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Dynamic Solar Tracking System

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Abstract: With the impending scarcity of non-renewable resources, people are considering using alternate sources of energy. From all other available resources sun energy is the most abundant and it's comparatively easy to convert it to electrical energy. Use of solar panel to convert sun's energy to electrical is very popular, but due to transition of the Sun from east to west the fixed solar panel may be able to generate optimum energy. The proposed system solves the problem by an arrangement for the solar panel to track the Sun. This project is based on the use of solar panel coupled to a stepper motor to track the Sun so that maximum sun light is incident upon the panel at any given time of the day and year. This is better compared to fixed panel method that may not be so efficient. Moreover, the code is constructed using C++ programming language and targeted to Arduino UNO controller. This will maximize the radiations incident on the panel at any given time of the day by solving the variation problem of solar radiations which causes solar panel to lose more than 40% of the collected energy. Therefore, the system has been proven working for capturing the maximum sunlight source for high efficiency solar harvesting applications. Further the work can be enhanced by using RTC (Real Time Clock) to follow the Sun. This helps in maintaining the required position of the panel even if the power is interrupted for some time.

Index Terms* - Arduino UNO Controller, *C++ programming language, RTC (Real Time Clock), Sun's Energy, Electrical Energy, Solar Panel, etc

I. INTRODUCTION

The increasing demand for energy, the continuous reduction in existing sources of fossil fuels and the growing concern regarding environment pollution, have pushed mankind to explore new technologies for the production of electrical energy using clean, renewable sources, such as solar energy, wind energy, etc. Among the non-conventional, renewable energy sources, solar energy affords great potential for conversion into electric power, able to ensure an important part of the electrical energy needs of the planet.

The conversion of solar light into electrical energy represents one of the most promising and challenging energetic technologies, in continuous development, being clean, silent and reliable, with very low maintenance costs and minimal ecological impact. Solar energy is free, practically inexhaustible, and involves no polluting residues or greenhouse gases emissions. Different researches estimate that covering 0.16% of the land on earth with 10% efficient solar conversion systems would provide 20 TW of power, nearly twice the world's consumption rate of fossil energy. This proves the potential of solar energy which in turn points out the necessity of tracking mechanism in solar systems.

II. RELATED WORK

- Photovoltaic solar energy is the most commonly used in housings due to its simple installation and good quality-to-price ratio compared to other technological applications (parabolic cylinder collectors, Stirling dish parabolic collectors, etc.), that even though reach higher levels of electric energy production, present practically insurmountable difficulties for its architectural integration. There is a great amount of research that tries to improve the performance of this type of installations using double-sided panels, concentration lenses, geometrically integrated into buildings panels, development of new solar cells, improvement in stages of conversion, etc.
- In order to obtain maximum output power of a photovoltaic module or a set of modules, it is necessary to have an automated system able to orient the surface of the panel in a way that the highest possible amount of solar radiation reaches its surface perpendicularly to generate the highest peaks of energy production. For that purpose, numerous authors developed diverse prototypes of solar photovoltaic trackers in order to improve the performance of this technology. In general, all of them have a fixed part of structure and moving part composed of tracking equipment and energy production equipment. Many projects have been done by using photovoltaic cells in collecting solar radiations and converting them to electrical energy. But most of these don't take into account the difference of sun's angle of incidence by installing the panels in a fixed orientation, which highly influences the solar energy collected by the panel. Out of all solar trackers existing in the market, the most effective are those that move in two axes, azimuthal and zenithal. Compared to a properly inclined fixed solar panel, energy gain can be considerably increased using this type of solar tracking systems. These systems of tracking with two axes have been developed using two types of the most commonly used automatic control systems, with open loop and closed loop. Tracking in closed loop is more effective as it uses various active sensors responsible for receiving signals of solar radiation, such as light-dependent resistance (LDR), and moreover, it has a feedback to the controller that allows constantly orienting the panel making the most of its effectiveness. At the moment, when an error signals previously calibrated coming from the control system is produced, the motors are activated and the surface of the panel is redirected.

