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Solar Panel Monitoring and Maintenance System

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ABSTRACT

Solar energy is a sustainable energy source. It is renewable as well. It has many applications like solar water heaters, solar air heaters and electricity generation. Solar panels require regular monitoring and proper maintenance for them to work in full capacity. The existing panel cleaning system is more manually controlled and has to be setup every single time on the panel and removed after use which is also quite expensive for a single service. The setup has to be mounted upon the panel very carefully. This too mainly depends on experienced solar maintainers. Our main objective is to develop a Solar panel cleaning system which could remove the accumulated dust on its surface on a regular basis and maintain the solar power plant output. To notify and alert immediately whenever there is a case of theft and to track it.

Keywords : Solar energy, PV Plate

I. INTRODUCTION

The sun is the primary energy source. This is fuel for most renewable systems, either directly or indirectly. The photovoltaic device is one that has a great chance of replacing conventional energy resources among all renewable systems.

The PV system operates at its best if it is directly facing the sun with minimal / no interference and is maintained at a lower temperature (250 c). Dust, once deposited on a PV panel glass, and typically prevents light from reaching the shell, reducing overall performance. Research has shown that, up to a limited amount of dust deposition at different settlement densities, PV output may benefit from the resolution of unwanted IRs. Because PV panels transform only the visible spectrum to electrical power, the rest is contributed as heat to the system. If the layer of dust increases beyond the threshold limit of 2gm/m2 then it makes a barrier to visible spectrum to reaching towards PV cell.

Due to this, the panel requires maintenance and frequent cleaning. Dust deposition depends on a variety of parameters. Those would be the inclination of the PV plate, the form of installation (stand alone or on the tracker), the wind direction, the humidity, etc.

Solar panel maintenance is necessary to ensure your long-term benefits. Some of the major problems to tackle are listed below

- Low efficiency of solar power conversion due to the accumulation of dust and dirt.
- Theft of solar panels when there is no security.
- Unaware of damage of solar panels.
- Reduce output and efficiency of the system completely if left untreated for years.

Most of the small scales to medium scale PV panel owners usually depend on complete manual cleaning of the debris which gets accumulated on the surface of the panel. This way is more oriented to human

intervention all the time and also time consuming and is more prone to damaging the structure if at most care is not taken.

There are various effects on the solar panel which affects the efficiency of the panel. Due to those effects, we get less performance and therefore the main objective of this project is to increase the efficiency of the solar panel. And these solar power systems have a major problem that is right maintenance. These days we see many accidents like breakage of solar panels, theft of solar panels which are highly expensive. In order to overcome these issues the system is proposed.

The proposed system is implemented with three features.

- Cleaning
- Monitoring
- Theft detection

The prototype system designed, mainly focus on building and developing two systems namely a cleaning system and monitoring system. The cleaning system focuses on timely cleaning of the surface of the panel which uses timers and microcontroller to give out instructions to then wiper mechanism which I set up on the panel surface. For the monitoring system, microcontroller and ESP8266 is used here to interfacing with solar panel and sensors. Panel voltage is obtained by applying in voltage sensor in voltage divider circuit. This data is then transmitted to remote server with the help of ESP8266 which is Wi-Fi gateway transfer the data to cloud. The cloud data is retrieved by user using mobile application. And cleaning part made by using help of DC motor and driver circuit. It will be fully controlled using different type of sensors. We are using microcontroller atmega328 for control this all working operation. We can see this all information on 16X2 LCD display. This display is interfaced with same microcontroller for user information.

