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Automatic Solar tracking System for maximizing battery charging

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Abstract: The word technology is an unstoppable power which has grown far impressively under few decades. The devices and the machines had almost optimized in every field, in every aspect and with the growing use of machines there is a need of an active energy source which should be comfortable for globalization and should be eco-friendly. Now the use of renewable energy resources are under important means as solar energy, for which solar panels have been an effective devices to charge the PV cells known as photo voltaic cells using solar energy. But the problem of efficiency occurs due to moving source, as sun changes its direction at every instant. An automatic tracker will be useful for such premises to track and automatically shift the panel to keep it perpendicular to sun rays. Initially the effective cost of the normal solar tracker is high but the proposed system gives a cheaper idea to maintain a smart solar tracker with additional functions. This paper describes the automatic tracking mechanism using a bidirectional stepper motor attached with solar panels which is controlled by LDR (light dependent resistor) sensors. ATmega8 microcontroller is used and it is connected with the LDRs for each direction. LDR sensors values decide how to actuate the stepper motor to position so that the solar panel can receive maximum amount of sunlight. As compared with any other type of motor, the stepper motor is more controllable, more energy efficient, more steady and has high tracking accuracy.

Keyword: ATMega8, MCU (Microcontroller controller unit), sun tracking, Stepper Motor, LED (light emitting diode), LDR (light dependent resistor).

I. Introduction

The alternative source of energy is continuously achieving popularity especially since the realization of fuel's shortcomings. Sources which instead known as renewable sources (Solar, Wind, Hydro and Geothermal) have all been utilized with varying levels of success. Solar energy could not make any impressive vision for working as an effective source of energydue to the relatively high cost of solar cells and their low conversion efficiency. For capturing, it is necessary to recover as much energy as possible from a solar power system because in an average only 15-20% of total incident energy can be converted into the usable energy. This low conversion ratio reduces again due to light gathering losses. The Light gathering is dependent on the angle of incidence of the light source to the solar cell's surface. The angle of incident is dependent of the efficiency of the panel, if the panel is laid horizontally to the ground then the panel will get the maximum energy when the sun light is incident at afternoon and it causes less efficiency in the time of evening and morning because the sun rays could not be made possible to directly incident on the panel at every incident [1]. Thus the total efficiency of the panel got affected and only 15-27 percent of energy could be transformed into electrical energy [3]. To neglect this issue it is necessary to create such method for which the panel could get the sunrays to the maximum at every instant. As such, a means of tracking the sun is required. This process of sensing and navigating the position of the sun is known as Solar Tracking. Improvement of solar cell efficiency and efficiency of the solar panel is an ongoing research work and people throughout the world are actively doing research on this. Maximizing the output power from the solar panel and integrating solar tracking system are the two ways whereElectronic design methodology can bring success. The came under the same as Maximum power point tracking (MPPT) which is the process to maximize the output power from solar panel by keeping the solar panel's operation on the knee point of P-V characteristics [2]. Solar tracking system track the sun's position that increases power output of solar panel 30% to 60% than the Stationary system. This is far more cost effective solution than purchasing additional solar panels for every direction and the tracking by means of microcontroller make solar tracker a smart solar tracker which could be programmed for many such functions. The project has been programmed to track the panel when the sun rays are present in the medium, perhaps as the day comes to an end the controller smartly sense no energy from the LDR's and switches off ADC and switches on the connected LED's with the microcontroller .The led and controller works from the same energy that panel had converted using a battery storage. The LDR's are still switched on to sense the sun rays and whenever any of the LDR tracks the sun the system switches of LED's and start solar energy conversion.

II. Tracking principle

There are numbers of methodologies available for tracking of sun rays. The idea should be taken into consideration to introduce the cheapest method for tracking of sun light. The simplest of all uses an LDR to detect light intensity changes on the surface of the resistor. Three LDR are used to get maximum efficiency.

The stable position is when any of the three LDRs having the maximum light intensity. When the light source moves, i.e. the sun moves from west to east, the level of intensity falling on LDRs changes and this change is calibrated into digital voltage using voltage dividers. After that ADC in MCU gets the digital value corresponds to calibrated voltage and then in accordance with this digital value instruction is given to the motor driver in order to track the direction of the sun rays.

