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Enhancing Solar Power Generation Using Gravity And Fresh Water Pipe

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Abstract - *The unsustainable nature of fossil fuels and conventional mass energy generation method has promoted the use of renewable energy methods. Among them this project makes use of solar panels which generate electricity by receiving solar irradiance. To enhance the performance of the solar panels, they are constantly aligned with the sunbeams with a tracking system which maximizes the exposure of solar panel to the sun's radiation in addition to this, mirrors are used to concentrate more light on the panel. But, the electrical efficiency of Photovoltaic Cell is adversely affected by the significant increase of cell operating temperature during absorption of solar radiation. In order to overcome this, the solar panel is cooled by a fresh water pipe through which the water flows under gravity resulting in the enhancement of solar power generation. Thus, this paper covers the design, development and experimentation of the solar panel utilizing the mechanisms such as Solar Tracking, Solar Concentration and Solar Panel Cooling.*

Key Words: **Renewable Energy, Solar Power Enhancement, Gravity, Fresh Water Pipe, Solar Tracking, Solar Concentration.**

1. INTRODUCTION

Energy plays a vital role for the progress and development of a nation's economy. The current methods of mass energy production have a lot of destructive effects on the environment and are not reliable. So, it is necessary to look at the renewable energy resources as a source of energy. The renewable energy resource is considered for the following two reasons namely: 1. The lower quality of life due to air pollution. 2. Due to the pressure of the ever increasing world population.

In that case solar energy has the least impact on the environment compared to any other energy source because it does not produce greenhouse gases and does not pollute the water. The solar panel produces more power without any interruptions when the intensity of light is more. One of the main obstacles we face in the operation of solar panel is overheating due to excessive solar radiation and high ambient temperatures. Overheating reduces the efficiency of the panels. This can be overcome by certain cooling methods. The cooling mechanisms reduces the temperature of the panel to a threshold value without affecting the output. Thus, the main objective of this paper is to enhance the efficiency of the solar panel using solar tracker, solar concentrator and fresh water for the purpose of cooling.

2. BLOCK DIAGRAM

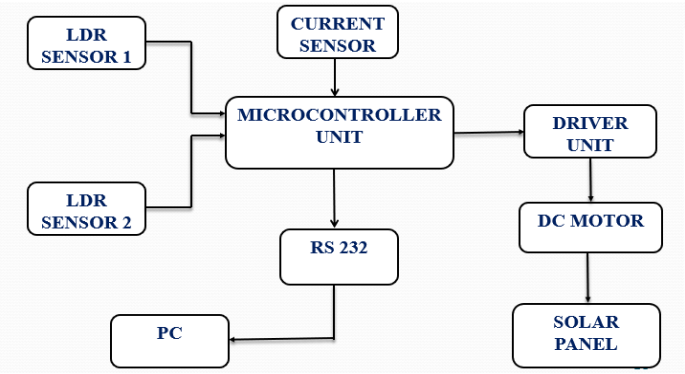


Fig -1: Block diagram

The block diagram for the working of solar panel is shown in the fig-1. The microcontroller is used as the controlling unit. Two LDR's (Light Dependent Resistor's) are connected to analog pins of the microcontroller. Sun is in left side- Light on sensor1 is high because shadow of barrier falls on sensor2 so solar panel rotates anticlockwise. Sun is in right side- Light on sensor2 is high because shadow of barrier falls on sensor1 so solar panel rotates clockwise. Sun is in the middle- Light on both sensors is equal so the panel will not rotate in any direction. The panel is rotated using gear motor through a driver circuit. The current sensor is used to monitor the current in the panel. The output of current sensor is fed to the microcontroller unit. RS232 the serial communication port is used to feed the current and voltage values to the PC. The output voltage and current from the panel is viewed via PC.

3. ENHANCING FEATURES FOR SOLAR POWER

3.1 Solar Tracker

The flowchart for the tracking system is shown in chart 1.

