Solar Tracking and Automated Water Pumping System

#1 S Sushruthi Pai, #2 Yashaswini Y Acharya, #3 Vibha K P
Department of Electrical and Electronic Engineering,
NMAMIT NITTE, Karkala-574110

Abstract: **Solar energy is an important means of renewable energy resource. Solar tracking urges extreme solar energy to generate out of the solar panel and enables to maintain a profile with the sun rays. The goal of our venture is to increase the amount of usable energy by utilizing a computerized tracking system to capture maximum intensity of the solar rays. This project deals with development of automated water pumping system using solar tracking. The rapidly increasing demand for energy calls a need for substitute for fossil fuels. Renewable energy source exhibits an outstanding figure for producing electricity without any fuel consumption.**

Keywords: LDR, MPPT, Ardino Nano board

INTRODUCTION

Energy plays a major role in the development of the nation. Present day scenario, huge amount of energy is produced using non-renewable energy sources. 85% of energy production is dependent on fossil fuels[1]. The resources of the fuels are limited and its usage is resulting to global warming due to emission of greenhouse gases. To provide a sustainable power production and safe world to the future generation, there is a rapid increase in need of energy from renewable resources like solar, wind, geothermal and ocean tidal wave [2]. Solar radiations are converted into electrical energy by solar panels. Solar panel constitutes of semiconductor materials. Major component used in the making of solar panel is Silicon, which is 24.5% efficient.[3].

To have the maximum utilization of the amount of intensity captured it is essential to use the tracking system and hence to maintain accuracy and precession. The control circuit for solar tracker is done by Arduino Uno board. This is programmed to detect sunlight using LDR and actuate the stepper motor to position the solar panel where it can receive maximum sunlight. Stepper motor is controllable, energy efficient, steady and have high tracking accuracy and suffers little environmental affect.The undertaking is expected to develop a programmed water system framework which controls the draw engine ON/OFF on detecting water level sensors. The water pump is attached to the battery. Since the pump works on DC power supply, it is directly attached to the battery. The water pumping system also consists of water level sensors used to detect water levels for automatic turn on and off of the water pump. This helps in the automation of water pumping systems in hospitals, factories, schools, public places etc. hence reducing manpower also maintaining the adequate usage of the resources[4] [5].

Solar based power is a rule progressively used worldwide as an inexhaustible wellspring of vitality. India has tremendous undiscovered sun powered off-frame work openings. This paper gives data about advancement methodology of an installed framework for off grid water system frame work [7]. Resource of water is indispensible for satisfying daily human needs varying, from agriculture to energy production. The demand of water for irrigation purpose is still an issue to be solved in developing countries, mainly rural areas with energy crisis and environmental pollution created mostly by the use of fossil fuel, this problem has unfolded a solution using solar photovoltaic water pumping system. Solar photovoltaic water pumping system has become so popular not only in the agriculture sector but also for drinking water and micro irrigation applications [8].

Abundant water supply in remote locations is required to ensure the grazing evenly. Water pumping is most accepted and admired application of solar energy in developing countries such as India. The proposed system is reliable, simple and requires less maintenance [9]. Many villages in India use fossil fuel based water pumping system for

irrigation due to a shortage of electricity. Fossil fuel causes great damage to the environment as they release harmful greenhouse gases. In this research work, we propose a solar energy based automated water pumping system is implemented to these villagers in terms of cost and profit. In addition, this can save a lot of water and is environment-friendly [10]. Increase in cell efficiency, maximizing the power output and employing a tracking system with solar panel are the three major ways to increase the overall efficiency.

Maximum Power Point Tracking (MPPT) 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. MPPT technology only offers the maximum power that can be received from a stationary array of solar panels at a particular time; it cannot, however, increase the power generation when the sun is not aligned with the system. This system is mechanized to track the sun's position that increases the power output of solar panel from 30% to 60% than the stationary system.

