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Design and Development of Solar Panel Cleaning Bot

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Abstract:- The most prevalent renewable energy source that doesn't harm the environment when produced utilizing solar photovoltaic (PV) panels is sunlight. Due to the solar panel's azimuth angle, the PV panel's efficiency is dependent on the amount of light that strikes it. Dust buildup on the PV panel lowers the efficiency of the energy produced. The PV panel must occasionally be cleaned in order to boost efficiency. The solar panel cleaning robot suggested in this study cleans PV panels on a regular basis. The panel's surface is cleaned by spraying a water and removing dust with a roller brush. Bluetooth is used to control the suggested robot. The suggested solution uses robotic cleaning to boost the power generation's efficiency on a regular basis.

Keywords:- *Solar, Photo, Voltaic, robot, plant, PV.*

I. INTRODUCTION

Over the past ten years, the solar Photo-voltaic (PV) industry has experienced substantial growth as a result of the rising need for renewable energy. as photovoltaic technology is readily available. It is becoming a typical investment for both commercial investors and private investors. As a result, studies to improve the overall output strength of PV systems have been sparked by this demand. Solar panel cleaning techniques are employed to maintain their effectiveness. With respect to many variables including variations in PV surface material, tilt angle, surrounding atmosphere, pollution, and varying weather conditions, the impact of dust deposition on PV cells' performance varies. PV cell performance is impacted by the dirt particles since soiling varies depending on the location. Solar power's efficiency is being compromised by dirty panels. Bird droppings, dust containing sand, pollen, and other airborne particles, as well as the development of lichen close to the lower edge of the module frame, can all cause PV cells to get contaminated. Our solar panel investment is tarnished by leaves, bird droppings, and airborne particles (due to dirt and pollen).

Energy loss among users nowadays might range between 25% and 30%. The time it takes for an investment to pay off can significantly increase if solar panels are unclean. The soiling impact for concentrated PV (CPV) modules demonstrates effectiveness. For one of the facilities that had losses of 6.9 percent after a year of exposure without cleaning, the systems were cleaned utilising a pressurised distilled water spray combined with brushing. Dust particles accumulating on the surface lower efficiency and make it difficult to clean the PV panel affordably and effectively. This makes it difficult to increase the PV cell efficiency by incremental numbers.

PV panels can be cleaned actively (manually or automatically), passively (using natural processes like wind, gravity, rain, and dew to remove dust), or both. For large-scale solar PV plants, a robotic system for cleaning photovoltaic panel arrays was created. The price of PV cells and voltage changes in PV modules are two reasons that are restricting the use of PV technology. Solar panel cleaning is not always that easy, though. The accessibility issue is the first to be addressed. It may be challenging to physically wash solar panels since they are frequently situated in risky and challenging locations, and it takes time to do it safely. Second, just cleaning a panel once a year may not have a significant impact on the annual energy output for the obvious reason that in no time at all, dirt will begin to accumulate once more, negating the effect. Nowadays, finding labor, in particular, to clean PV panels, is a difficult task.

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Fig 1:- Solar panels

II. LITERATURE SURVEY

A. *"A FULLY PORTABLE ROBOT SYSTEM FOR CLEANING SOLAR PANELS". Mohammad A. Jaradat, Mohammad Tauseef, Yousuf Altaf, Roba Saab, Hussam Adel, Nadeem Yousuf, and Yousef H. Zurigat, 2015 IEEE10th International Symposium on Mechatronics and its Applications (ISMA).*

The GCC region is rich in solar energy, but the desert conditions are highly dusty, endangering the PV system's ability to generate power. The main focus of this research is on finding a solution to the problem of dust deposition on solar panels in this location. The robotic system suggested in this research is an easy solution to efficiently address this difficulty. This system's limitation that it can only remove dust makes it unsuitable for usage in all solar plants.

B. *"Solar Panel Cleaning Bot for Enhancement of Efficiency-An Innovative Approach". Prof.J. B. Jawale, Prof. V. K. Karra, Dr. B. P. Patil, Puneet Singh, Shailender Singh, Saloni Atre.2016 IEEE Third International Conference on Devices, Circuits and Systems (ICDCS'16)*

The effectiveness of solar panels depends heavily on cleaning and maintenance. An 8-panel array's efficiency has increased by 30–33%, and as a result, we can infer that it will be more useful in a solar park where there are significantly more cells. A thorough cleaning is highly beneficial because the performance of the entire array is impacted when a single panel is compromised by collected dust. This system's disadvantages include the fact that it is larger, heavier, and requires more time to assemble the entire system than is ideal.