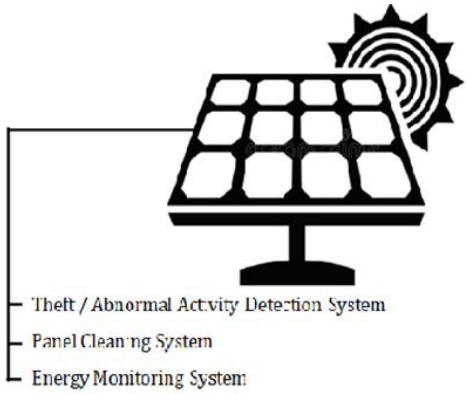


Fig 1. Solar panel with proposed systems of maintenance and monitoring

II. SYSTEM DESIGN AND IMPLEMENTATION

METHODOLOGY

Cleaning system

The main challenge is to maximize the capture of rays of the sun upon the solar panel; hence we use the cleaning system to maximize the output of electricity. By using the microcontroller the whole mechanism is controlled. In this system, we basically use sliding wiper to remove the dust saturated on the surface of the solar panel.

This combination is mounted on the surface of the panel and for movement; we use DC motor assembly which is controlled by a microcontroller. To detect the end of an array of solar panel we can use a sensor

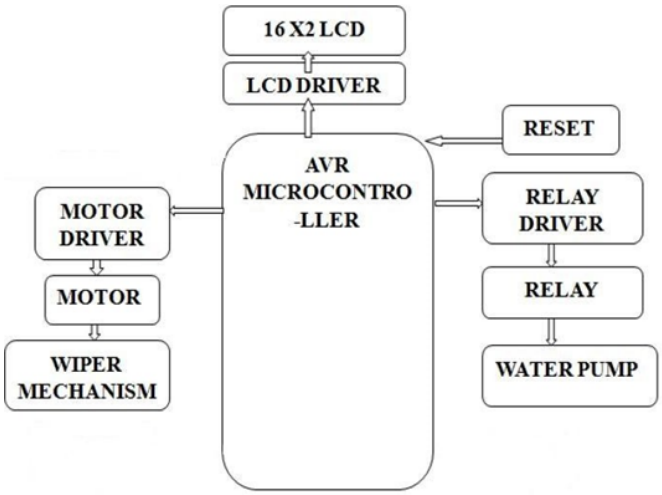


Fig 2. Flowchart showing Cleaning System

The above figure shows the flow chart of the cleaning system and its working procedure. Rotating brushes, edge detection and end position detection are the main integral steps which are the used as outputs and inputs to the cleaning system.

The above fig 3 shows the flow chart of the monitoring system and its working procedure. Energy monitoring and abnormal/ Theft detection are the key features in this system. Remote notification through IOT is also designed.