To develop single axis solar tracking system which captures maximum intensity from the sun rays efficiently store the generated energy in the battery for the future application to develop automated water pumping system which helps to save water and minimize man power. Overall objective is to build a power conserving, less use of manpower, resource conserving project for the sustainable development and to help the mankind save time.

II. SOLAR TRACKING SYSTEM

Deciding the specification of the PV panel depends on the need of water tank, followed by rating of pump and battery. Single axis tracking is done using LDR controlled by Arduino Uno board and the panel is rotated accordingly which is driven by stepper motor using the driver L298N. The I-V and P-V characteristics and other parameters of solar panel is then obtained. Constant voltage which is obtained from the panel is made to store in the rechargeable battery for future application i.e Pumping system. Hence the automated water pumping system with relay protection is developed.

The proposed system mainly consists of two parts, solar tracking and water pumping system. The first part of the system, the solar tracking system consists of LDR, stepper motor and solar panel. These LDR's are connected to the two ends of the solar panel. Based on the intensity of light falling on the LDR the arduino will decide the direction of rotation of stepper motor. Stepper motor is in turn connected to the panel. Thus arduino controls the rotation of both stepper motor and solar panel.

The second part of the project namely the water pumping system consists of water level sensors, DC motor and battery. The water level sensor is used to control and detect water level in the tank. The solar energy is stored and it is collected in battery. The absorbed power is then sent to the motor which runs the pump.

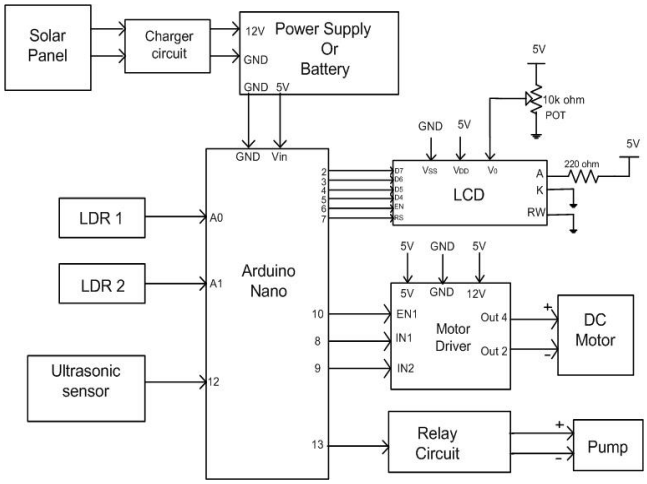

Figure 1: Configuration of Solar Tracking and Water Pumping System

2.1 Solar Panel

Solar panel mainly consists of numerous photovoltaic (PV) cells which is combined to form a module. These PV cells are made up of semiconductor material namely silicon that is usually connected in series or parallel to get additive voltage or current. The solar panel is basically a P-N junction, when sunlight falls on the PV cell; the electrons gain energy and jumps out of the atom hence leading to the flow of electricity.

Table 1: Solar panel specification

Parameter	Value
Maximum Power	10 W
Vmax	18Volts
Imax	0.56Amps
Voc	21.6Volts
Vsc	0.64Amps
Rechargeable Battery	12Volts
Dimension	280*54*22
Weight	1.5kg

The solar energy is extracted from the solar panel such that maximum energy is captured and made to store in the rechargeable type of battery. This work makes use of a 12V, 4.5Ah lead acid battery. The battery maintenance is required for better performance. If the battery is overcharged, it might get heated up and if the battery is over discharged, the

life cycle of the battery eventually decreases. To maintain the battery life and to have better performance, battery should never be overcharged or over discharged.

The intensity of the rays falling on the solar panel is sensed using LDR which is controlled and programmed using Arduino Nano board. In the parallel case the relay circuit of the water pump is also controlled by the Arduino. Then the energy is utilized to run the water pump. Pump is device that moves water content by mechanical action and are most commonly used to lift the water from ground level. In the project the water tank needs to be automatically filled based on levels sensed by ultrasonic sensors.

