

Automatic Solar Tracking and Cleaning System of PV Panel

Aishwariya¹ and Mr Viswanath M N²

¹⁻²PES University/Dept of Electrical & Electronics Engineering, Bengaluru, India
Email: aishwaryaharvi@gmail.com, vishwanathmn@pes.edu

Abstract—Solar energy is a modern source of energy that requires a low cost of production and storage. Solar PV panels can convert energy from sunlight into electricity directly. A solar panel with a standard design and set adjusted at a certain angle limits the area exposed to sunlight due to the earth's rotation.

To get more energy from sunlight, there is a need for an automated system with its function to constantly synchronize the solar panel following the direction of sunlight. The automated solar tracking system solves this problem. The system consists of computer hardware components such as microcontroller based I/O configuration, an LDR as a comparative unit for detecting solar energy and rotating the panel for alignment to obtain maximum output from sunlight. The system is connected to a cleaner/wiper, which cleans the panel periodically with proper rotation with the help of a DC motor.

The cleaning system is automatically controlled by a microcontroller. This feature helps to maximize the efficiency of the solar PV panel thus calculating less expensive energy production. This is an eco-friendly model for power generation, as there are no extracts from fossil fuels and residual products.

Index Terms— solar energy, LDR, microcontroller, arduino board, colour sensor and fossil fuel.

I. INTRODUCTION

A. Introduction to Solar Energy Generation

Solar energy is a clean and cheap source of energy. The Photovoltaic cells can generate electricity directly from the sunlight. The existing Solar PV panels of older design, which has a fixed flat surface with zero movements about the axis, restricts the area of exposure to the sunlight. Since the earth is rotating continuously, the angle of incidence of sunlight also varies over time hence the amount of solar energy absorbed by the PV panel also varies over time. To achieve the motive to maximise energy extraction from the sunlight, there is a need for an automatic system that is capable of rotating the PV panel continuously in the direction of the sunlight. The solar tracking system with an automatic mode of function helps to solve this problem. A microcontroller-based system with an Input-Output configuration is used as the hardware component with the help of a group of LDRs as a comparison unit for detecting the direction of sunlight along with its strength and moving the panel at an angle at which maximum output is derived from the sunlight. This system has the added advantage of a cleaning wiper connected with a DC motor, which can clean the panel in a suitable direction when activated. The cleaning system in the system is controlled with the command given by the microcontroller, which is again in automatic mode of operation. The cleaning function in the PV panel accounts to improve the overall efficiency of the

energy absorbed by the Photo Voltaic panel thereby accounting for low cost-efficient power generation. This is an eco-friendly or green mode of power generation since there is zero emission of flue- gases and zero residual products.

B. Introduction to Arduino Microcontroller

Arduino was first introduced at the Ivrea Interaction Design Institute. It is a simple prototyping utility. It is intended for the use of professionals who have little or no knowledge of electronics and systems. With widespread public access, the Arduino board started to emerge to fulfil new needs and challenges faced by users, expanding its offering from eight-bit boards to utilities and products for IoT functionality, wearable, 3D printing, and also surroundings. All existing Arduino boards in the industry are fully open sourced, delivering druggies to make them standalone and ultimately adapt and change to the needs of users. Software is also open-sourced and is continuously evolving due to the benefits provided to the druggies worldwide. The Arduino board can be powered on via a USB cable attached to a computer or power supply to the wall. The USB connection can also be utilised to upload the program to the Arduino board. The recommended voltage that has to be powered for most of the Arduino boards varies between 6-12 volts. If the power supply is greater than 20 volts this could damage the Arduino board. The pins that can be recognised on the Arduino board are -5V/ 3.3V /GND, Analog pins, Digital pins, PWM pin, AREF pin. All of these pins present are used for various purposes depending upon the need. The 5V PIN powers 5V of power and the 3.3V PIN powers 3.3V of power to the circuits externally connected.to the Arduino board. The GND PIN represents the. The pins marked AO - A5 are analog pins that are utilised to read analog sensor signals and transform them into a corresponding digital voltage value. The pins DO-D15 are digital pins that are utilised for both digital input as well as output. AREF stands for Analog Reference which is sometimes used for setting up the external reference voltage as the maximum limiting voltage for the analog input pins. The Arduino board also has a reset button and is used to reset the running program on the Arduino board. The small LED of green or yellow in colour (Power LED indicator) lights up generally when the Arduino is powered up by a power source.