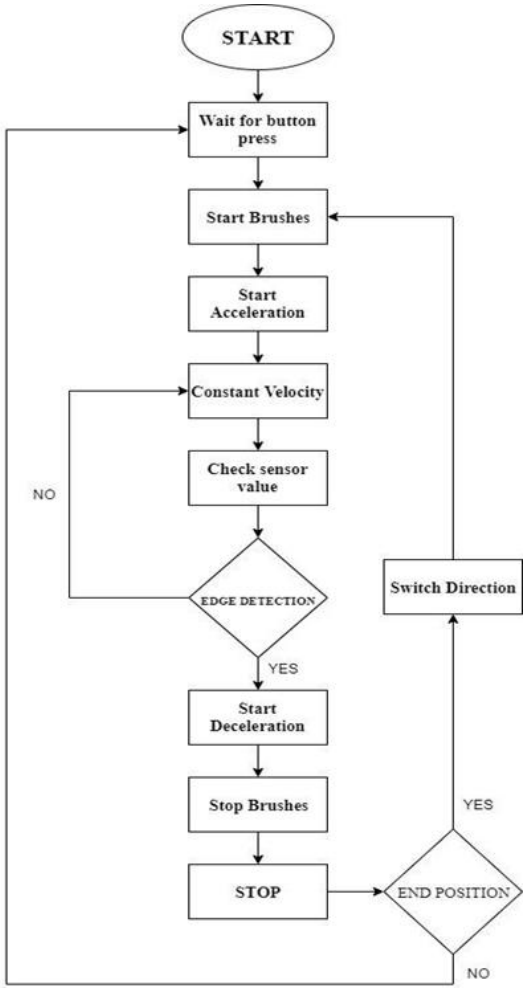


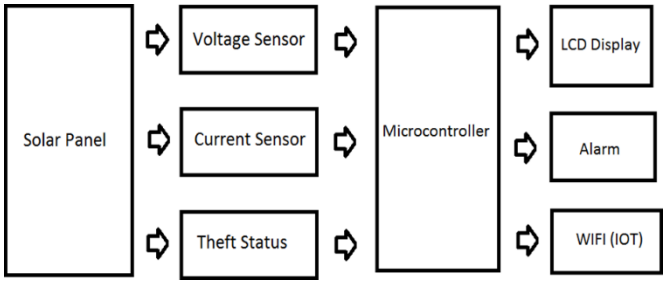
Fig 3. Flow chart for monitoring system

Monitoring System

Using the Internet of Things Technology to track the generation of solar power, will greatly enhance the efficiency, monitoring and maintenance of the plant. With the development of technology, the cost of renewable energy equipment is decreasing globally, promoting large-scale solar plant installations.

This massive scale of solar system deployment requires advanced systems for remote monitoring of the plant using web-based interfaces, most of which are installed in inaccessible locations and therefore can not be monitored from a dedicated location. The project is based on the implementation of a new cost-effective methodology relying on IoT for remote monitoring of a solar power plant for performance

evaluation. This will enable preventive maintenance, fault identification and real-time monitoring of the facility.



Solar power plants need to be monitored for optimum power output. This helps retrieve efficient power output from power plants while monitoring for faulty solar panels, connections, and dust accumulated on panels lowering output and other such issues affecting solar performance. So here we propose an automated IOT based solar power monitoring system that allows for automated solar power monitoring from anywhere over the internet.

We use ATmega controller based system to monitor solar panel parameters. Our system constantly monitors the solar panel and transmits the power output to IOT system over the internet. Here we use IOT Thingspeak to transmit solar power parameters over the internet to IOT Thingspeak server. It now displays these parameters to the user utilizing an effective GUI and also alerts the user when the output falls below specific limits. This makes remotely monitoring of solar plants very easy and ensures best power output.

III. HARDWARE REQUIREMENTS

All the systems are implemented on a 12v Solar panel and with the help of an Arduino Uno, which is a microcontroller board built on the ATmega328P which acts as a central processing unit for all the systems.

List of hardware components used:

Cleaning System

COMPONENT	USAGE	TYPE
Motor Driver	Drive the motor	Application
Motor	Movement	Output
Rack and pinion	Movement across panel	Application
Wiper	Cleaning	Application
Object Sensor	Edge detection	Input
IR Sensor	End position detection	Input

Monitoring System

COMPONENT	USAGE	TYPE
Voltage Sensor	Energy monitoring	Input
IR Sensor	Theft detection	Input
LCD Display	Status display	Output
Buzzer	Audio Warning	Output
LEDs	Visual Warning	Output
Wi-Fi Module	IoT	Application

Software used:

- Arduino IDE
- Embedded C language for program

HARDWARE IMPLEPENTATION

The connection for cleaning system and the monitoring systems are established separately and integrated together on to the solar panel.

Cleaning system

IR sensors are connected to the arduino and positioned at the edges so as to provide end positions of the panel to determine the panel movement. The wiper mechanism is mounted on to the rack and pinion setup which moves along the panel surface in a linear motion. This motion is achieved with the help of a DC motor to which the operating power is fed by a relay. RTC timer is installed to give specific time interval pulses to the arduino board