III. Solar Charging Circuit

This circuit is mainly used to maintain constant DC voltage obtaining from solar panel. This provides protection from over charging and over discharging of the battery.

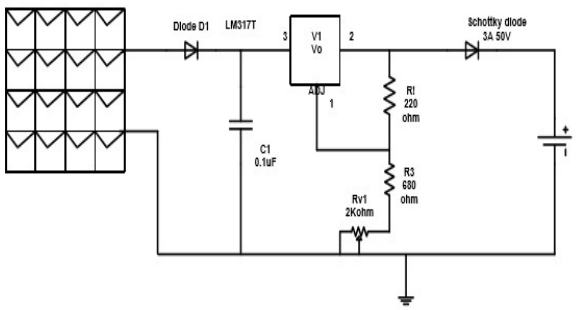

Figure 2: Circuit diagram of Solar Charger circuits

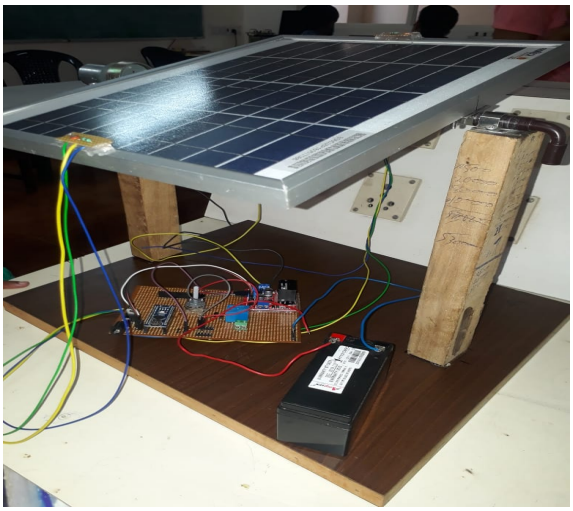

Figure 3: Solar Tracking Unit

IV. Solar panel Characteristic

The electrical power generated by solar panel depends on the intensity of the solar isolation. The amount of solar energy that passes through the atmosphere and strikes a given area on the earth over specific time varies with latitude seasons and the weather which is known as 'insulation' (incident solar radiation). Due to the variation in the intensity of the sun rays during the day and variations in the length of the day, the power generated by the solar panel also varies. The current voltage characteristic of the solar module provides useful information. The parameters obtained from the I-V curve include short circuit current 'Isc', open circuit voltage Voc, maximum current Imax, and maximum voltage Vmax at the maximum power point Pmax.

Solar panel characterization is done by connecting the solar panel in series with the ammeter followed by a rheostat and voltmeter connected across the rheostat. The resistance is varied and corresponding solar panel voltage and current are recorded, the I-V curve plotted for a 10W solar panel is shown in the below figure 4.

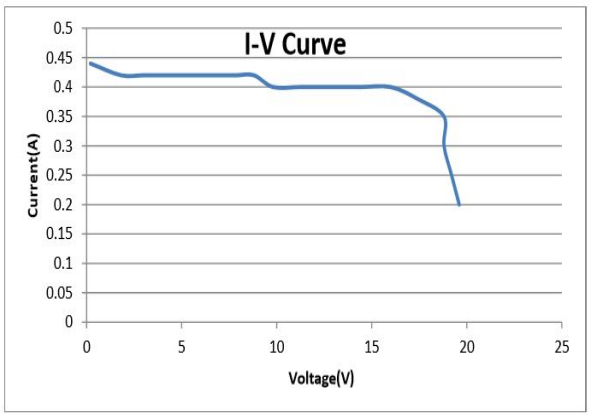

Figure 4: I-V Characteristics of solar panel

The IV curve for the solar panel is plotted during the peak time of the day say approx 2pm. The graph is plotted by taking voltage along x-axis and current along y-axis. The graph having the maximum current of 0.4A obtained at voltage of 10V.

