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New-solar Auto Dust-free Environment using PIC Microcontroller

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ABSTRACT: With growing costs of electricity and concern for the environmental impact of fossil fuels, implementation of eco-friendly energy sources like solar power are rising. The growth in the use of solar panels is increasing as the energy generated by solar has many applications in domestic, commercial and industrial places. Research has also increased towards improving the efficiency of the panels. Cleaning the panel improves efficiency. However, accumulation of dust and debris on even one panel in an array reduces their efficiency in energy generation considerably and emphasizes the need to keep the panels' surface as clean as possible. Also the major drawback that the humans face is reaching the heights for cleaning the panels. So there is maximum probability of them getting injured. We have studied that excess quantity of water is used for cleaning the solar panels in large scale. The goal of our project is to create an automated solar panel cleaner that will address the adverse impact of soiling on commercial photovoltaic cells and solar street lights. This system reduces human efforts, it saves time and it works automatically at specified time. Considering the power output of the solar panels, we decided to choose Microfiber technology instead of bristles for cleaning the panel. Microfiber technology effectively removes moisture and dust particles without scratching it. The microfiber-based wiper is the most efficient method when both cost and improvement rates are considered. Overall it increases the efficiency of solar panels.

KEYWORDS: Solar Energy, Automatic cleaning system, IR sensor, PIC Microcontroller, Photovoltaic panel, No water usage, Fabricated cleaning system.

I. INTRODUCTION

In developed and developing countries, global issues related to the greenhouse effect and limited fossil energy reserves have prompted the governments to make efforts to conserve and diversify fossil fuel based energy. One way is to use solar energy as an environmentally friendly alternative energy. Solar energy is a renewable energy source available in excess amount and free of cost. Cleaning solar panels is not always a straightforward task. To begin with, there is the issue of accessibility. Due to the fact that PV panels often are situated on dangerous and difficult to reach places, it might be hard to clean them manually and it takes time to do it safely. Secondly, cleaning panel only once a year might not have a significant impact on the yearly energy yield for the simple reason that dirt stacks up again in a short period of time making the difference negligible. Especially if one needs to contract someone to clean the panel; it might just not be economical. However, leaving panels without cleaning might not be wise either since soiling can lead to permanent damage of the glass limiting the lifespan of the installation. Because cleaning the panel seldom pays off and they might be unreachable to clean, the logical solution is to clean them automatically and autonomously. But such products are not available in abundance. As a result cleaning robots are only cost-effective on vast areas.

II. STATEMENT OF PURPOSE

The research gathered on soiling shows that solar panels need to be fully cleaned in order to collect the maximum energy possible. To address this need for a cleaning mechanism, we have developed an automated cleaning system for solar panels. Our device will boost the efficiency by increasing the energy output of solar panels in a quick and cost-effective manner. The automation of the system will also reduce the risk of an operator injuring himself in a high voltage environment. A successful device will clean multiple solar panels in an array and increase their efficiency by at



least the same amount that rainfall can. We aim to provide a non-wasteful approach to cleaning commercial sized solar panel systems by using minimal amount of power while requiring little to no maintenance. This system will clean a single row of panels periodically.

III. BLOCK DIAGRAM OF PROTOTYPE

For cleaning solar panel, we are going to design and develop the system. The system works in horizontal and vertical direction. For vertical motion of the system 2 DC motors are used which are sliding on the slider which is fabricated to place the solar panels. DC motor is used for horizontal motion of the frame. The dust cleaner or wiper is fitted on the system. DC motor is used to rotate the dust cleaner. This cleaner cleans the panel from top to bottom. Whole system is controlled using microcontroller. The logic supply and motor supply are designed differently to avoid damage of the controller. In this block diagram, signs are given for clear explanation of electrical power, mechanical action and data. Power supply from transformer is given to the microcontroller and to the relay module. Then the data is fed to the relay module from the PIC microcontroller. The power is supplied to the DC motors from relay module and then the motors perform mechanical actions according to the input given. Then the cleaning system cleans the solar panel properly.

