SOLAR ENERGISED SOLAR PANEL CLEANING ROBOT

[1]Prof. Lokesha A. M, [2]Madhu Singh K, [3]R Dharshini, [4]Srushti Sidaraddi, Sweekruthi Shetty R

[1]Assistant Professor, [2,3,4] UG Students

[1,] Electronics and Communication Engineering, Cambridge Institute of Technology, Bengaluru, India

[2,3,4]Electronics and Communication Engineering, Cambridge Institute of Technology, Bengaluru, India

Abstract: This design proposes a solar- powered robot for drawing solar panels, exercising solar energy for both power generation and drawing operations. The system integrates rechargeable batteries, a robotic platform with drawing mechanisms, and a mobile app for stoner control. It's ideal is to optimize solar panel performance by maintaining cleanliness without homemade intervention. The robot's cleaning mechanisms are designed for effectiveness and minimum panel damage. Control commands are transmitted via Bluetooth from the mobile app, enabling real- time monitoring and adaptation. The tone- sustaining power system ensures nonstop operation, suitable for remote or out- grid installations. Overall, this innovative result offers a cost-effective and sustainable approach to solar panel conservation.

Index Terms – Arduino, Cleaning, sensors, Brushes, Bluetooth, Automation

I. INTRODUCTION

In today's world, the search for sustainable energy solutions has reached unprecedented levels, with solar energy emerging as a key competitor in the renewable energy sector. However, the efficiency and longevity of the solar panel installation is highly dependent on maintenance, which is a big challenge, especially for large installations. In response to these challenges, our new design presents an innovative solution: a solar-powered robot designed to clean solar panels. By using an optimization-oriented energy source, this robot promises to change the landscape of today's energy system maintenance and management. Solar panels, the cornerstone of our system, serve two purposes. This means that not only will it generate the energy needed to power the robot, but the sun will also contribute to the cleaning process. This autonomous power model ensures uninterrupted power, making these robots ideal for remote or stand-alone installations where access to electricity is limited.

In addition, the versatility of our solar washers extends to various components to meet the different needs of various applications. From large solar power plants spanning vast fields to commercial and residential rooftops adorned with solar panels, these robots offer a cost-effective and self-sufficient solution to keep watch. Advanced communication technology improves the performance and usability of our system. The smartphone interface allows users to monitor and control the robot and adjust cleaning tasks to specific situations. The Bluetooth connection allows for easy communication between the user and the robot, allowing for feedback and adjustments. This dynamic response team effectively protects solar panel installations across a variety of scales and functions, contributing to longevity and peak performance. In short, our comprehensive approach to solar panel maintenance not only ensures efficient energy production, but also demonstrates our commitment to sustainability in the renewable energy sector.

II. LITERATURE REVIEW

[1] Development of solar panel cleaning robot using Arduino. F. H. M. Noh, M. F. Yaakub, I. N. A. M. Nordin, N. Sahari, N. A. Zambri, Sim Sy Yi, Muhammad Syukri Mohd Saibon . This paper presents a robotic design for automated cleaning of PV panels and addresses the time, water and energy issues associated with conventional cleaning methods. Controlled by an Arduino system, this robot uses two soft sponges and a water pump to directly remove dust and debris from the PV panel surface. Group efficiency measurements before and after cleaning showed significant improvements in current output and power output of up to 50%. This solar cleaning robot provides an efficient and effective solution to keep your solar power system running optimally.

[2] Smart solar photovoltaic panel cleaning system Nasib Khadka , Aayush Bista , Binamra Adhikari, Ashish Shrestha, and Diwakar Bista, In this paper, we present a model that automatically cleans solar panels to prevent performance degradation due to dust accumulation. The system includes a mobile cleaning robot with special rotating brushes and a cloud interface for monitoring and remote control. Smart devices can monitor the performance of power plants remotely. Retrospective analysis of clean floor and dust data informs the smart device's specialized tools to predict optimal cleaning times. Evaluation of the PV demonstration model confirmed the system's ability to remove dry dust, suggesting it could be scaled up to larger solar plants by adding metal rails.

[3] Autonomous robot for cleaning photovoltaic panels in desert zones. Michele Gabrio Antonelli, Pierluigi Beomonte Zobel, Andrea De Marcellis, Elia Palange. In desert regions, dust and sand storms can reduce the efficiency of solar panels by up to 80%, and lack of water and poor practices make manual cleaning expensive. To solve this problem, a low-cost unmanned robotic system has been proposed. It works without gel and uses a spiral brush to remove dirt without water. Real-time location detection using ultrasonic sensors and the ARDUINO DUE control system ensure precise movements and efficient cleaning. Experimental tests of the model confirm the robustness, reliability and low energy consumption, providing the best solution to maintain the efficiency of solar panels in desert environments.