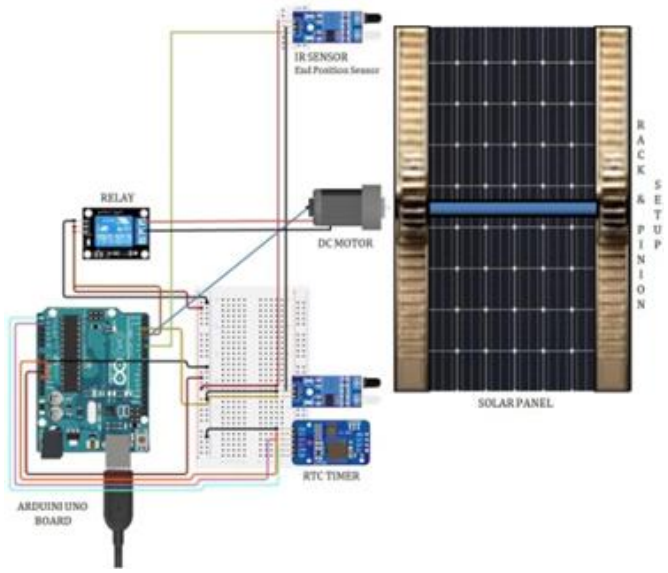


Fig 4. Schematic diagram of cleaning system

Two main features of the monitoring system installed are the energy tracking system and the physical theft/abnormal activity detection system. An IR sensor is placed facing the solar panel and connected to the arduino; this continuously keeps the track of the physical status of the panel. In case of abnormality a buzzer is setup as an audio alert. An voltage divider circuit is built, which takes in the voltage read in of the panel and gives the information to the arduino; this helps in keeping the track of energy output of the panel.