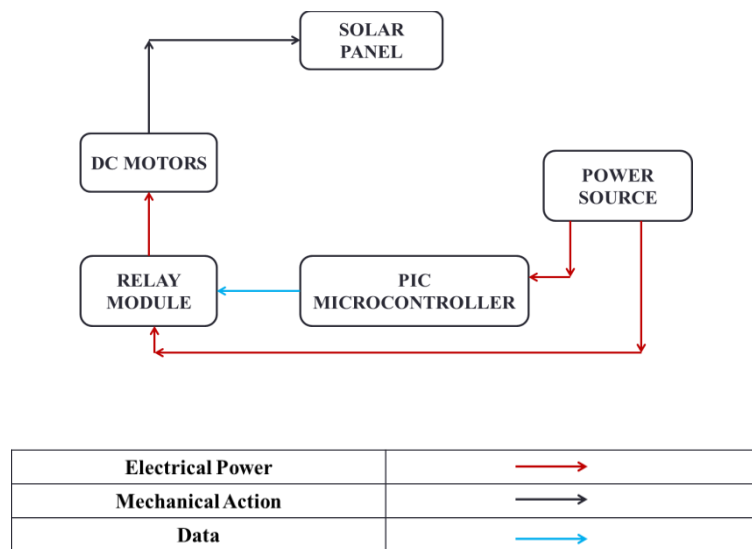


Figure 1: Block Diagram of Prototype

IV. DESIGN IMPLEMENTATION

Our robot is a water-free robotic cleaning process combines a powerful-soft microfiber brush supposed to remove 99% of dust daily and keeping panels at optimal production rates. The design will be fairly simple and should be relatively easy to fabricate. Our main considerations for this design were maximizing effectiveness and minimizing costs. With this in mind, we prioritized the design of the cleaning mechanism with the mounting and control systems being secondary. The design will be fairly simple and should be relatively easy to fabricate. The simplicity of the design will also reduce the maintenance required. The control systems required by this device are minimal. The device will periodically move along the panel before returning. A PIC Microcontroller is sufficient to implement the required logic. The device will need to recognize the correct time to clean and then run the cleaning system.

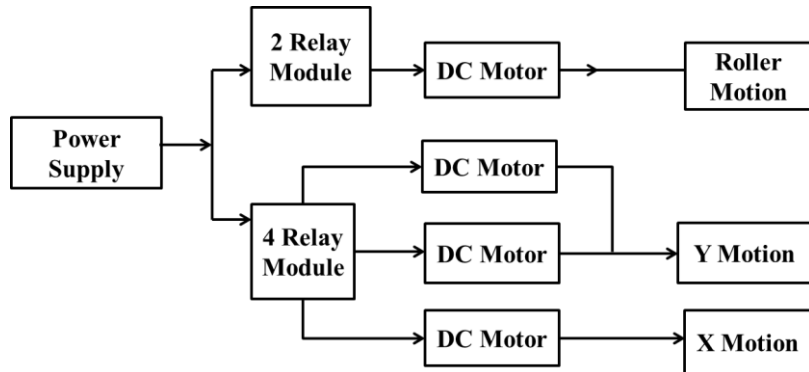


Figure 2: Design Implementation

V. ROBOT OPERATION

The flow diagram of robot cleaning system operation is shown in Figure 10.1. After receiving the command, the robot starts moving in one direction while cleaning the panel. During the operation, the robot keeps moving at constant speed until the sensors signal to reach the panel edge at which point the robot slows down and stops. If this is the robots first pass on the panel, and then it moves backwards until it reaches the edge again where the carrier subsystem is located Sensors are connected in both sides of the robot signal the reach of panel edge at which point the robot returns back to the starting position, making a second cleaning pass.

The flowchart gives the flow of working of Solar Panel cleaner for horizontal as well as vertical motion.

Implementation of flowchart is as follows,

- i. Start the cleaning mechanism.
- ii. Initially first DC motor runs the cleaner panel in horizontal direction. Simultaneously second DC motor starts which rotates the brush cleaner in circular rotation.
- iii. At the same time third and fourth DC motor is used to move brush cleaner in up down direction.
- iv. Repeat step ii and iii for cleaning the solar panel. Cleaning process of solar cell completed. Frame is transfer to next panel simultaneously process takes place as above.
- v. Stop the cleaning mechanism.

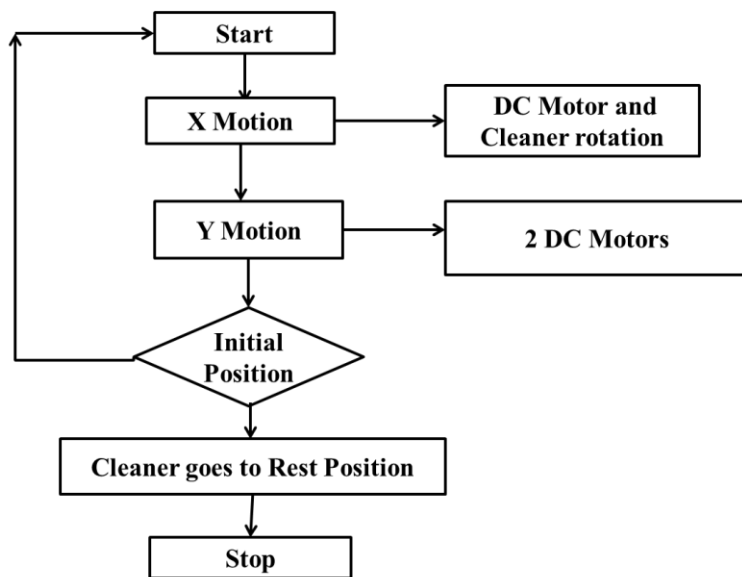


Figure 3: Robot Operation Flowchart



VI. FINAL PROTOTYPE

The fully integrated robot cleaning system is launched to clean the panel surface. During cleaning, the robot moves along the length of the panel. Sensors installed at front side of the robot where signals the reach of panel edge after that the robot returns back to the starting position, making a second cleaning pass. PIC based solar panel automatic cleaning system for those area where dust effect on solar panel. By many reason the efficiency of solar energy can be decreased. Such that dust from environment, bird shit or any other small obstruction. The system will clean the solar panel as our preprogrammed schedule. The project designed by using PIC16F877A microcontroller, relay module to control the motor. The design and construction is reliable that it won't hamper for solar power consumption. The whole construction needs a little place so it can be attached with solar panel very easily.