TX RX LEDs lights up during serial communication that is transmission and receiving terminal pins.

C. Introduction to Tcs230 Colour Sensor Module

The major device present in the module is a low cost RGB sensor chip - TCS230. This chip is a universal color detector that can not only detect but also can measure almost all the variety of colors that are visible.



Figure 1. Colour sensor

The sensor can be traced in the middle of the module board. It is surrounded by four white coloured LEDs. These LEDs light up when the module is powered up. These LEDs help the sensor to operate even in the complete darkness to minute color or light present.

The TCS230 functions with a supply of voltage between 2.7 to 5.5 volts. It provides an output at a very reasonable TTL level. The TCS230 detects color taking the help of 64 photodiodes.

All the photodiodes are connected with each other and in certain combination. There are two control pins s2 and s3 which are used to selection. This module can also be used to measure the frequency which allows it to be compatible to be used by almost all the microcontrollers and many other devices.

D. Introduction to Relay

Relays are commonly used as in switching applications. It has two important parameters, the Trigger Voltage level, which is the voltage at which the relay contacts change from NC to NO or vice versa. The next important parameter being the Load Voltage & Current, this indicates the magnitude of power or current that the relay can withstand. Relay has the following contacts or terminals: - COM = Common, for both NO and NC. NC means Normally Closed contact with ref. to COM. NO means Normally open contact with ref. to COM.

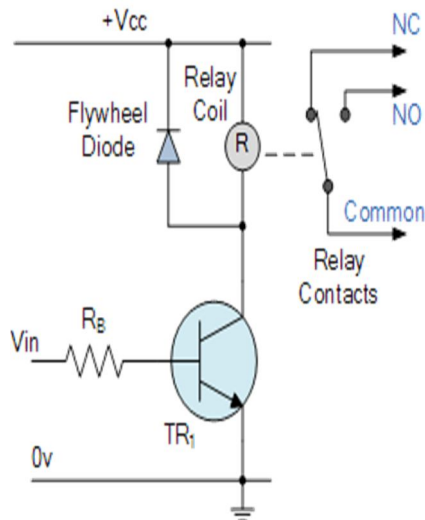


Figure 2. Motor Control Circuit

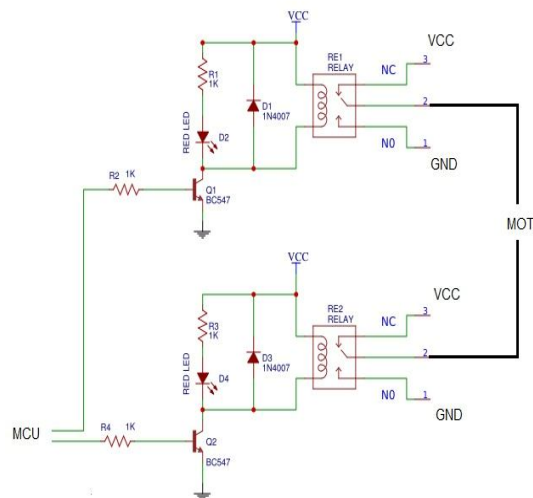


Figure 3. Tracking motor control circuit

The transistor works very well as a switch when adjusted by standard emitter configuration, which means that the BJT transmitter must always be directly connected to the "bottom" line. "Ground" means the negative line in the NPN case and the negative line in the PNP BJT mode.

When NPN is used in a circuit, the load must be connected to the collector, which will allow it to be turned on / off by changing the negative line ON / OFF.

Specifications: -

- Rated Load of 10A and 250VAC or 10A and 30VDC
- Max Switching Current of 10A
- Max Switching Voltage of 110VDC or 250VAC
- Coil power of 0.45W

E. Introduction to Speed Control and PWM

PWM DC Motor Control

The average voltage value is applied to the device using pulse-width modulation (PWM) by changing its value by turning on and off the signal at high speed. The operating cycle in PWM is defined as the frequency of signal above ref., compared to frequency of signal below the ref. An increase in the operating cycle indicates that the average output voltage is high and therefore the vehicle speed will be higher. The concept of a work cycle can be studied better using below figure.

