is the internetworking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings and other items-embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data. In 2013 the Global Standards Initiative on Internet of Things (IoT-GSI) defined the IoT as "the infrastructure of the information society." The IoT allows objects to be sensed and/or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer based systems, and resulting in improved efficiency, accuracy and economic benefit.

III. DESIGN METHODOLOGY

3.1 Design details

Hardware Components:

1. Arduino Uno
2. Light Dependent Resistor (LDR) [4 units]
3. IR sensor [4 units]
4. DC Motor of 10 RPM [2 units]
5. Motor Driver
6. Solar panel
7. 9V Battery
8. Wires

Software Components:

1. Arduino Compiler
2. Arduino Code

3.2 Block diagram

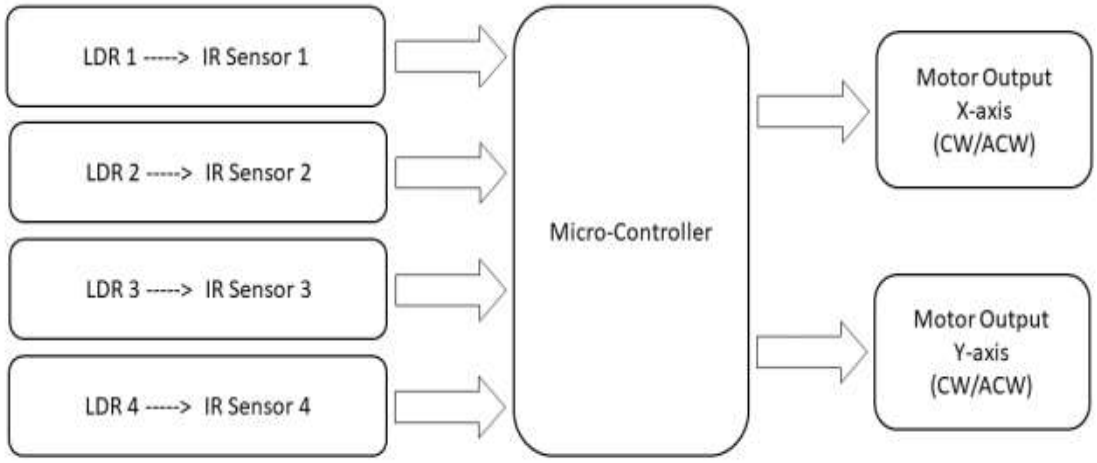

Fig 1: Block diagram of solar tracker

WORKING

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 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 dc 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. When light will fall on LDR 1 solar tracker will adjust itself by moving in downward direction. Similarly, LDR 2 will move in upward direction. When light will fall on LDR 3 solar tracker will move in clockwise direction and when light will fall on LDR 4 solar tracker will move in anti-clockwise direction.

3.3 METHODOLOGY

The Methodology used by us in the Construction of Dual Axis Solar Tracking System. A Variety of Process, Equipment and Material are used in the Production of Solar Tracker System. Solar Tracker is a system used to position an object at an angle relative to the sun. The Most Common Applications for Solar trackers are positioning photovoltaic (PV) panels (solar panels) so that they remain perpendicular to the sun rays and positioning space telescopes so that they can determine the sun direction. A solar tracker is a device that orients a payload toward the Sun. Payloads are usually solar panels, parabolic troughs, Fresnel reflectors, lenses or the mirrors of a heliostat. For flat-panel photovoltaic systems, trackers are used to minimize the angle of incidence between the incoming sunlight and a photovoltaic panel, sometimes known as the cosine error. Reducing this angle increases the amount of energy produced from a fixed amount of installed power generating capacity .In standard photovoltaic applications, it was predicted in 2008-2009 that trackers could be used in at least 85% of commercial installations greater than one megawatt from 2009 to 2012.

