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Integration of Renewable Energy into Smart Power Supply System using Solar Cells

Prof. Mrunalini Bhandarkar[1], Kalyani Kadam[2], Nikita Kadam[3], Saurabh Gangale [4]

Professor, Dept. of E&TC Engg, PCCOE, Pune, India[1]

Dept. of E&TC Engg, PCCOE, Pune, India [2, 3, 4]

ABSTRACT*:* Solar energy is rapidly advancing as an important means of renewable energy resource. Solar tracking enables more solar energy to be generated because the solar panel is able to maintain a perpendicular profile to the sun's rays. In this paper, a comprehensive study has been explored on the design and performance analysis of solar tracking system and monitors the power generated. The control circuit for the solar tracker is based on an ATMega328 microcontroller. This is further programmed to detect intensity of sunlight through the solar cells and then actuate the servo motor to position the solar panel where it can receive maximum sunlight. The D.C power generated from the solar panels is directly fed to a rechargeable battery. Then this power is supplied to the inverter (dc to ac converter) which is connected to load.

KEYWORDS: - Photovoltaic cells, Arduino, PWM, Servo motor.

I. INTRODUCTION

As we know that, solar energy is collected by the solar cells made up of PV module. Photovoltaic cells, by their very nature, convert radiation to electricity. This phenomenon has been known for over half a century, but until recently the amounts of electricity generated was good for measuring radiation intensity. Solar cell system has many competitive advantages in comparison to other renewable energy resources. The solar panel is made to rotate in all the directions facing the sunlight. The basic idea of the project is to increase the efficiency of the solar energy. This system uses servo motor to control the angle of rotation of the panels. The power generation, which aim to efficiently transform a DC power source to a high voltage AC source, similar to power that would be available at an electrical outlet? There are different topologies for implementing sine wave inverter. Sine wave inverter is widely used in many commercial and industrial applications including uninterruptable power supplies, induction heating, variable frequency drives, electrical vehicle drives and HVDC links. The extracted energy and its intensity are viewed through the data logger.

II.LITERATURE SURVEY

From the paper titled as "A New Voltage Control Method for Single-Phase PWM Inverters" used the methodology, to control the output voltage, a voltage control based on new virtual LC resonant circuit. Concluded that virtual LC resonant circuit is used to achieve a zero steady-state error and virtual resistor is used to damp the oscillation [3]. The paper "DC/AC Pure Sine Wave Inverter" has the implemented the methodologyasthe first being the conversion of the low voltage DC power to a high voltage DC source, and the second step beingthe conversion of the high DC source to an AC waveform using pulse width modulation.

Also,concludedthatpure sine wave inverters, on the other hand, produce a sine wave output identical to the po wer coming out of h electrical outlet [6].The paper named, "Use of Solar Tracking system for extracting solar energy", have applied the technique such as Controlling panels through sensors and logical blocks and concluded rotation of solar arrays following sun path [1]. The paper titled "Solar Tracking System", has implemented the method as

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Balancing of tracker causing it to tilt. The results were in movement of stepper motor when the intensity of light is maximum. Publishes - International journal of scientific and research publications [2].

III.PROPOSED SYSTEM

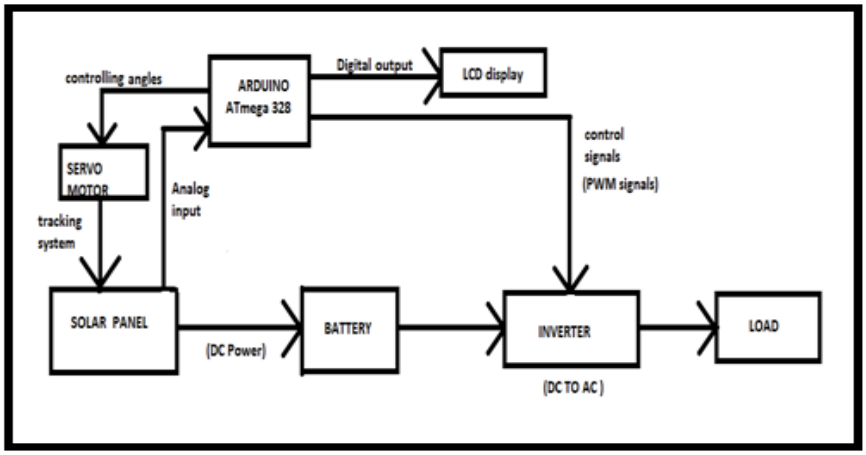

Fig 1: Block diagram of system

A. *Elements of block diagram are as follows:*

a) *Photovoltaic Cells:*

A photovoltaic system, also known as PV system or solar power system is power system designed to supply usable solar power by means cells. In this project, we used polycrystalline solar panel. The purposed of using this type of panels is because of its efficiency. The efficiency of polycrystalline-based solar panels is typically 13-16%.