C. *A Solar Panel Cleaning Robot Design and Application", European Journal of Science and Technology.*

This paper will make it easier to clear up the dust particles that have gathered and formed on the surface of solar panels. A microprocessor will be responsible for the device's control. The specially created equipment uses limit and distance sensors to automatically finish the cleaning operation. It will be able to recharge the battery in the parking garage so that it is prepared for the subsequent washing cycle with no additional work. A seamless transition from the gaps between the Solar panels is made possible by the pulley pallet system, which was specifically created for the Solar panel, in the movement system. Cheap, lightweight, automatic, and low-maintenance cleaning will be made possible by lowering the cost and weight of the developed SPCR system. This particular kind of solar panel cleaning robot cleans one section at a time before moving on to the next until every solar panel has been cleaned.

D. *"Solar Panel Cleaning Robot Using Wireless Communication", Dr.K.S. Dhanalakshmi, S. Magesh Raj, K. Santhosh Kumar, R. Keerthivash.*

This paper focuses on the robotically assisted architectural design of the automatic cleaning panels. With the aid of a highly rhythmic pressure dumbed by the robot, the automatic cooling principle has been put into practice. All of the debris and dust, both dangerous and benign, are removed. Removes each solar panel one at a time using the left and right-conditioned motors and a strong spray of water. The primary goal of this proposed automotive innovation was to completely remove human interaction.

III. METHODOLOGY

The proposed solar panel cleaning robot is used to remove the dirt and dust that have been deposited on the solar panel, allowing it to absorb the most energy possible. The proposed solution comprises of a cleaning robot that moves alongside the solar panel and cleans the entire panel. The cleaning robot's brush removes dirt and dust from the panel with its help. The robot's activities and movement from one panel to the next are managed by a microcontroller that has been programmed. The capacity to clean multiple solar farm panels with a single robot is the primary design criterion for the cleaning system.

A. *Block Diagram*

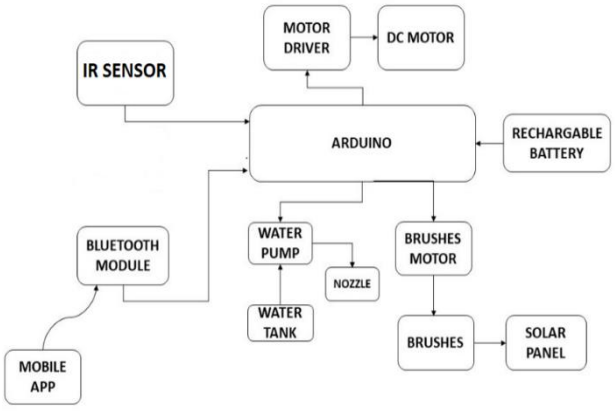

Fig 2:- Block diagram

The Arduino microcontroller serves as the system's brains and is its key component. With the aid of a motor driver that is interfaced with the Arduino, the system's motors are managed. The cleaning is done by the robot by repeating the first process. The cleaning robot's proposed system operation sequence travels the complete length of a solar panel. The robot features four wheels with four motors each, sensors, and a controller subsystem in addition to brushes and a water spraying sector. The robot frame has two motors mounted on

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each side. To strengthen the stability of the robot, four motors are utilized to drive unique wheels, while three other motors are used to drive each brush in the front and back.

Through this, we create a technology for cleaning solar panels that is affordable. On the Arduino development board, the system's software is put into practice. Both the vertical and horizontal axes of the system are supported by PV modules. The cleaning brush moves on the vertical axis as the robot moves from one panel to the next on the horizontal axis. To maintain the desired limiting array, position switches can measure the length of the solar panel array.

B. Hardware Components

ARDUINO UNO: An ATmega328P-based microcontroller board is called Arduino UNO. It has 6 analogue inputs, a sixteen MHz ceramic resonator, a USB port, a power jack, an ICSP header, and a reset button. It has 14 virtual input/output pins, 6 of which can be used as PWM outputs. It comes with everything required to support the microcontroller; simply connect it to a computer with a USB wire or power it with an AC-to-DC adapter or battery to start going.