III. Hardware configuration

ATmega8 MCU is an AVR family microcontroller. MCU requires a 5 volt regulated voltage supply and a battery is attached to the system to store the charge of electrical energy from the panel. ADC is the internal peripheral of MCU which has been used for detecting the maximum sunlight out of three different LDRs.

Stepper motors are the rotating dc motor subjectly used for step by step rotations. Stepper motors are commonly used in precision positioning control applications. The reason behind choosing the Stepper motor instead of others is its features. Stepper motor is brushless, load independent, has open loop positioning capability, good holding torque and excellent response characteristics [4-5]. Motor is also compatible to wear load of the panel for rotation. A typical controller for a hybrid stepper motor includes Logic Sequence Generator which Generates programmed logic sequence required for operation of stepper motor. Power Drivers are power switching circuits which ensure a fast rise of current through the phase windings which are to be turned on at a particular step in the Logic sequence. ULN2003 stepper motor driver has been used in the prototype. Current limiting circuits are meant to ensure a rapid decay of current in Phase winding that is turned off at a particular step in the logic sequence [7].

The L293D IC is a motor driver IC used to give instructions to the stepper motor. It is a quadruple high-current half-H driver. It is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V.

IV. Working

The working of MCU based solar tracker is not limited to track the sun rays and shifting panel to respective sides .The tracker provides operation and control mechanism through the coded program written in microcontroller. In normal day light condition, three different LDR's are used in the solar tracker to compare the output voltages from junctions and then the comparator using ADC. As the sun rotates from east to west in the day time, ADC channels on which LDR connected are used to sense the rotation of the sun. This condition is considered as normal day light condition and tracker rotates the panel according decision from the microcontroller.

In bad weather condition when the sky gets cloudy, there will be less striking of light in all the LDR's. The voltage created by the weak sun rays will not be greater than the threshold value to rotate the tracker. At the meantime, sun continues rotating in the western direction. To solve this problem, if the Microcontroller is not getting any voltage from the LDR it switches on the LED's connected to the system, perhaps if no light the LED's will be useful to work in that situation. Still if LDR's detect some power after the weather cleans the start to work from that instant accordingly.

At day time, the solar tracker will rotate in only one direction from east to west. When the sun sets, no more rotation is needed in western direction. For the next day, the solar panel needs to go to the initial position in the morning to track the sun's position again. The controller is programmed to automatically rotate the panel using stepper to get back to its initial position.

Figure 1 shows the simulation of the proposed system in proteus simulation software and Figure 2 shows the flow chart algorithm of the prototype designed. The functions which have been programmed in the prototype are not limited and the controller still could be multiplexed for more functioning. This section has been included in the future scope subtitle included within the report.