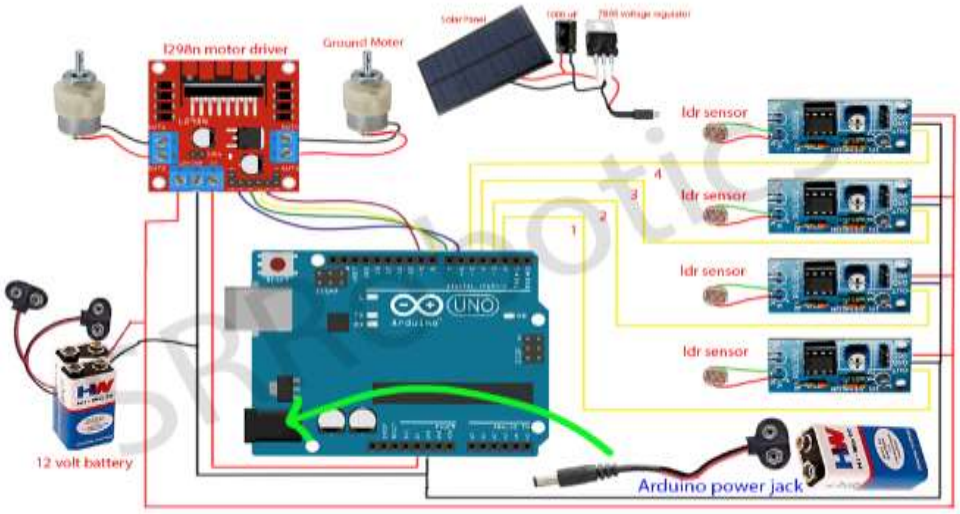

Fig 2: Circuit Diagram

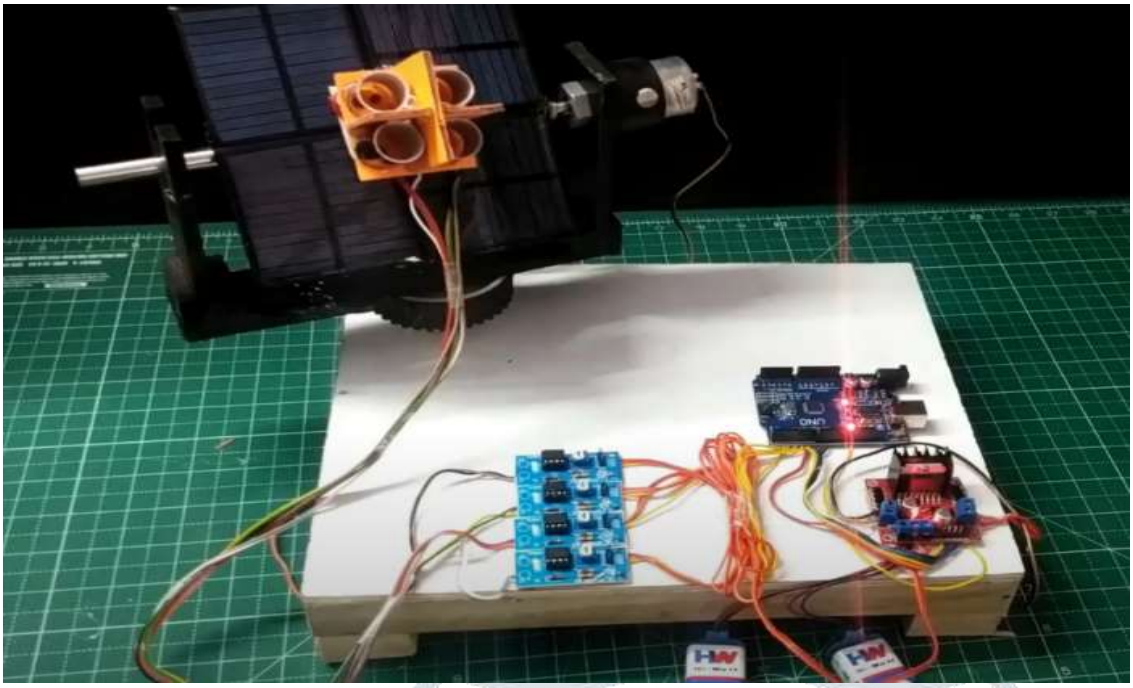

Fig 3: Implemented System

IV. FUTURE SCOPE

In the coming years, technology improvements will ensure the solar becomes even cheaper. It could well be that by 2030, solar will have become the most important source of energy for electricity production in a large part of the world. This will also have a positive impact on the environment and climate change. Generation of solar energy has tremendous scope in India. The geographical location of the country stands to its benefit for generating solar energy. The reason being India is a tropical country and it receives solar radiation almost throughout the year, which amounts to 3,000 hours of sunshine. Solar power is the crucial future production method in the move to clean energy, and as economies of scale drive prices down, its importance will only increase. What are the advantages of solar power? The main advantage is that it is a renewable, clean source of electricity. Solar power is also scalable. Renewable Energy in the future is predicted that by 2024, solar capacity in the world will grow by 600 gigawatts (GW), almost double the installed total electricity capacity of Japan. Overall, renewable electricity is predicted to grow by 1 200 GW by 2024, the equivalent of the total electricity capacity of the US. There Is enough scope for the development of solar energy It has bright future in India because (a) many parts (regions) of the country received sunlight on 300 days annually and so it becomes possible to generate 20 MW solar energy per square kilometer in such areas. India has set a driven objective to create60, 000 MW of power from wind by 2022.

The Indian Government's Ministry of New and Renewable Energy announced another wind solar based mixture strategy in May 2018. The Department of Energy concludes that solar power can provide up to 40% of the nation's energy supply. This is particularly important because demand for electricity is projected to grow by 30% between 2020 and 2035, the study says. Improved ways to store solar energy also can fortify energy-grid resilience. One of the biggest problems that solar energy technology poses is that energy is only generated while the sun is shining. That means nighttime and overcast days can interrupt the supply. Commercially, dual axis solar tracking is still rare even in countries wherever a major part of electricity is being produced by solar energy as they claim that single axis tracking is doing the work. However dual axis tracking will noticeably increase the potency. For our research work we've implemented this procedure on a sporadic power PV panel.

