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Rooftop Solar Panel Cleaning System Using Internet of Things (IoT)

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ABSTRACT

In general, solar panels are installed in dusty areas. Because of excessive dust accumulation and bird droppings the power generation efficiency of solar panel is affected. Cleaning the solar panel manually is tedious and cumbersome. In this paper we propose a programmable system to clean solar panel using water and wiper. The project is implemented using Internet of Things (IOT) technology. The system will be controlled by the Microcontroller and various sensors. The system can be controlled by using android device. The system notifies the user about the various operations performed through text message. The system may be converted to portable so that it can be used in various locations.

Keywords : SPV Panel, Motors, Microcontroller, IOT, Sensors

I. INTRODUCTION

The sun is a very good energy source, so there is plenty of solar energy available in nature. If whole solar energy could be made available for utilization, supplying the world's energy demand would be more sufficient. However, due to atmospheric conditions, this is not possible. Solar energy can be converted via solar panel into more usable forms of energy. Renewable energy, in particular solar energy, which provides electricity without causing any impact on gas emissions, is of wide interest.

Many alternatives have considered the photovoltaic m ethod of extracting electricity from solar power. It promises to meet the ever-increasing energy demand. Due to weather conditions, the efficiency of the solar panel is limited, so parameters like dust, moisture and temperature are extremely important. In this respect, the efficiency study of the solar panel was carried out with and without dust accumulation. The project includes a dust cleaning system design and implementation.

The main aim of the project is to provide an automated cleaning mechanism for dust from the solar panel. Many factors affect the efficiency of Photovoltaic (PV) power, such as snow, high temperatures, pollen, dust and dirt. The main factor affecting the efficiency of a PV panel is dust, which, depending on the environment, can reduce its efficiency by up to 50 percent. Cleaning has traditionally been done manually. Manual cleaning has disadvantages such as accident and panel damage, movement problems, poor maintenance, etc. The automatic dust cleaning system of solar panels has resolved the problems of conventional cleaning and also creates effective cleaning and prevents inconsistencies in efficiency due to the deposition of dust. Studies conducted to assess the efficiency of the solar panel for one day, one week and one month of dust collected on it. The efficiency of the solar panel was also calculated one day, one week and one month after cleaning the surface. And finally, it is proven that the efficiency of the solar panel increases significantly by comparing both efficiencies. The developed model improves the performance of the solar panel.

II. METHODOLOGY

Dust deposition on the solar panel can reduce the level of performance of the solar panel and reduce the productivity of solar cells and, if the panel is not cleaned, the efficiency is approximately 50 percent over 6 months. This leads to significant annual monetary losses. We proposed a cleaning mechanism in this paper to clean the accumulated dust on the solar panel. This proposed system is completely automatic and does not require any human intervention, but the system can be initiated / triggered via the android device if the automatic system sometimes does not respond. Regardless of their size, the system can be attached to any solar panel. The system operates via the microcontroller fixed to the frame and moves using stepper motors with wheels. The power is supplied to the entire system via batteries or solar panels. The cleaning wiper is triggered by the initiation of the water spray mechanism as soon as the dust sensor detects dust. No dust notifications about the cleaning operation are sent to the user after the dust sensor senses.

The methodology involves the following steps

1. Details on the effect of accumulation of dust on the solar panel on the efficiency of power generation.
2. Designing an automatic cleaning system model.
3. To keep the cost minimum and produce an efficient system, select the microcontroller, sensors, water nozzles and other components for the system.
4. Design of an effective communication system for communication between user and microcontroller.

III. ANALYSIS OF DUST ON PANEL

The accumulation of dust on the solar panel surface reduces radiation to the filament and causes voltage and power loss. Dust not only reduces radiation in the solar cell, but also changes the reliance on the incidence angle of solar radiation. Research shows that the daily energy loss caused by dust deposited on the surface of the PV module is around 4.4% over a year. Daily energy losses can be higher than 20% during longer period of time without rain. Moreover, the loss of radiation is not perpetual during the day and immensely depends on the angle of sunlight and the ratio of attenuation to direct radiation. The loss of solar output is symmetrical at noon when studied according to position of the sun, where the minimum value is reached. Different pollutants were tested for the performance of the PV module. Depending on the amount and sort of contaminant accumulated, a decrease in the voltage and output power of the PV module is observed when particles of dust are stashed in the Solar module. In addition, there is a greater reduction in the temperature of the PV module. The PV modules are clean and cool, as well as efficient system performance. The generation of electricity in the solar panel is calculated scientifically with dust and without dust with different load resistance.