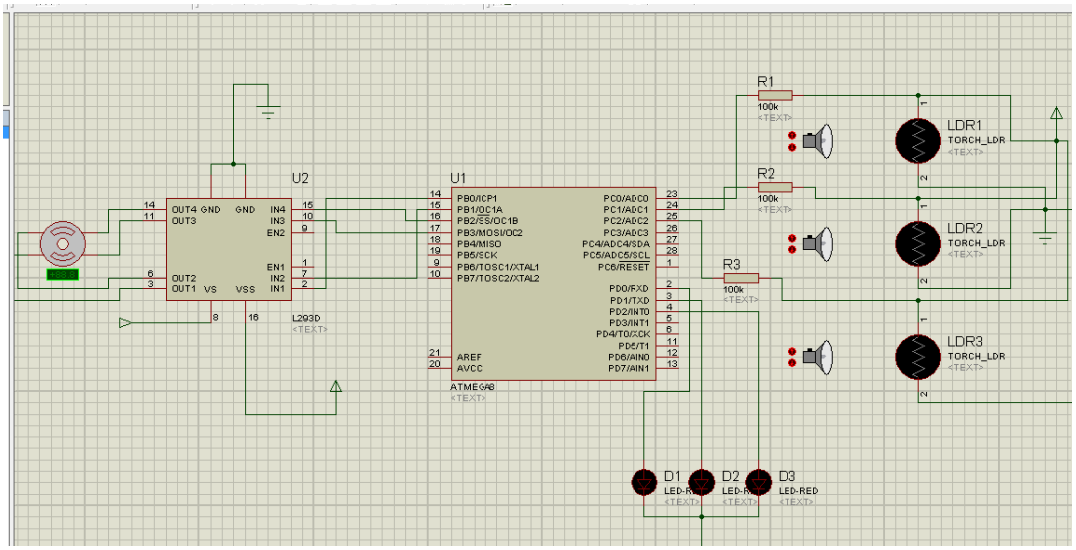

Figure 1: Simulation hardware of proposed system.

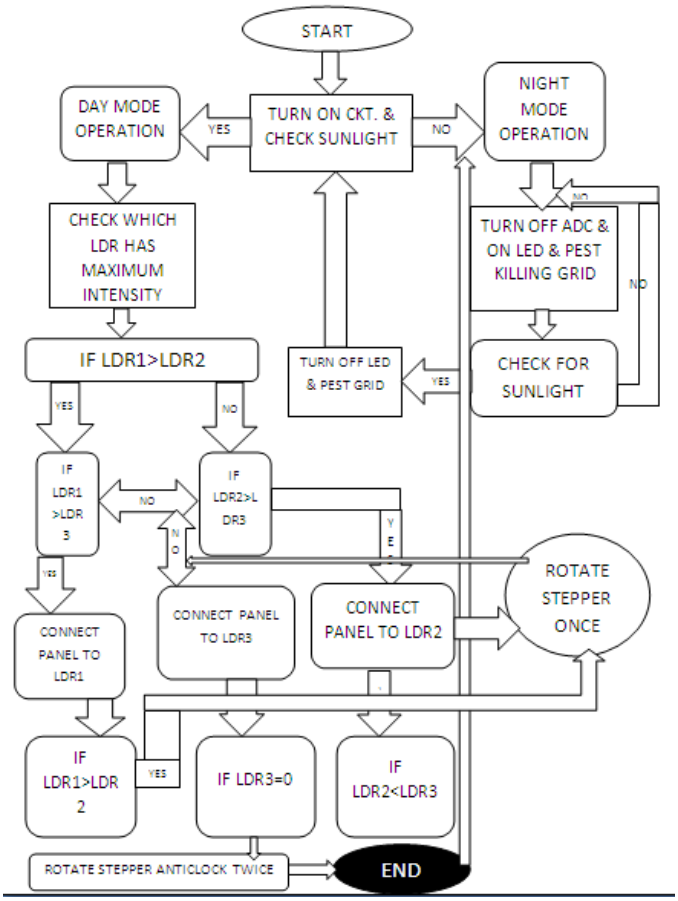

Figure 2: Flowchart of working.

V. Future scope and advancement

This section provides the necessary details and other functions which either can be applied to the prototype in the further advancement. The other advancement and functioning which could be done in the system are like the solar panel modules are generally employed in dusty environments which is the case in tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. To reduce this loss, a brush along with rollers can be fixed with the panel. This brush-roller system is so programed that it rolls down twice in 24 hours using another motor in the system.

The system could also be used in agricultural areas and in farms as a farm fielder which protects the field from pests and flies. The system can use UV rod or metal wire grinding to kill pests which could be connected to the system using the Microcontroller.

The system is also applicable as an automated street lighting. In this the system uses light source connected to the battery which was been charged though the tracker.

The system could also track the sunlight using timer, the timer function in the microcontroller could shift the panel after each minute some amount of degrees to the west to track the sun, some calculations should be done to measure exact sensing and tracking sun rays.

VI. Conclusion

The prototype designed is made for temporary analysis of the system and 12v solar panel is used for analysis. As a miniature system, it works outwell. Larger Solar panel must be integrated with the system to prepare better result and cost analysis. It has been proven from this research solar tracking system increase energy output by approximately 30%. This project has presented a means of controlling a sun tracking array with the use of embedded microcontroller system. The electronics and materials needed to activate the motors are simple and the system can be applied to any electromechanical configuration. With minors of adjustments and programming it can be used with various types of collectors and using multi-functioned coding of the system.

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