III. PROPOSED SYSTEM

Our project aims to develop a dynamic solar tracking system that will track the sunlight and its intensity and adjust itself in such a way that maximum sunlight is incident upon it at any given time of the day. The proposed model of Dual Axis Solar Tracker is most compatible for obtaining maximum efficiency. Dual axis trackers have two degrees of freedom that act as axes of rotation. These axes are typically normal to one another. The axis that is fixed with respect to the ground can be considered a primary axis. The axis that is referenced to the primary axis can be considered a secondary axis.

The sensor-based system consists of the LDR sensor, comparator and microcontroller. In the tracking operation, the LDR sensor measures the sunlight intensity as a reference input signal. The unbalance in voltages generated by the LDR sensor generates a feedback error voltage. The error voltage is proportional to the difference between the sunlight location and the solar panel location. At this time the comparator compares the error voltage with a specified threshold (tolerance). If the comparator output goes high state, the motor driver is activated so as to rotate the dual-axis (azimuth and elevation) tracking motor and bring the PV panel to face the Sun. Accordingly, the feedback controller performs the vital functions: PV panel and sunlight are constantly monitored and send a differential control signal to drive the PV panel until the error voltage is less than a pre-specified threshold value.

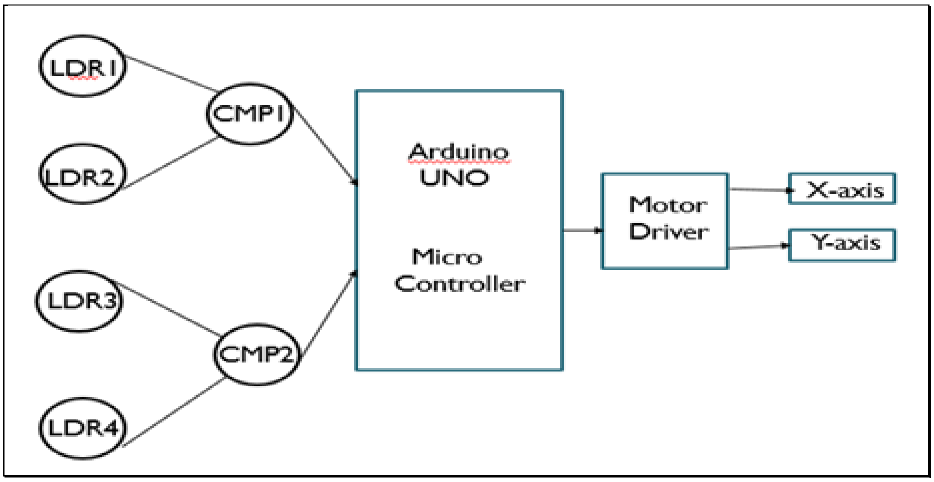

Fig.1: Proposed System Architecture

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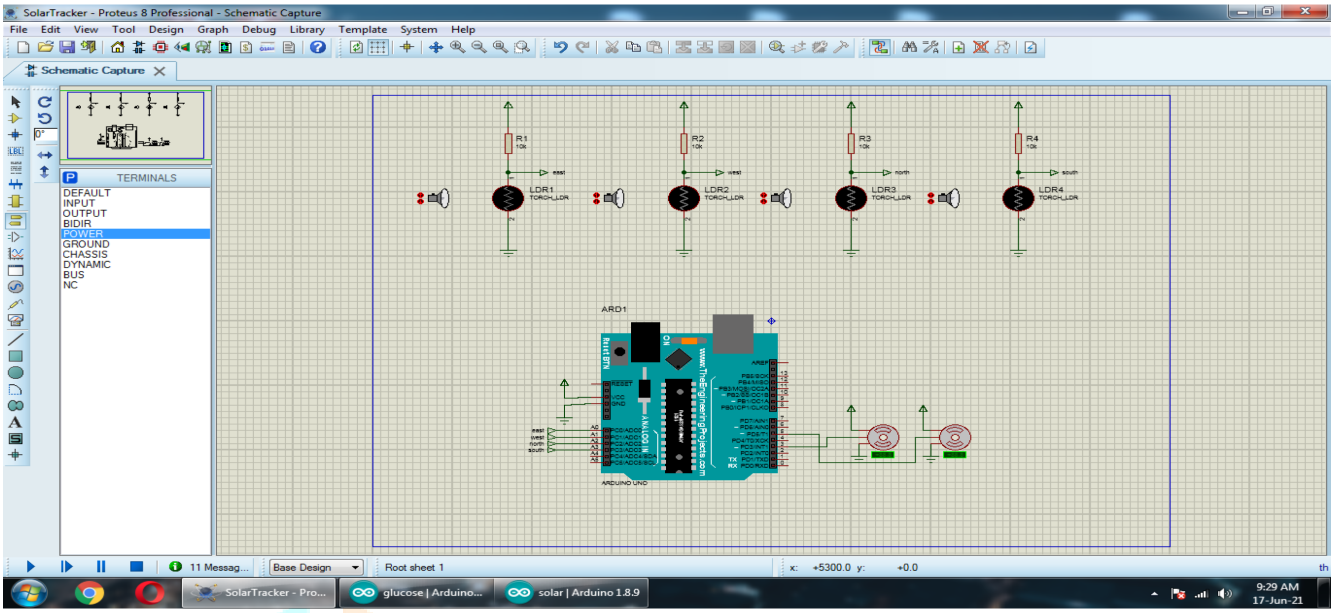
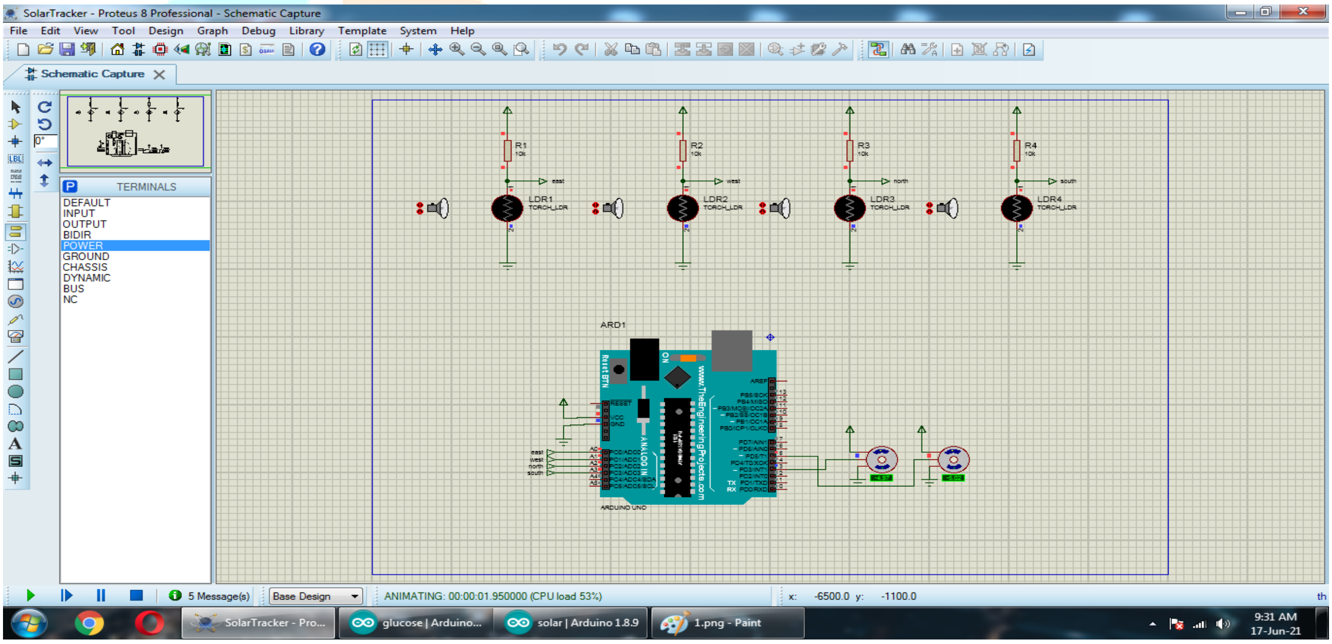
IV. IMPLEMENTATION ENVIRONMENTS