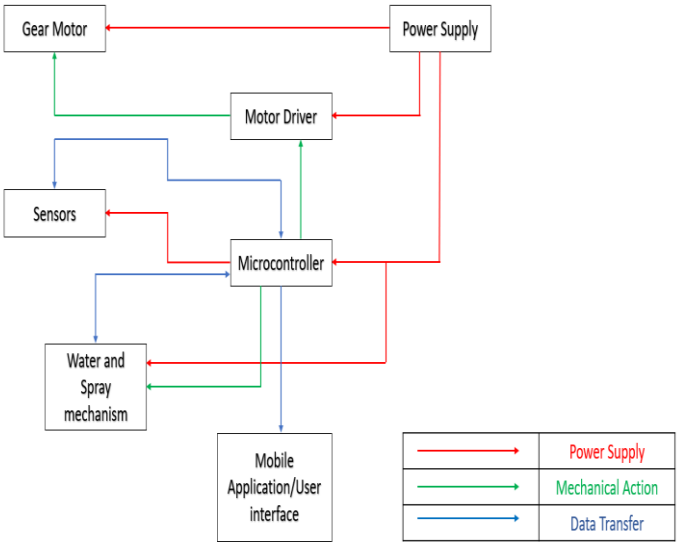


Figure 1. Flow Diagram of Cleaning System.

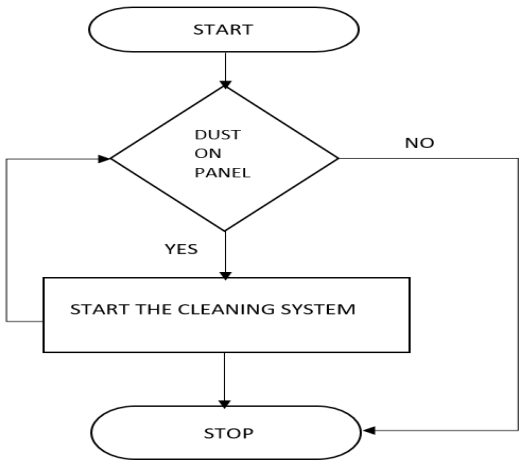


Figure 2. Automated Solar panel cleaning Algorithm.

This project consists of 4 modules
1. Sensor module
2. Motor module
3. Cleaning module
4. User Interface

1. Sensor Module

The dust sensor detects dust on the solar panel. If there is dust on the sensor, it generates a voltage and threshold and if the threshold is more than a specific predefined value then the system will be automatically triggered.

The microcontroller on the basis of data, communicates with the other modules to initiate cleaning or not.

2. Motor Module

The motor module deals with the movement of the cleaning device. When dust is accumulated on the panel, the dust sensor generates the threshold and triggers the microcontroller, which then initiates the motor driver to activate the cleaning device.

3. Cleaning Module

The cleaning module deals with the cleaning of the panel. As the motor driver gets initiated, the microcontroller then asks the wiper to start the clean operation and also activates the spray mechanism. The cleaning operation is performed till the dust sensor gives a negative value.

4. User Interface

The user interface enables the communication between the user and the device. The device sends text messages to the user through GSM module to tell him about every operation that is being performed. Also, in this module the user can initiate to clean his solar panel own through the mobile application.

IV. WORKDONE

There are various types of solar panels are available in the market and the most used solar panels types are:

- Monocrystalline Solar Panels (Mono-SI)
- Polycrystalline Solar Panels (Poly-SI)
- Thin-Film Solar Cells (TFSC)

Mono-SI and Poly-SI are the solar panels which are mostly used in residential usage, Mono-SI is 12% to 16% more efficient as compared to Poly-SI.

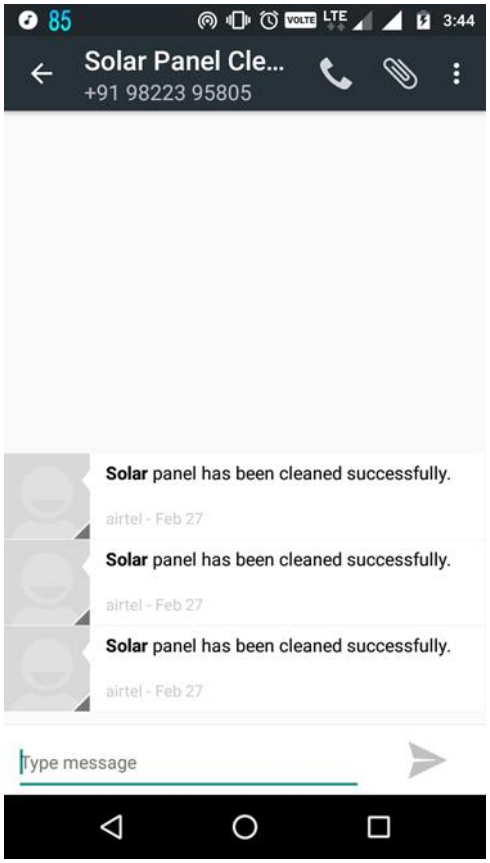
Mechanical department has designed a model of actual panel cleaning system with the fabrication of the cleaning arm which consists of 4 gear motors installed over it two of them are of 100 revolutions per minute (RPM) and other two are of 30 revolutions per minute (RPM) respectively. 30 revolutions per minute (RPM) motors are installed on the either edges of the solar panels which will driven over the tracks on the panel. Arm has two 100 revolutions per minute (RPM) motors in the middle which will clean the panel. Water sprays are installed on the upper edge of the solar panel which will spray the water over it when the pump is been triggered.