As this project will operate by automatically so it is designed as user friendly. By rotating automatically it will clean the solar panel for a certain period of time. For the first step the wiper will move to forward side of the solar panel and after that it will reverse back to the solar panel. Then it will take a delay time of 12 minutes in our prototype project (which will take 12 hours in real implementation). After that the system will again clean the solar panel as follow the above methodology. User can change the delay time of cleaning system after how much of time the system will run. The system will run with some code in which the delay time can be increased or decreased.

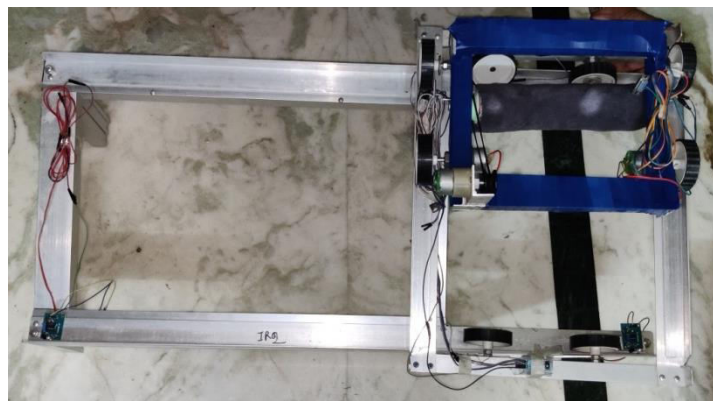


Figure 4: Final Prototype

VII. RESULTS AND ANALYSIS

Following tables shows the results of cleaning system:

Day	Voltage (volts)	Current (amp)	Power (watt)
1	15.60	1.25	19.5
2	15.27	1.24	18.93
3	15.12	1.14	17.23
4	15.04	1.08	16.24
5	15.01	1.09	16.36
6	14.92	1.06	15.81
7	14.70	1.01	14.84

Table 1: Power Output Reading before Installation of Cleaning System

Day	Voltage (volts)	Current (amp)	Power (watt)
1	16.00	1.25	20
2	15.98	1.24	19.81
3	15.98	1.23	19.85
4	16.01	1.24	19.82
5	15.99	1.26	20.14
6	15.97	1.25	19.96
7	15.99	1.24	19.95

Table 2: Power Output Reading after Installation of Cleaning System

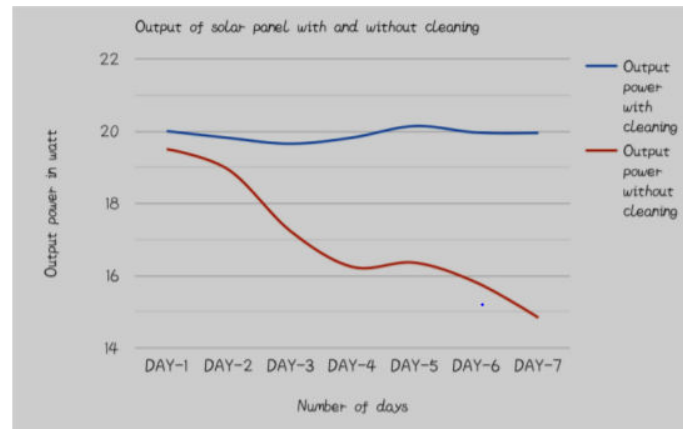


Figure 5: Output Graph

This result graph shows the performance of cleaning system before and after the installation of cleaning system. From this graph we can understand, if cleaning system is not used, then the graph with red line goes in decreasing order i.e. the output power from solar panel decrease day by day. If solar panel with cleaning system is used, then the graph with blue line tries to maintain its output power i.e. the output power is maintained due to daily cleaning of solar panel. From the blue line graph we can understand how automatic cleaning system is useful for solar street lights

VIII. CONCLUSION

The goal of Project NADE is to create an automated solar panel cleaner that will address the adverse impact of soiling on commercial photovoltaic cells. The next step for our project is finding a mechanism that allows the project to move through spaces between arrays easily without human factor. This automated cleaning system mainly focuses on small system but adding some normal changes in system it can be useful for over large arrays. Our system can be installed on solar street light or also on solar roof top systems.

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