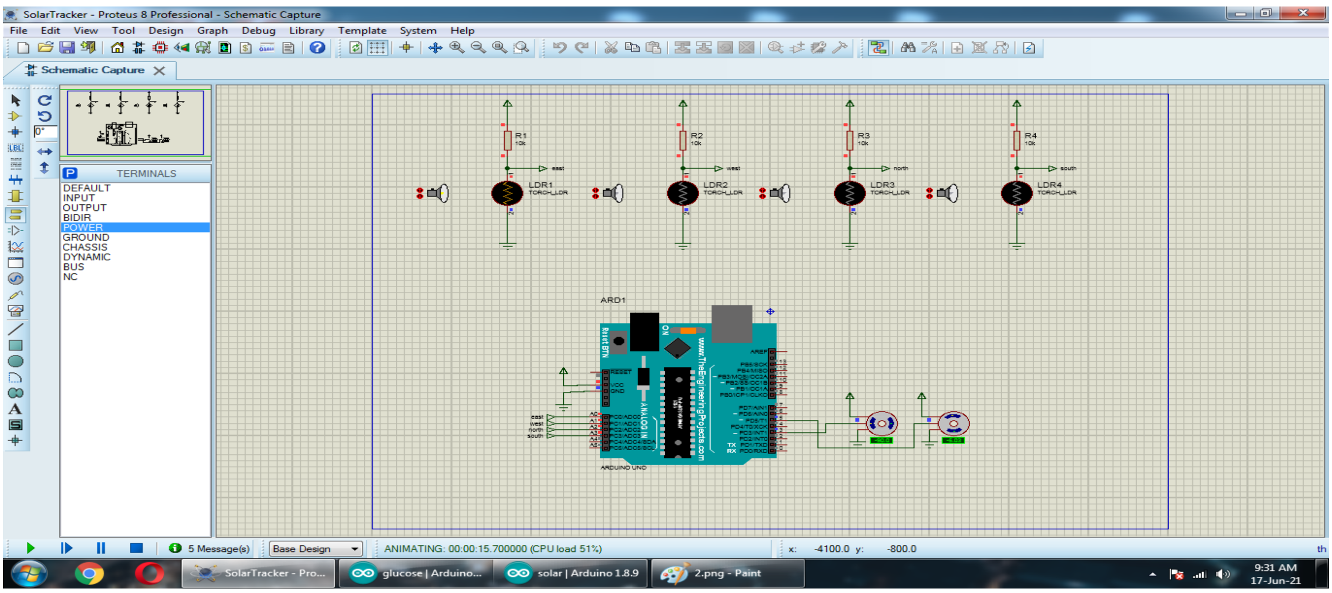
In terms of large-scale production, such as solar farms, developed solar tracker is not competitive with commercial systems that are able to move hundreds of photovoltaic panels. However, it can be competitive for small less powerful installations placed on flat surfaces. Lightweight of this type of prototype is one of its advantages for installation in houses, where it is not feasible to place large masses that can generate loads on the building structure, or vibrations caused by rotating movements that could coincide with fundamental resonance frequencies of the building structure. Moreover, the fact of using Arduino as electronic control card, provides it with a power comparable to any commercial PLC, but at lower cost, not only because of the device itself, but also because of great amount of developed freeware programs that allow modeling, programming and simulating of previous behaviour of these systems. That is why this type of prototype is ideal for its installation in houses without presenting any serious technical difficulties and at a reduced cost.