Now, as far as the computer science & engineering department concerned is responsible for making the whole system to be programable. So, Internet of Things (IoT) technology is being implemented. The brain of the whole cleaning system is NodeMCU and Arduino which are called as the Microcontroller.

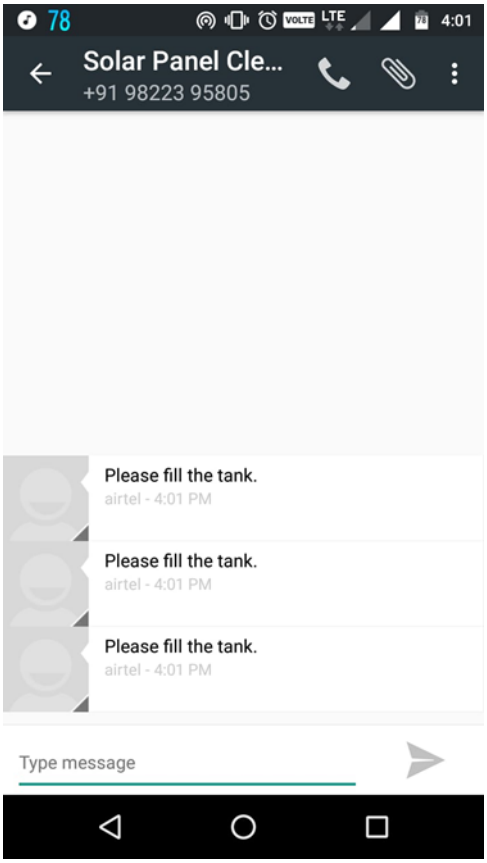
These microcontrollers are connected to the ultrasonic sensor, GSM module, dust sensor, water pump & the cleaning arm motors.

Steps of cleaning process:

- User can trigger the cleaning process by their own mobile phone just by clicking on the "ON" button.
- As, the process starts the water pump will spray the water over the panel and the cleaning arm will move in forward direction for particular time which can be a variable time according to the panel length.
- After few second's forward movement of the cleaning arm, the arm will come backwards up to its original position and at that time the water pump will stop the water spray, and the user will get the message on their mobile phone that the cleaning process has been successfully done.

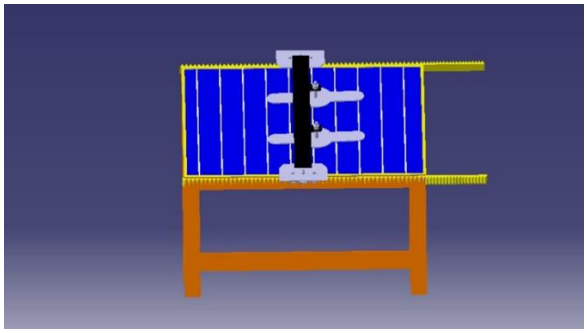


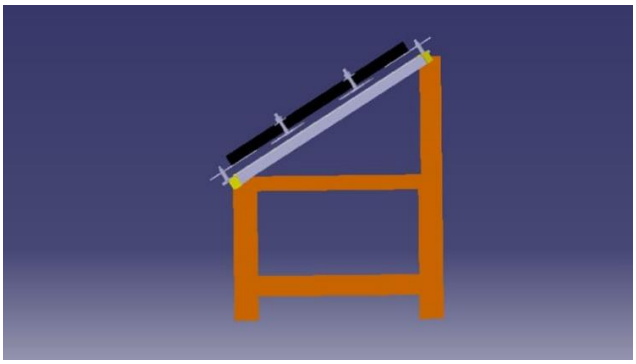
- The ultrasonic sensor is being installed in the water tank which will inform the user about the status of the water in the tank. If the distance of the water is more than 15cm then the sensor will trigger the message on the user's mobile phone, "please fill the tank" and the system will not get triggered until the water is filled in the tank.