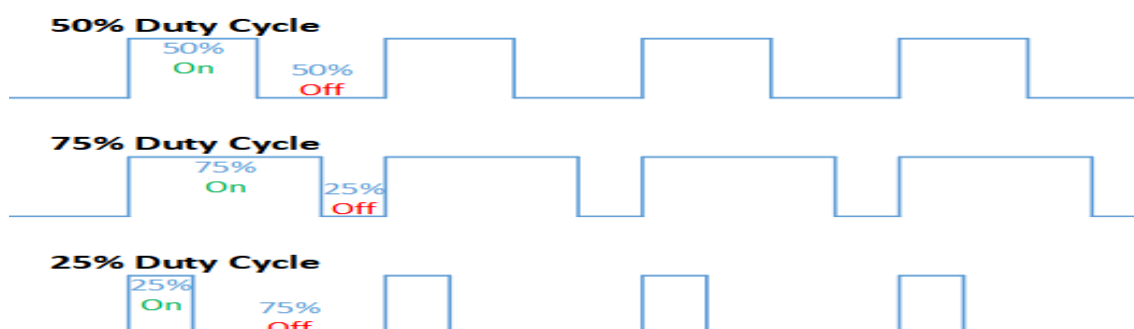


Figure 4. The concept of the Duty Cycle

Arduino has a PWM output pin, this PWM output is connected to the MOSFET gate. One side of the power supply will be connected to the terminal, whereas the other terminal is connected to the MOSFET. The MOSFET's Source pin will be connected at the bottom. The speed is controlled by the Arduino PWM signal. MOSFET acts as a switch. Arduino cannot control directly, because the signal has low power, moreover, the

Arduino will heat up due to excessive current used by motor. Thus, this power signal is only used to turn on and off the transistor of the field effect. In this way, the speed of the DC car is controlled using Arduino.

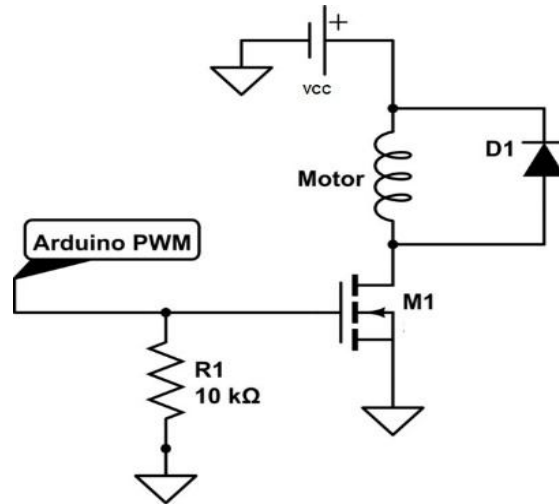


Figure 5. Circuit diagram for speed control

MOSFET came into existence to overcome the drawbacks of FETs low performance. In some situations, MOSFETs are also referred to as IGFET (Insulated Gate Field Effect Transistor). MOSFET is a voltage-controlled FET device.

The major difference found among FET and MOSFET is that the MOSFET has an electrode of a Metal Oxide Gate which is electrically closed with a n-channel or p-channel with a skinny layer of oxide or a glass. This separation increases the input resistance of the MOSFET. It will always operate as a three-terminal module. The image below shows depicts the N-channel and the P-channel MOSFET respectively.