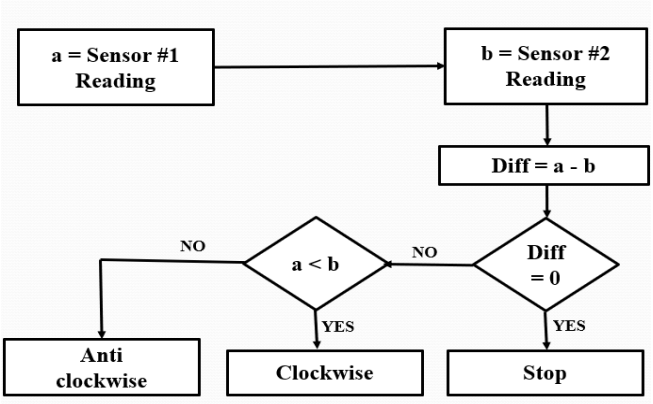


Chart -1: Flowchart for Solar Tracking

Two light dependent resistor (LDR) sensors are used whose resistance is inversely proportional to the light intensity. The resistance values determined from the sensors are fed to the controller unit. The difference between the two sensors are analyzed. If the difference is equal to zero, the panel will not rotate. If the difference is not equal to zero, then it checks for the greater value of LDR. If the value of sensor1 is high, the panel rotates in anti-clockwise direction and if the value of sensor2 is high, the panel rotates in clockwise direction.

3.2 Solar Concentrator

The design of the whole system is done by considering the size of the Solar Panel having power output 12w. concentrated solar system use mirrors or lenses to concentrate large area of light on the panel. The power produced by using concentrators is equal to the power produced by a large solar panel. Geometrical method has been employed. Design of concentrator is based on the dimension of the solar panel and concentrating ratio. The focal point and the depth of the concentrator is designed because of the size of the panel available.

In this case, the solar radiation first falls on the concentrator and then on the panel. The solar panel is placed at the high position than the focal length to get uniform solar radiation on all surface of the panel. The depth of the concentrator has been selected on the basis of concentrating ratio.

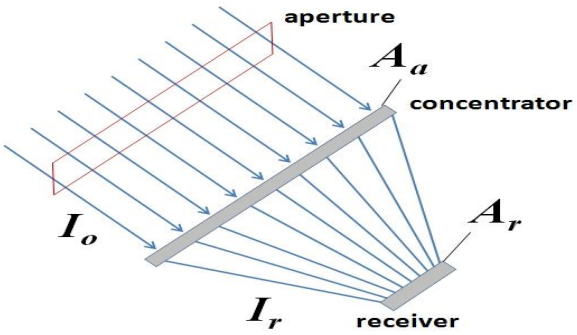


Fig -2: Solar Concentrator

3.3 Solar Panel Cooling

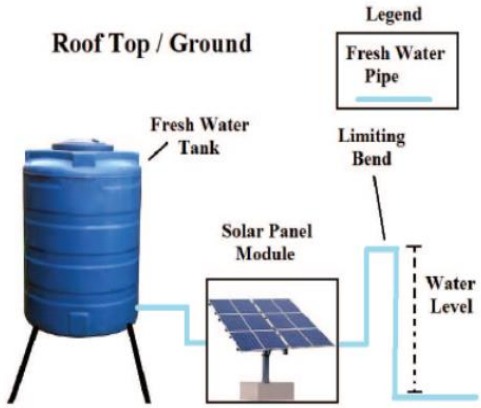


Fig -3: Solar Panel Cooling System

The performance of the panel decreases if the temperature is very high. Thus it is necessary for the panel to be maintained in a normal temperature. The panel is mounted and shielded in a way such that the fresh water from the tank continuously passes through the upper layer of the panel. The water is made to flow on the panel due to gravity. It is done by the bends made in the pipe. Thus, the temperature in the panel is reduced during the hot weather, enhancing the performance of the panel.

3.4 Combined Approach

Even though all the above mentioned solar power enhancement features play a positive role in the power enhancement, in some places, more than one of these factors have been utilized for achieving the desired requirements. Solar Tracking and Solar Concentration was developed for achieving better performance whereas Solar Panel Cooling is done by fresh water pipe during hot weather to cool the Solar Panel and also to clean the panel during cold weather to get efficient output (Since the radiations during cold weather is low the panel must be efficient in producing maximum power from the obtained light which is done by cooling and cleaning of the panel). Thus it produces high output power and also warm water for daily use resulting in versatile outputs.