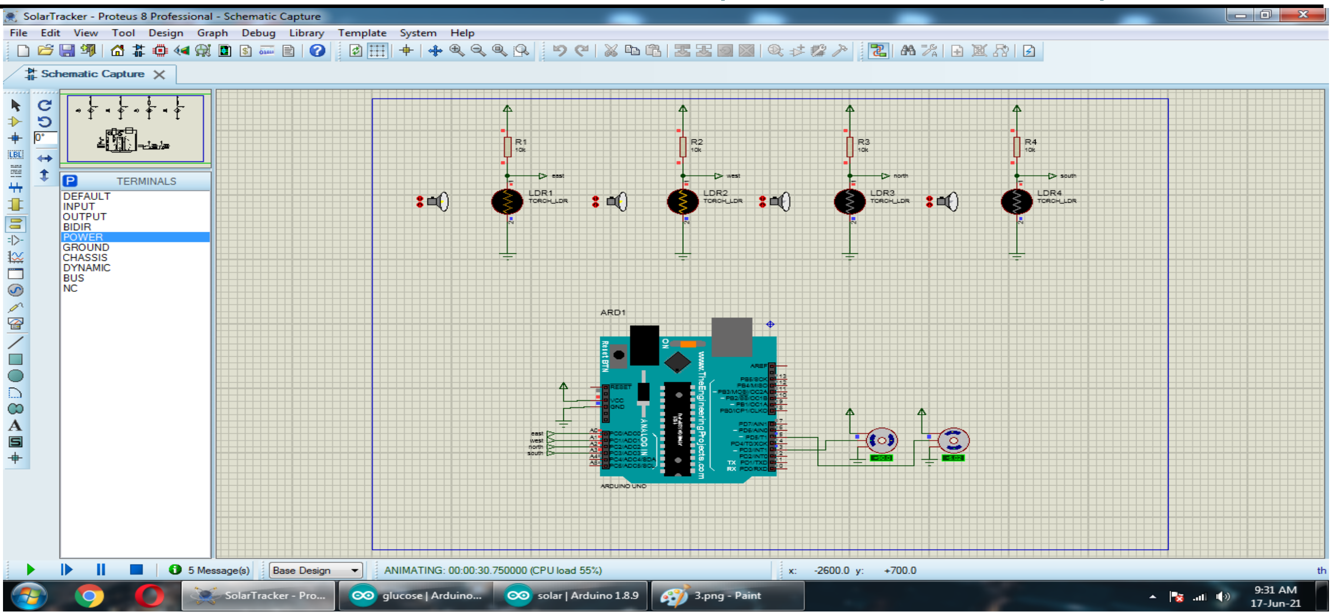
IV. RESULTS AND DISCUSSION

Results and Analysis









V. CONCLUSION

Solar radiation Tracker will play a vital role in increasing the efficiency of solar panels in recent years, thus proving to be a better technological achievement. The vital importance of a dual axis solar tracker lies in its better efficiency and sustainability to give a better output compared to a fived solar panel or a single axis solar tracker. The tracking system is designed such that it can trap the solar energy in all possible directions. Generally, in a single axis tracker that moves only along a single axis it is not possible to track the maximum solar energy. In case of dual axis trackers, if the solar rays are perpendicular to panel throughout the year. Hence, maximum possible energy is trapped throughout the day as well as throughout the year. Thus, the output increases indicating that the efficiency more than a fixed solar panel (about 30 -40% more) or a single axis solar tracker (about 6-7% more). This system will have many advantages including increased efficiency, reduced pollution and more use of solar energy for the generation of energy.

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