b) *Rechargeable Battery:*

Batteries in solar applications need to meet the demands such as unstable grid energy, heavy cycling (charging and discharging). Because of these reasons, a 12V-12AH rechargeable battery is used in this system.

c) *Inverter:*

A typical power inverter device or circuit requires a relatively stable DC power source capable of supplying enough current for the intended power demands of the system. The input voltage depends on the design and purpose of the inverter. The AC output frequency of a power inverter device is usually the same as standard power line frequency, 50 or 60Hz

d) *Load:*

As per the requirements of the current, the following loads are decided. The following values show different components that can be driven using a 10W solar panel. Also, the power required by each component is calculated.

1) Tube light=40Watts
   LED light=7Watts
   Fan=70Watts
   Total Load=70+40+7=117
   (approx. =120Watts)
2) Maximum power factor for home appliance standard=0.8
   117/0.8=146.25 (approx. 150)
   Power of inverter=150Watts
3) Load=(150*2)/12 =25Ah
   = 25 *2 =50 Ah
   For Fan => W = V *A

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70 = 220 *A
A = 0.31 amp
For Tube light => W = V *A
40 = 220 *A
A = 0.18 amp
For LED light => W = V *A
7 = 220 *A
A = 0.031 amp
Total current required for above loads=0.31+0.18+0.031=0.53 amp

B. Circuit Implementation:

PWM signal Generation-For a circuit to give a sine wave signal as an output, use of PWM signal is made that will change the output depending upon the width of the pulse. The pulse width modulator produces the timing signals that trigger the gates of the MOSFET.

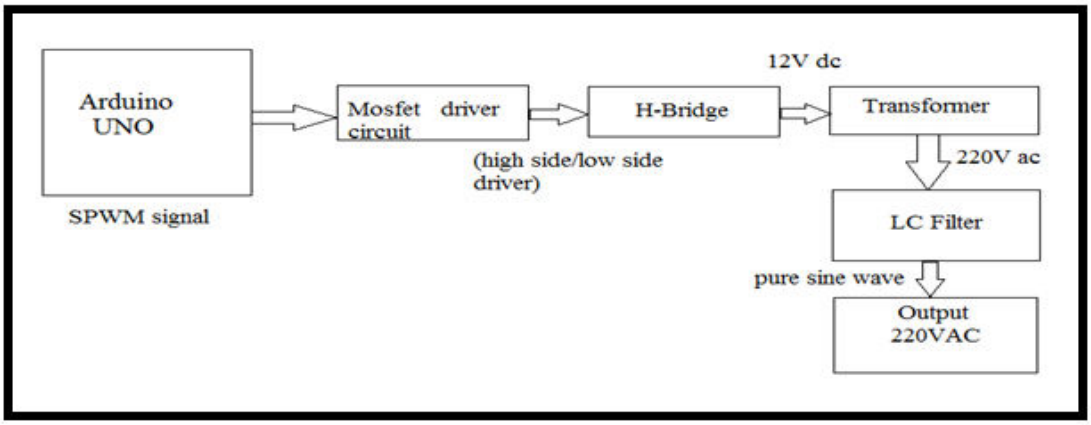

Fig .2. Functional Block Diagram

In Topology, the DC-AC inverter stage, the PWM control signal produces two output pulses with varying duty cycle in order to drive the full bridge inverter circuit. The full bridge inverter converts the DC voltage supplied into desired AC voltage. The low-pass filter eliminates the switching frequency. At the final output the 220VAC is being generated.

C. Elements of the system

a) Arduino:

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino board designs use a variety of microprocessors and controllers.

b) Function:

To have the control of servo motor to give specific angle rotation to the panel. It is also used to generate control signals which are applied to the inverter circuit. The arduino's ADC pins are used to configure and display the light intensity as well as the temperature.

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c) Servo Motor:

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.[1] It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

d) Rechargeable Battery:

Rechargeable batteries typically initially cost more than disposable batteries, but have a much lower total cost of ownership and environmental impact, as they can be recharged inexpensively many times before they need replacing.