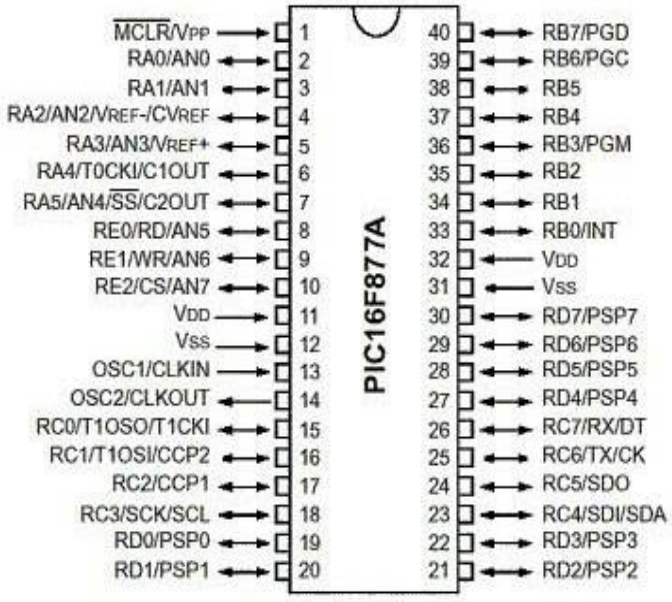
4. HARDWARE DESCRIPTION

The hardware consists of various components such as Solar Panel, LDR Sensor's, PIC Microcontroller, Gear Motor, RS232, Driver Circuit, PC, Power Supply Unit, Optocoupler, Boost Converter, Inverter and Battery.

4.1. Solar Panel

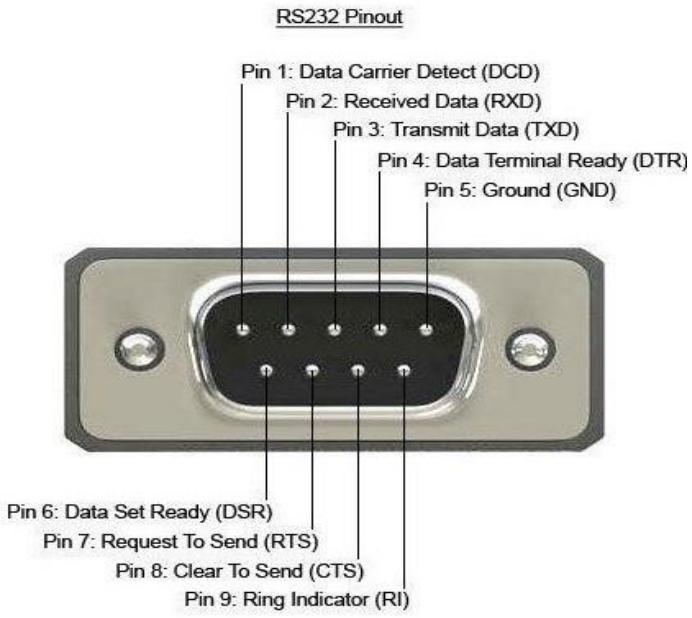
It is an array of several solar cells (Photovoltaic cells). It is responsible to collect radiation from sun and transfer it into electrical energy. It generates electricity by converting photons of light into electrons.

4.2. PIC Microcontroller



The microcontroller PIC 16F877 used in this paper is one of the most advanced microcontroller from Microchip. It consists of five ports, ADC, CLK & MCLR. It is inbuilt with 40 pins. It has 35 single word instructions with high performance RISC core architecture. The microcontroller accepts and gives the output in digital form.

4.3. RS232



RS232, Recommended Standard 232 is a standard used for serial communication transmission of data. It is a standard for serial binary data signals connecting between a DTE (Data Terminal Equipment) and a DCE (Data Circuit-Terminating Equipment). It is commonly used in computer serial ports.