II. METHODOLOGY

A. Block Diagram of the Tracking System

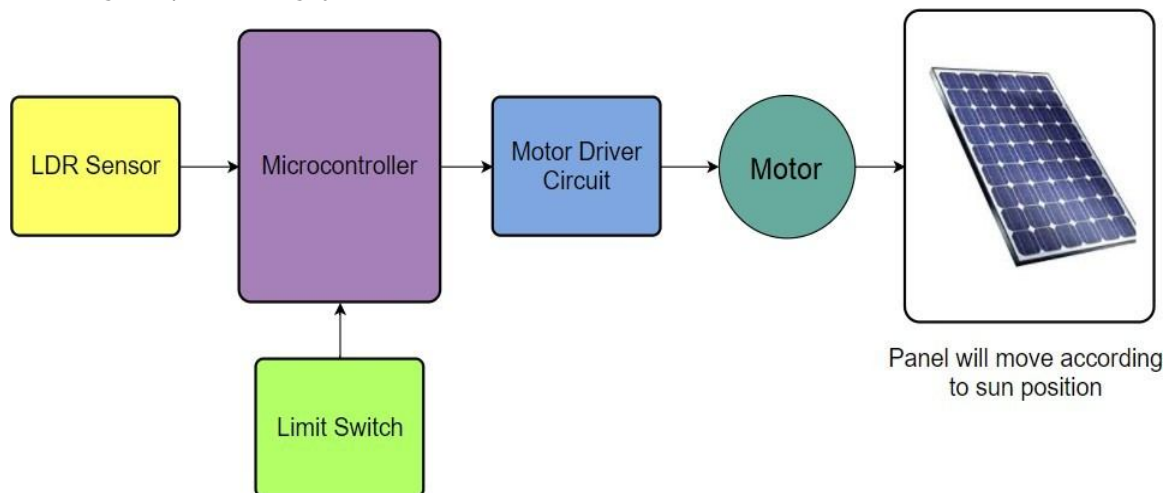


Figure 6. Tracking System

Working methodology:

- ❑ In tracking system, the solar panel will track the sunlight and will automatically move in the direction of sunlight.
- ❑ LDR sensors are used along with motor and its driver connected to Arduino microcontroller to serve the purpose of tracking

- ❑ Based on the resistance between the LDR terminals, different voltage levels is monitored according to sunlight.
- ❑ The motor driver will start the motor and stop the motor based on the trigger signal received by the microcontroller.
- ❑ If left LDR gets the sunlight signal, the motor will move in anticlockwise direction and if right LDR gets the sunlight signal, then the motor will move in clockwise direction.

B. Block Diagram of Cleaning System

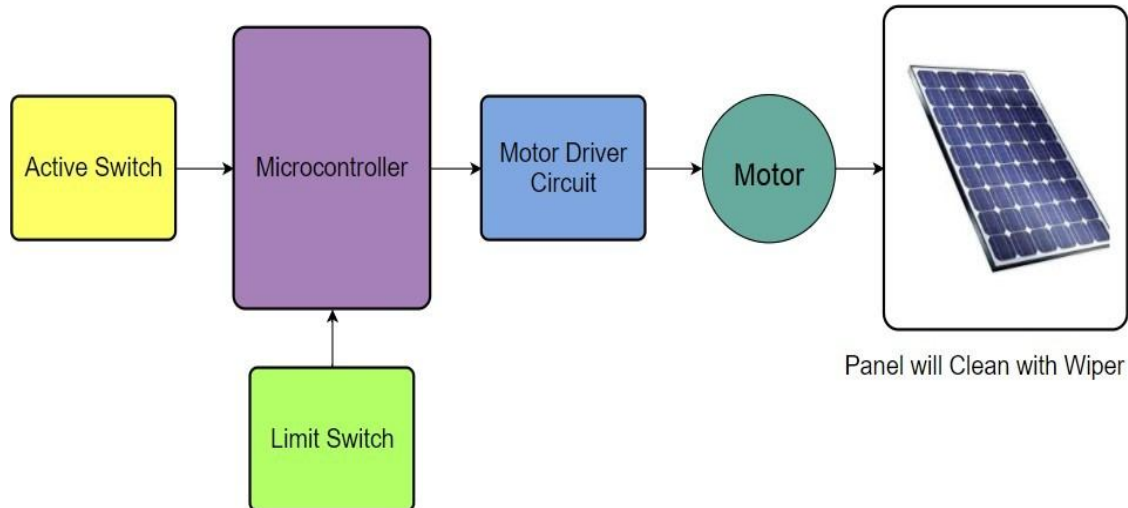


Figure 7. Cleaning System

Working methodology:

- ❑ A start key is interfaced with microcontroller pin.
- ❑ If the user activates the start key for cleaning system, then microcontroller will send a trigger signal to motor driver circuit.
- ❑ The motor is connected to cleaning wiper.
- ❑ A limit switch is interfaced at the end of panel which will detect whether the wiper has reached to the end of panel or not.
- ❑ So wiper will ensure that it stops when it reaches end and the panel is cleaned.

III. RESULT

This project is the implementation of solar panel tracking and cleaning system. The designed system is tracking solar energy by rotating automatically as a motor direction change based on the LDR sensor. To make it a more advanced cleaning system it has been implemented with a dust sensor to give the information about dust saturation on the panel surface depending upon this sensor working, the panel can be cleaned automatically. According to the requirement, the microcontroller has been programmed. The panel is moving successfully, and the cleaning system can clean the panel surface automatically. This panel has rated power output of 50W, when this panel without tracking and cleaning part is kept in sunlight for a day then it would produce an average of 100W per day at 12V (depends on the sunlight intensity over the day). When the tracking and cleaning part is added to the panel then it would produce an average of 104-106W per day at 12V (under same sunlight conditions). This means that the energy harnessed improves up to a percentage of 4-6 with the application of tracking and cleaning section.