Features:

- Case is leak-proof
- Long life span
- Will power a broad range of devices
- Easy to install

IV. SOLAR TRACKING MODEL

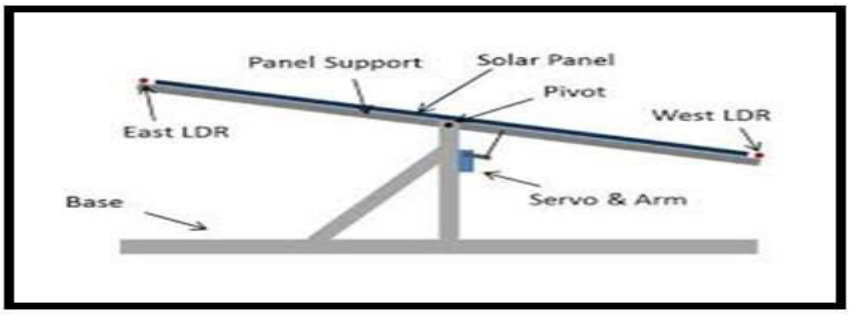

Fig .3. Solar Tracking Model

The above diagram shows the solar panel on a support to which the servo motor is fixed at one end. The panel is attached to the side bars in such a way that it would rotate from its pivot point where the motor is fixed. The LDR's at the ends will measure the light intensity. For the tracking purpose, the panel will move from east to west when it reaches a certain time period. The panels only move at a specific time to optimize the power required to rotate the motor that in turns will rotate the panels. This will not only optimize the power used by the motor, but also will maximize the extraction of energy by the panels.

V. FLOWCHART

A. Flowchart of Data Logger:

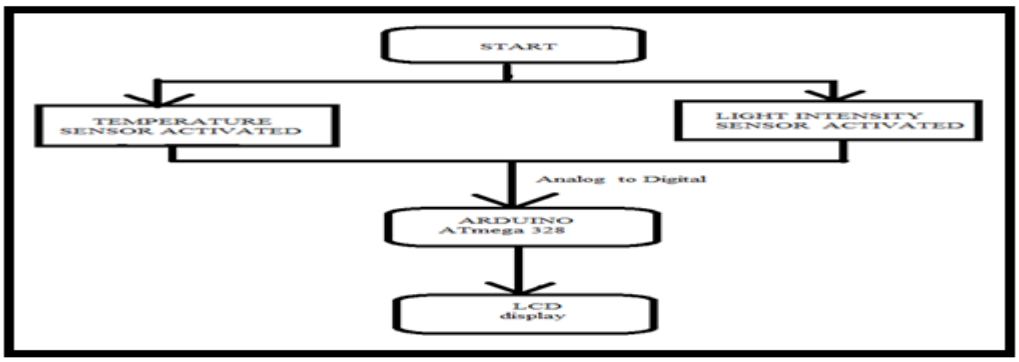

Fig .4.Flowchart of Data Logger

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The data logger system which includes the temperature sensor and light intensity measurement circuits. The temperature sensor will display the real time temperature value. The light intensity sensor will monitor the amount of light that is extracted from the panels. Both the readings are further processed and will be displayed on the LCD.

B. Flowchart of Tracking System:

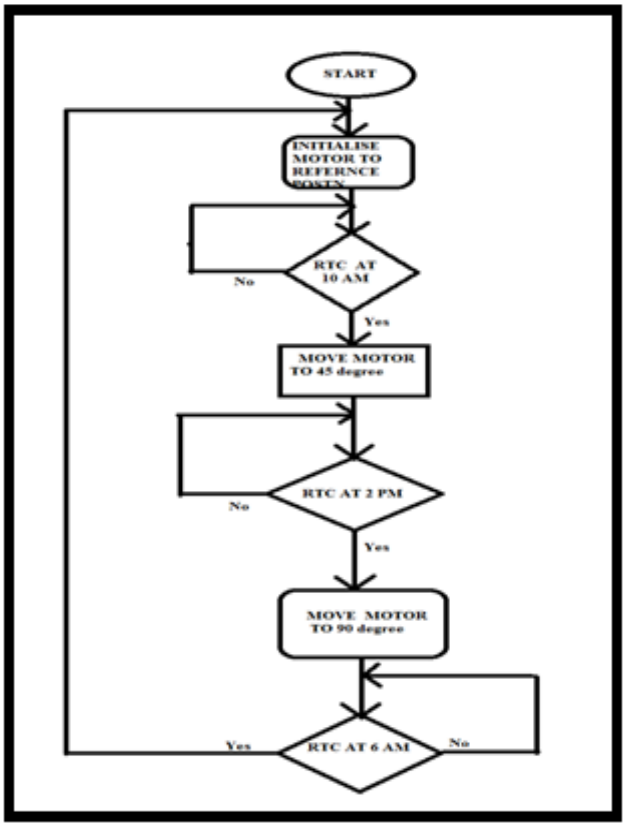

Fig .5. Flowchart of Tracking System

The flow from initializing the servo motor to a reference position and tracking the panel is shown. The motor is moved according to the code that specifies the time of motion of the panel and at a certain angle.