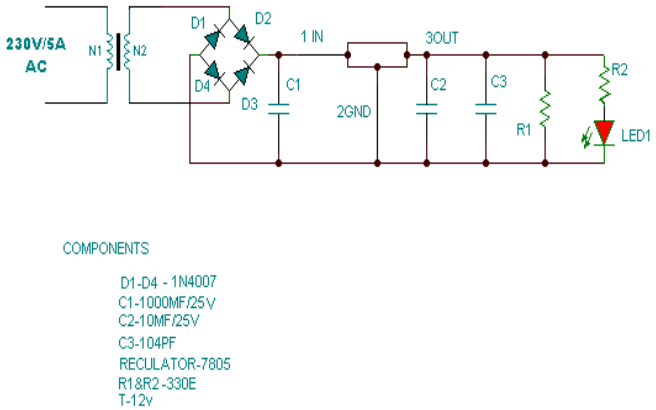
4.4. Gear Motor

A DC gear motor consists of a rotor and a permanent magnetic field stator and an integral gearbox or gear head. The magnetic field is maintained using either permanent magnets or electromagnetic windings. DC motors are most commonly used in variable speed and torque applications.

4.5. LDR

A photo resistor or LDR is an electronic component whose resistance decreases with increasing incident light density. It is made of a high resistance semiconductor and are usually referred as Light Dependent Resistor, Photoconductor and Photocell.

4.6. Power Supply Unit



The power supply output is given to micro controller and other circuit also. The design of the power supply is mainly because of the micro controller, the micro controller work in Dc source with a voltage of +5v. As we are getting the line voltage (VL) has 230v in ac source, so it is not possible to operate the microcontroller. This power supply designs an output of +5v Dc to activate the micro controller.

5. CIRCUIT DIAGRAM

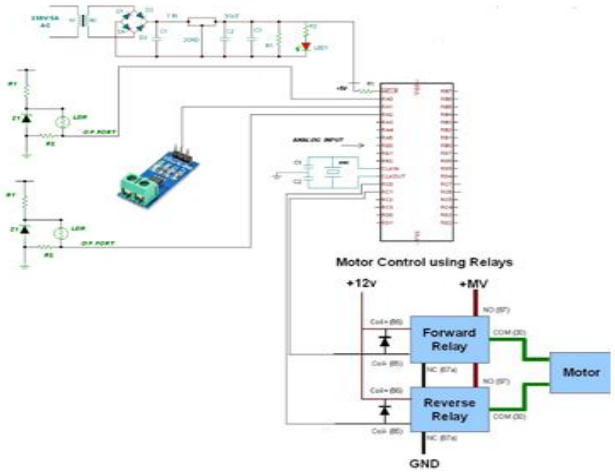


Fig -4: Circuit Diagram for the working of Solar panel

The circuit diagram for the working of Solar Panel module is as shown in Figure-4. The power supply of +5V DC is fed to the microcontroller through the optocoupler which transmits the electric signals from the supply unit to the controller. Two LDR sensors kept on opposite sides are connected to the controller which senses the light intensity, compares the values of two sensors and rotates the motor attached with the solar panel either in clockwise or anticlockwise direction. Thus, the solar panel is made to focus in the direction of high intensity of light. The output obtained from the solar panel is fed to the boost converter. The boosted DC output is then fed to the inverter to get the desired AC output and then connected to the load. RS232, the serial communication device is used to display the output voltage and current values in PC.

6. PROPOSED MODEL

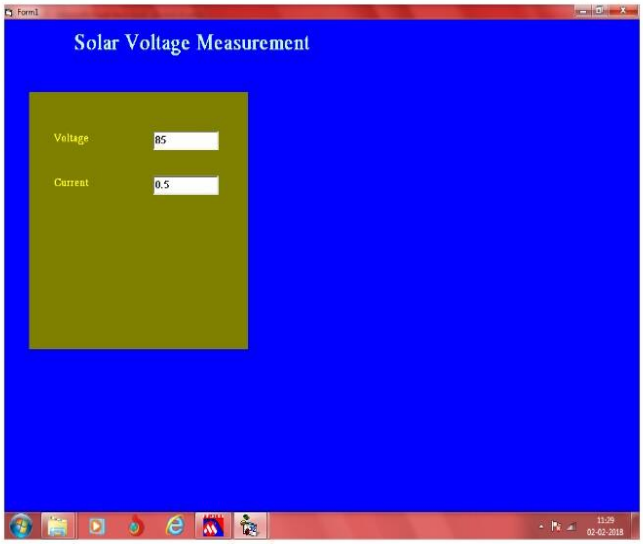
Fig -5: Proposed hardware model for the enhancement of solar power generation

The combined approach methodology is obtained by integrating Fresh Water Pipe, Gravity, Solar Tracking, Solar Panel Cooling and Solar Concentration in a prototype and its performance was analyzed.