Cost Effectiveness and proposed system potency may be discovered on a business level. This research used mono crystalline PV panel. But a poly crystalline material based PV panel also can be used for this proposed model. We used LDR for this proposed model but LDR is not a good choice as a sensor as it affected by dust. So in future, we can also use the more efficient sensor. A reliable structure is very expensive compared to solar panel cost; therefore, adding an additional panel to the system instead of spending on tracking structure is much more cost effective.

IV. RESULT

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 dc 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 stages were; an input stage that was responsible for converting incident light to a voltage. A control stage that was responsible for controlling actuation and decision making. A driver stage with the dc motor. It was responsible for actual movement of the panel. 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 dc motor that moves in accordance with the generated error. The final stage was the driving circuitry that consisted mainly of the dc motor. The dc motor had enough torque to drive the panel. Dc motors are noise free and are affordable, making them the best choice for the project.
We operated solar tracker in sunlight for 1 hour approximately. We have seen that the dual axis solar tracker adjust itself in such a way that the solar panels are align to the maximum radiation of the sunlight.

Dual axis solar tracker receives maximum radiation of sunlight from sun and generates large electricity power.
Using Solar Panel we have generated power of 24 volts from solar panel. We have charge mobile phone from the power generated. Dual axis solar tracker increases the amount of energy produced from a fixed amount of installed power generating capacity.

V. CONCLUSION

Dual axis tracker perfectly aligns with the sun direction and tracks the sun movement in a more efficient way and has a tremendous performance improvement. The proposed system is cost effective also as a little modification in single axis tracker provided prominent power rise in the system.

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.

(i) Our panel senses the light in a sensing zone, beyond which it fails to respond.

(ii) 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

VI. ACKNOWLEDGEMENT

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