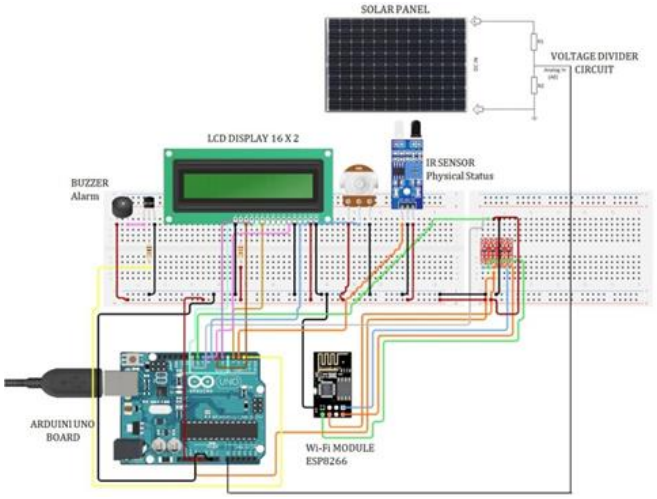


Fig 5 : Schematic diagram of monitoring system

IV. RESULT & ANALYSIS

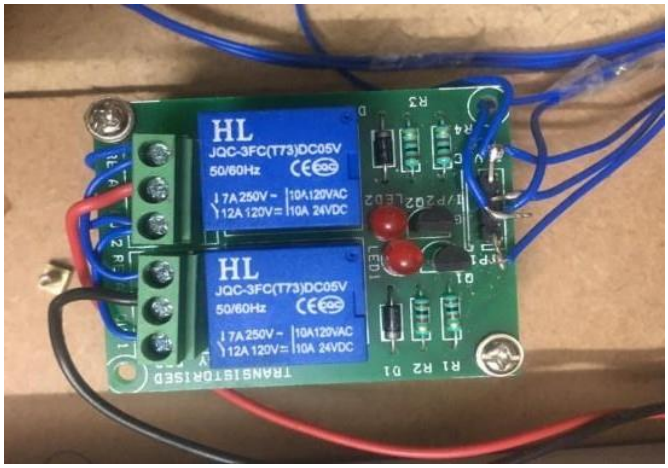
Cleaning system

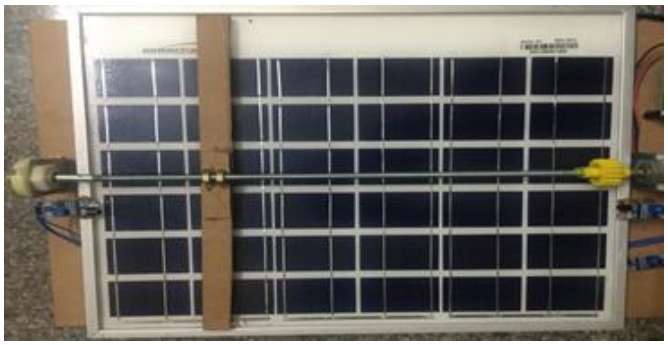
The RTC (Real Time Clock) are set accordingly, when the time is arrived as set in RTC, The power supply and initializing is given to the cleaning tool through the Arduino.

The cleaning tool moves on the surface part of the solar panel in a forward and backward motion. At the beginning point when the cleaning tool is at its initial state, the initial position switch (first IR sensor) is in actuated position or in ON condition. Thus this gives first input signal to Arduino, there by an output signal is given through the Arduino to the gear motors which runs in a forward direction (clockwise). As soon as the gear motor starts moving, the wiper mounted on the cleaning tool units also start moving in the forward direction. This entire cleaning tool is carried by the pinion which is guided by rack. Along the entire path, the wiper moves on the solar panel, it forces the dust to move in the direction of the movement of the cleaning unit and simultaneously the wiper wipes the panel and the dust flows away at the edge of the panel. Once the cleaning unit reaches the other end, end position (second IR sensor) gets actuated. Thus this gives the second input signal to Arduino, there by an output signal is given through the Arduino to the gear motors which now runs in backward direction (anti clockwise).

Now the cleaning tool starts moving towards the initial position, their by the wiper fully wipes the panel. As the cleaning tool comes to the initial position the cycle completes and the process is stop.

Now the cleaning tool will be move again on the solar panel to clean once when the RTC are set for the next cycle and the above process repeats completely.





Monitoring system

Microcontroller analog inputs measures DC voltage between 0 and 5V the range over which the microcontroller can measure voltage can be increased by using two resistors to create a voltage divider. The voltage divider decreases the voltage being measured to within the range of the microcontroller analog inputs. So here we are using two resistances for decrease the voltage level according to microcontroller range.

The work of IR transmitter or Infrared transmitter is to transmit the infrared waves whereas the work of IR receiver is to receive these infrared waves. IR receiver constantly sends digital data in

the form of 0 or 1 to Voltage out pin of the sensor. If there is an object in front of IR sensor, the transmitted infrared waves from IR transmitter reflect from that object and are received by the IR receiver. IR sensor gives 0 in this condition. Whereas, if there is no object in front of the IR sensor, the transmitted infrared waves from IR transmitter is not received by the IR receiver. And IR sensor gives 1 in this condition. And using microcontroller we will read pin status and showing in LCD display solar physical status using this IR sensor and energy using voltage divider circuit.

These monitored data is then processed with a Wi-Fi module so that the data can be available and the status can be monitored anywhere across the world with the specific application tool on a smart phone.

V. CONCLUSION

This project explains the study for solar panel cleaning and monitoring system. The main goal of this project is to develop an equipment to measure the status of solar panels in real time and send the result parameters to IOT cloud. The test results of the solar panel output, is analyzed by the monitoring system by using Arduino Atmega328 and with the help of sensors and Wi-Fi module. It successfully displays the values of voltage generated by solar panel via an IOT app on a Smartphone. This proposed system has more advantageous because of a combination of monitoring and cleaning system as a single system. Sometimes when dust or other particles gets accumulated for a longer period of time on a solar cell, it damages the Aluminum strip of the solar plate. We can avoid this damage by this cleaning system. Overall it aid in increasing the efficiency of the solar plate. By this system, we make the life of this plate longer than another plate. This system helps to generate more energy in Indian

climatic condition. This system can be implemented for array system and it is extremely advantageous to increase efficiency. The implemented prototype is removable so it can easily mount on another array.

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