6.1. EXISTING SYSTEM OUTPUT

6.2. PROPOSED SYSTEM OUTPUT

The output obtained from the combined approach model is as shown below.



7. SIMULATION OUTPUT

Proteus is a great electrical suite for circuit simulation process. It is a virtual system modelling. The simulation of a single processor or multiple ones can be done at the same time. Here the motor rotates either in clockwise or in anticlockwise direction in accordance with the command given by the controller. The direction of rotation is displayed in the LCD and viewed.

7.1. ANTICLOCKWISE ROTATION

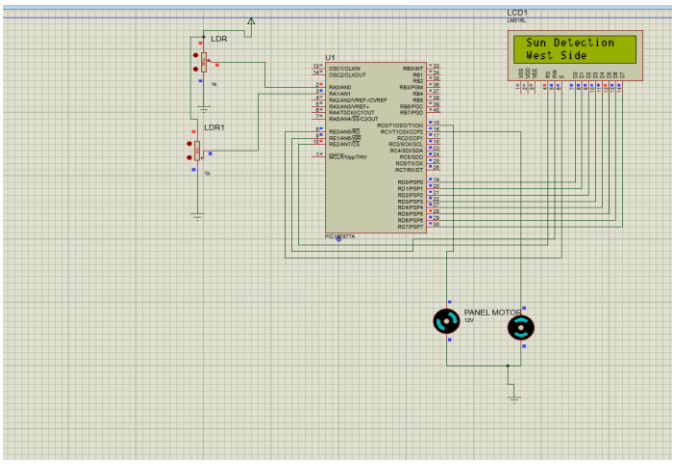


Fig -6: Sun Detection – West Side

Sun is in left side- Light on sensor1 is high because shadow of barrier falls on sensor2 so solar panel rotates anticlockwise.

7.2. CLOCKWISE ROTATION

Sun is in right side- Light on sensor2 is high because shadow of barrier falls on sensor1 so solar panel rotates clockwise.

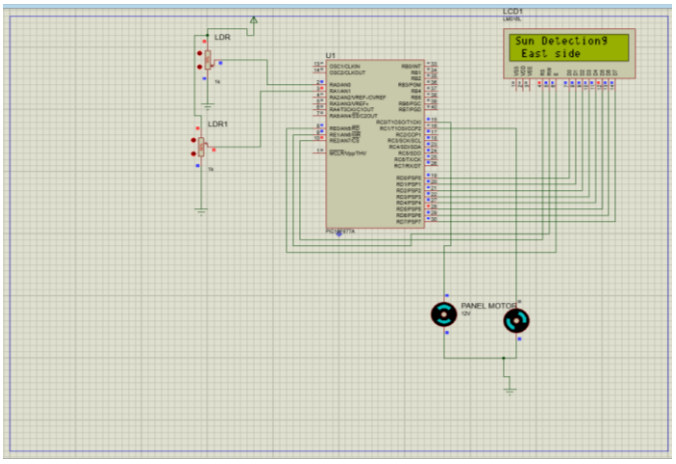


Fig -7: Sun Detection –East Side

8. CONCLUSION

The recommended prototype of this paper in its default configuration (Tracker + Concentration + Cooling) outperformed all its counterparts in terms of efficiency, maximum power produced and average power produced. It is true that power enhancing features contribute positively to the output of solar panels in accordance with their need at particular instances. Thus, the developed prototype utilizing the renewable energy were a success and versatile in addressing the power enhancing needs of the P.V solar panel for different cloud and temperature conditions.

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BIOGRAPHIES

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