IV. CONCLUSIONS

The tracking cum-cleaning system is a new way of harnessing max. energy from the sunlight. It is noted that the daily energy production of a flat PV module (kept standing) increases by about 15% in the case of clean cum-tracking and tracking of a single axis, respectively. The proposed tracking cum-cleaning system is well suited to the needs of modern industries. The above system can be kept tilted north or south accordingly to achieve the best power output from the PV modules.



Figure 8. Front View of Solar Panel

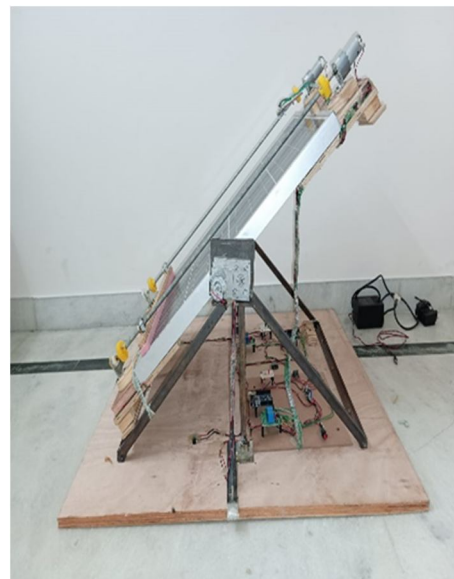


Figure 9. Side View of Solar Panel

ACKNOWLEDGMENT

I extend my deep sense of gratitude and sincere thanks to our chairman-Dr. M.R. Doreswamy (Founder, Chancellor –PES University), Pro-Chancellor of PES University- Prof. Jawahar Doreswamy, the Vice Chancellor of PES University-Dr. J Surya Prasad, Registrar-Dr. K.S. Sridhar, Chairperson and Dean of Faculty of the Department-Dr. Keshavan. B. K, MTech project coordinator-Dr. Venugopal. N, Project guide-Mr. Viswanath. M. N for their valuable guidance and suggestion technically and logically for doing my Project work. I also extend my sincere gratitude to my family and friends who supported me whenever in need to complete the Project work.

REFERENCES

- [1] Vaibhav Dharmik, International Journal of Advanced Research in Computer and Communication Engineering Vol. 9, Issue 5, May 2020
- [2] Dr. Venugopal. N D.V. Roopashree | A Low-Voltage Ride-Through strategy using fuzzy based controller for 3phase grid connected PV system | 2021 6th International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT) | August 27th & 28th 2021
- [3] Santosh Kumar S, Shivashankar, Keshava Murthy, Solar Powered PV Panel Cleaning Robot , 2020 International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT), 12-13 Nov. 2020.
- [4] Thorat M. L. et al.; International Journal of Advance Research, Ideas and Innovations in Technology, © 2019
- [5] Kaushik Kushalappa Naik, N Venugopal | Multi Output Forward-Flyback Switch Mode Power Supply | 2018 3rd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT) | 2018
- [6] C Prasanna Kumar, N Venugopal | Performance and stability analysis of series-cascaded, high-gain, interleaved boost converter for photovoltaic applications | Power Electronics and Drives | 2018
- [7] Dounia Dahlioui, Salima El Ayane, Soukaina Medaghri Alaoui and Abdelfettah Barhdadi, Innovative Cleaning Technique for PV Modules on Helioslite Biaxial Solar Trackers , 2018 6th International Renewable and Sustainable Energy Conference (IRSEC), 5-8 Dec. 2018
- [8] MAHIPAL SONI, IRE 1700235 ICONIC RESEARCH AND ENGINEERING JOURNALS | IRE Journals | Volume 1 Issue 9 | ISSN: 2456-8880, MAR 2018
- [9] Sujata Shivashimpiger, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (An ISO 3297: Vol. 6, Issue 6, June 2007
- [10] Kaushik Kushalappa Naik, N Venugopal | 1kW Home Inverter Using Cascaded Current Fed Push Pull Converter and SPWM Inverter | 2018 9th International Conference on Computing, Communication and Networking Technologies (ICCCNT) | 2018