VI. EXPERIMENTAL RESULTS

By considering all the parameters for generating power that will be provided for house hold applications, the results are for the tracking system that changes its position to extract maximum energy from east to west direction and regain its original position after one complete cycle.

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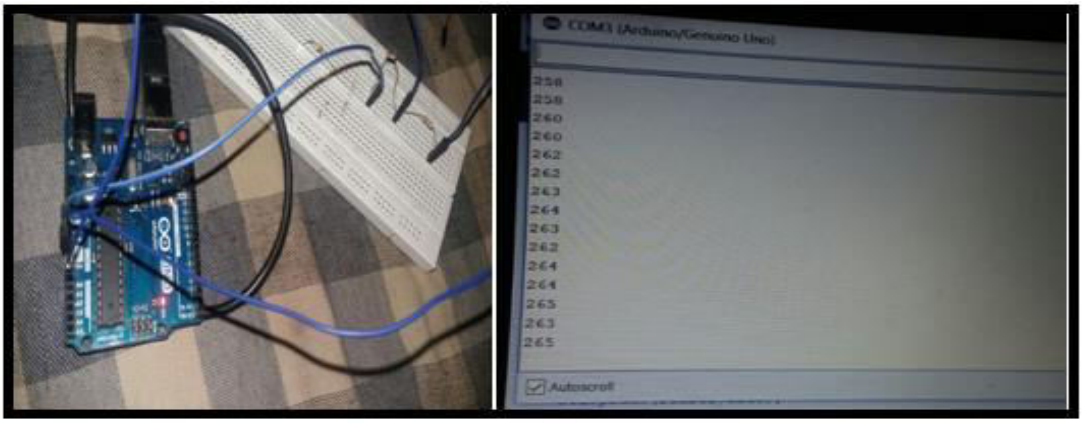

Fig. 6. Light Intensity Measurement

For providing an AC supply for load, an inverter circuit that converts a DC source to an AC output, which is further applied to bulb.

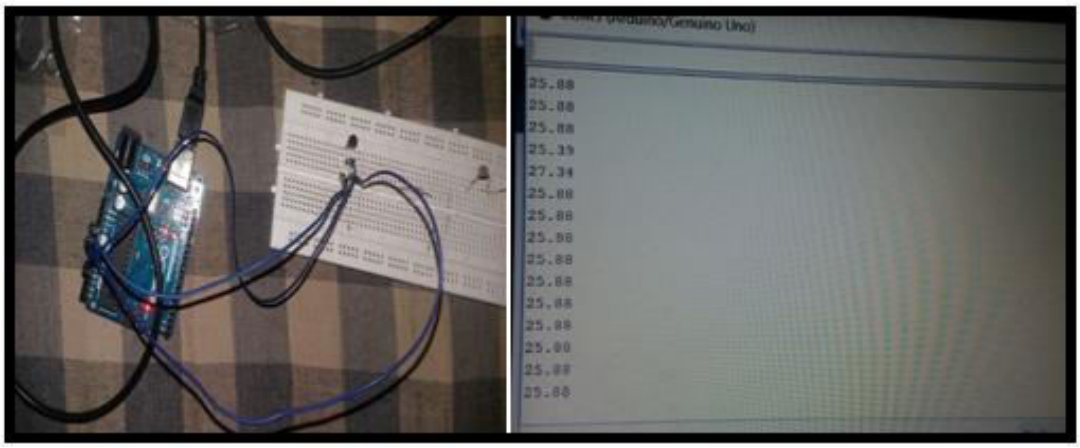

Fig. 7. Temperature measurement

VII. ADVANTAGES

- The output wave-form is a sine-wave with very low harmonic distortion and clean power like utility supplied electricity.
- This is an inexhaustible source of energy and the best replacement to other non-renewable energies. Inductive loads like microwaves and motors run faster, quieter and cooler.
- Reduces audible and electrical noise in fans, fluorescent lights, audio amplifiers TV fax and answering machines.

VIII. APPLICATIONS

- To drive ceiling fans, tube light, led bulbs, etc.
- Widely used to power the industrial automations.
- To provide power to aircrafts and satellites.

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IX. CONCLUSION

We have successfully implemented the Solar Tracking system along with the temperature and light intensity measurement system, which is displayed with the help of data logger. We studied the design and operation of inverter along with the working of solar panels. We have calculated the power consumed by home appliances such as LED light, tube light, ceiling fan which are considered as load for the project. We also have calculated the power requirement of battery which can supply the power to load when interrupt has occurred.

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