- The dust sensor is connected to the arduino, dust sensor detects the dust which passes through it and generates a threshold and voltage when ever dust goes through it.
- It gives a specific threshold when the value is more than a predefined value the microcontroller will trigger the whole cleaning system.

V. DESIGN REPRESENTATION OF ACTUAL MODULE





The above-mentioned sketches are the representation of the actual module which consists of the 2 gear motors which will move over the solar panel, Tracks are installed on both the edges of the solar panel so that the mechanical cleaning arm can move along the panel for cleaning. The motors situated in the middle of the mechanical arms are of 100 revolutions per minute (RPM) which will move 360 degrees and the motors which are driving the arm are of 30 revolutions per minute (RPM). 12 Volts battery is used as the main source of power supply for whole module to be processed, the battery which is being used is rechargeable battery which gets recharged by the solar panel itself. Water tank consists of the water pump which sprays the water over the surface of the solar panel.

VI. RESULTS

The system is being successfully triggered programmabaly as well as manually and each module is performing their respective work efficiently and user is getting the proper response from the system as desired.

VII. APPLICATION

In the 21st century, the use of non-conventional energy resources for electricity generation increased. More and more people install solar panels on their home's roofs to generate electricity. However, when dust is accumulated on the solar panel, the flow rate is reduced and less electricity is produced. Therefore, cleaning the panel as soon as the dust is accumulated is very important for the correct power generation. But it is a very tedious task to clean the panel, requiring human effort and time that most people do not have. The elderly cannot clean the panel even regularly. The solar panel cleaning device therefore helps the user solve all the problems mentioned above. It automatically cleans the panel using a dust sensor, cleaners and communicates with the microcontroller. The device also allows you to communicate so that the user can also start cleaning whenever the user wants.

VIII. ADVANTAGES

1. System has to be installed only once.
2. Low operation and maintenance costs.
3. Easily replaceable components.
4. Easy installation.
5. Low production cost.
6. Highly safe cleaning system with no threat to humans.
7. Easy to operate and maintain.
8. No heavy machinery is required.
9. Working of system is very easy.

IX. DISADVANTAGES

1. Microcontroller may get damaged due to irregular voltage supply.
2. Wiper needs to be changed when worn out.

X. LIMITATION

1. The actual dust sensor which works with the 100% efficiency doesn't exist.

2. The periodic cleaning is not possible because the microcontroller is limited in terms of the memory and microcontrollers works on the microsecond measures so the hours values in teams of microseconds is way more higher which is not possible to implant in the microcontroller.

XI. CONCLUSION

Existing automated cleaning systems focus primarily on large solar power plants and are not generally useful for installation on smaller solar panels on dwelling roofs. This means that only a smaller solar panel must be installed for those with space constraints, which is why this project offers these smaller solar panels a huge advantage. The system can be installed on the top of the roof for solar panels.

XII. REFERENCES

[1]. "Microcontroller Based Automatic Cleaning of Solar Panel", S. B. Halbhavi, S. G. Kulkarni, Dr. D. B. Kulkarni, Department of Electrical & Electronics Engineering, Gogte Institute of Technology, Belgaum Karnataka, India, ISSN: 2278-621X.

[2]. "Solar Panel Cleaning System", Mr. Ashish Saini, Abhishek Nahar, Amit Yadav, Arnim, Dhruvash Singh Shekhawat, Mr. Ankit Vijayvargiya, Department Of Electrical Engineering Swami Keshvanand Institute Of Technology Management & Gramothan, Ramnagaria, Jagatpura, Jaipur (Raj.), ISSN: 2454-1362.

[3]. Automated Self-Cleaning Solar Panel, Yousaf Abdul Salam, Terry Green and Yann Tyng Lin.

[4]. "The Effect of Soiling on Photovoltaic Systems ", Located in Arid Climates, Adrianne Kimber, Sunpower Corporation,2954 San Pablo Ave. Berkeley, Ca 94702 USA.

[5]. "Solar Tracker Cleaning System and Method", Moshe Meller, Tel Aviv (Il); Eran Meller, Tel Aviv (Il), US 9,455,665 B1.

[6]. "Dry Brush Assembly and Method of Operating Dry Brush Assembly for Cleaning Solar Panel Modules", Eddie Bug, Perrysburg, Oh (Us), US 2016/0015164 A1.

[7]. "Automatic Solar Panel Cleaning System", Manju B 1, Abdul Bari 1 and Pavan C M 2, UG Student1 and Assistant professor2, Department of Mechanical Engineering, G Madegowda Institute of Technology, Bharathinagar, Mandya, INDIA, DOI: 10.31695/IJASRE.2018.32778