Fig 3:- Arduino Uno

BLUETOOTH (HC-05): The HC-05 Bluetooth module (Fig. 4) is made for wireless communication. This module can be set up as a grasp or slave. All devices that support serial communication can communicate with one another via Bluetooth serial modules.

Fig 4:- HC-05

MOTOR DRIVER: The twin H-Bridge motor driver, model number L298N, enables simultaneous speed and direction control of two DC motors. With a peak current of up to 2A, the module is capable of driving DC motors with voltages ranging from 5 to 35V.

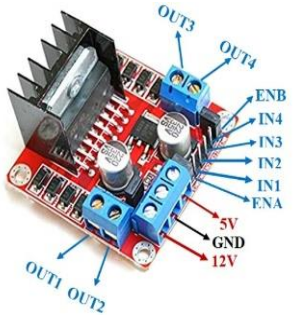

Fig 5:- Motor Driver (L298N)

IR- SENSOR: An infrared (IR) sensor is an electrical device that measures and detects infrared radiation in its environment. When cleaning solar panels, an IR sensor is employed for edge detection.

Fig 6:- IR-Sensor

ROLLER BRUSH: These brushes are employed in the project to clean the solar panels' surface. These are joined to the robot's body, and it uses them to clean the surface once water is shot from the nozzle through the pump.

Fig 7:- Brushes

IV. PROTOTYPE WORKING

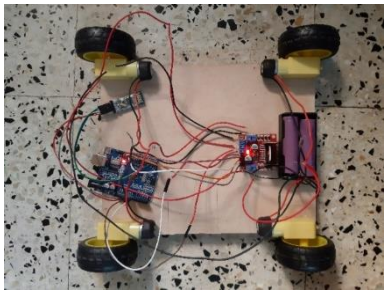

Fig 8:- Prototype - 1

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The prototype-1 up top demonstrates the bot's basic design and operation. As can be seen from the above illustration, we only needed a basic set of motors, batteries, and a short piece of wood. This prototype's design was rejected because it employed the wrong materials, the motor used could not support the entire weight of the bot, and the batteries, which are a crucial component of our automated bot, could not be used for extended periods of time.

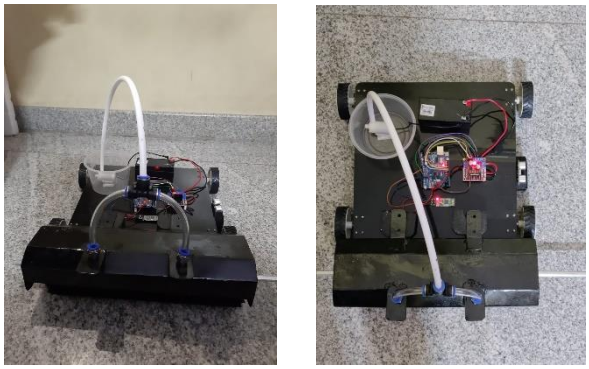

Fig 9:- Prototpe-2

Within Prototype-2 with the aid of a Bluetooth module connected to an Arduino board with wheels and a motor, the system is managed. The key component of cleaning the solar panel is the rolling brush, which is mounted inside a casing as depicted in the diagram. To spray water on the solar panel, the nozzles are built within the roller brush's case. The pump is used to transfer water from the sprinklers to the water hose. Additionally, it includes IR sensors for edge detection.

V. CONCLUSION

This experiment demonstrates how contaminants including dust, dirt, pollen, sea salt, and bird droppings affect the effectiveness of PV systems. The effectiveness and performance of the solar panels are greatly impacted by dust. Whereas solar energy is abundant in the GCC region. The robotic system suggested in this research is an easy solution to properly handle the challenge. Although the prototype produced encouraging results, more tweaks and testing are needed to produce a cleaning solution that is more reliable and self-sufficient.

A few benefits of this method include simplicity of maintenance, affordability, and reduced power consumption. Finally, by adopting this cleaning technology, the decrease in peak power generation can also be mitigated. The test findings suggest that robot cleaning increases the efficiency of the PV panel. On the other hand, this cleaning approach can be used for an economical operation that is designed to increase electricity output.

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