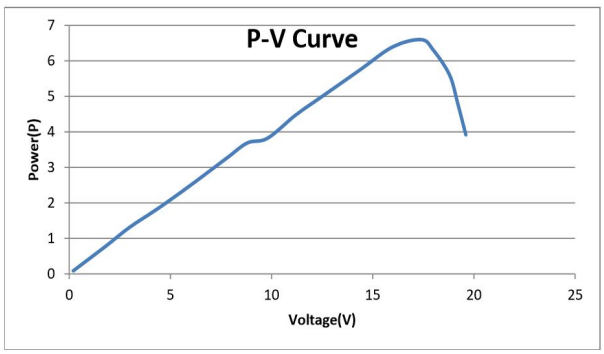

Figure 5: Power v/s Voltage Curve of the solar panel

This graph is obtained by taking solar panel voltage along x-axis and power (obtained by multiplying voltage and current at each point) along y-axis .It can be seen that the maximum power of 6.61W is obtained at voltage 17.4V and current 0.38A. From the above graph it can be inferred that the solar isolation is not constant throughout the day and the power generated varies accordingly, therefore, there is a need to store the electrical energy generated by the solar panel during maximum productivity. To achieve this battery is used as, renewable energy along with batteries allows stand-alone operations and therefore the batteries are now a standard component of solar power system.

I. V. Working of proposed system

Figure 6: Solar Tracking and Automated Water Pumping Unit

When the solar panel is exposed to sunlight, the LDR sensors are activated through arduino code and then the LDR senses the intensity of the sunlight and then decide whether the LDR1 or LDR2 is receiving maximum sunlight. And followed by the rotation of the solar panel through the DC motor driven by motor driver L298N in the direction of the maximum intensity.

Once the solar energy is obtained it is made to store in the lead acid battery for the future scope and for the protection of the battery the power trapped by the panel is made to pass through the solar charger circuit and then towards the battery. Meanwhile the ultrasonic sensor which is situated on the water tank keeps sensing the water levels and sends the message through LCD display. Once the sensor detects that the water level is low then the water pump is turned on with the relay protection circuit, powered from the lead acid battery which was storing the solar energy. Once the water level in the tank reaches its maximum point the sensor senses and then turns off the pump automatically.

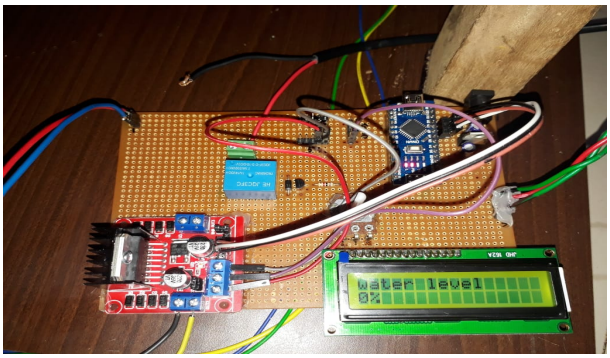

Figure 7: LCD display showing the water level

II. VI. Result and conclusion

In this project the single axis solar tracking system is successfully implemented. The constant DC voltage of 12V is obtained with help of solar charger circuit. The energy obtained from the panel is stored into the rechargeable battery of 4.5Ah. The charge controller circuit prevents over charging and over discharging of the battery. Later implemented automation of water pumping system which senses the water level in the tank and automatically turns on and off the pump, based on the water sensed in the tank which is programmed using Arduino Uno.

The production of solar energy by tracking increases its efficiency there by making it more useful. Solar energy is eco-friendly, widely available. The automated water pumping system helps in saving of water and electricity. As the system is automatic manual interaction is not required. The system designed is efficiently used to run the water pump and can be installed at consumer site.

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