[4] Design and Implementation of Automatic Solar Panel Cleaning Robot Dorge, Prabhakar; Kamatkar, Harshada; Sakalkar, Anushka; Dani, Atharva; Bhagat, Nupur; Damahe, Lalit; Doifode, Vaibhav; Titarmare, Abhijit; Nagmote, Sachin. Solar panels, which are essential for the production of solar energy, face efficiency problems due to dust accumulation. The analysis showed that impurities such as ash, sand and silica can cause problems in the process. A computerized cleaning system targeting different particles is proposed to increase production by 30%. Traditional manual methods are time, water and energy intensive and lack automation. A special cleaning robot controlled by Arduino is proposed. A microfiber brush and water pump system can remove dust and debris to keep your appliance running smoothly.

[5] Design of Bluetooth-based Solar Panel Cleaner Robot R. Priya, K. S. Radha and M. Karthikeyan . Oil and water scarcity is a major challenge worldwide. In many regions, up to 70% of energy needs are met by burning wood and waste products. Solar energy provides a renewable solution using the sun's abundance. In countries like India, where solar panels are being deployed, dust production is greatly reduced during operation, reducing electricity production by 50% in just one month. To solve this problem, the PIC cleans the cleaning equipment, washes the panels to remove dirt and increases efficiency. Expanding the use of solar energy is critical to future sustainability amid fuel scarcity and water challenges.

[6] Performance Analysis of a Solar Panel Cleaning Autonomous Robot (SPCR) with comparative study . S. Barua, A. N. Oishi, M. Shadman Shafkat Tanjim, A. A. Mansur, I. Ahmed and A. Shihavuddin . Solar systems, the backbone of renewable energy, must be highly efficient for maximum performance. Dust build-up can seriously impair a solar panel's performance, requiring innovative cleaning solutions. Manual cleaning is ineffective, time-consuming and expensive. To solve this problem, a solar panel cleaning robot (SPCR) was proposed. Equipped with sensors, motors, cameras and water tanks, the SPCR improves cleaning based on the type of dust. The performance of the system will be evaluated through several case studies to demonstrate its effectiveness compared to existing methods. These advances promise to improve the efficiency and stability of solar power generation, which is essential for a wide range of renewable technologies.

[7] Development and Experiment Analysis of Solar Panel Cleaning System. John, L.G., Thing, G.T., Ragupathy, J., Chua, H.S., Han. The efficiency of solar panels is limited by environmental factors such as dust accumulation, which reduces power output by 3 to 25 percent. In this study, a solar panel cleaning system

consisting of the upper brushes, the water tank and the control electronics is considered. Tests on acrylic panels equipped with LDR sensors showed an improvement in cleanliness and efficiency from 60% to 98% after three cascade cleanings. This innovation addresses the challenge of maintaining optimal solar panel performance, which is critical to advancing the deployment of renewable energy in the pursuit of a greener world.
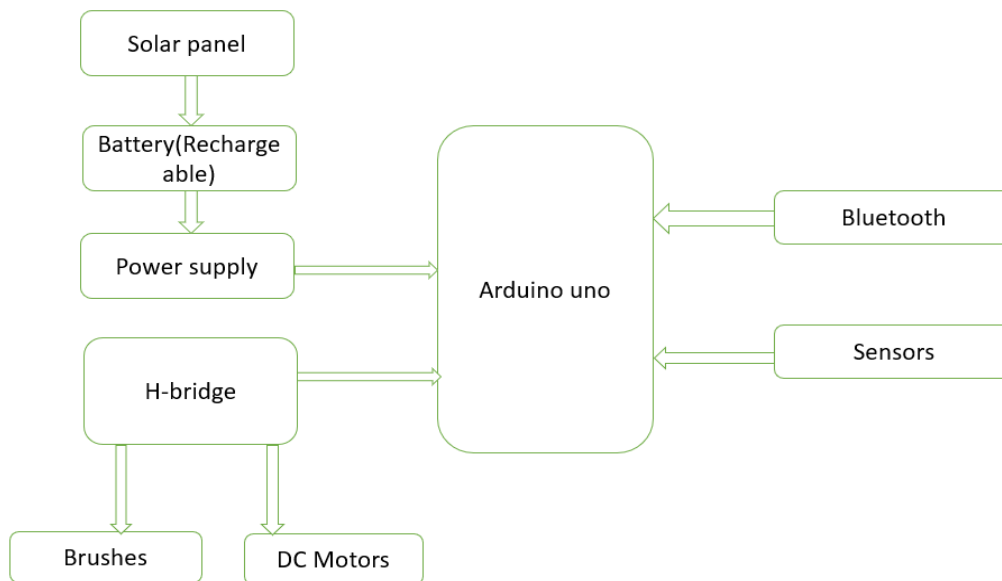
III.METHODOLOGY

Fig 1: Block diagram of solar panel cleaning robot

Manual cleaning styles, constantly the primary expedient, are labour-ferocious, time- consuming, and precious, particularly for large- scale installations. This reliance on manual labour not only increases functional charges but also introduces the trouble of mortal error, leading to inconsistent cleaning quality and implicit damage to delicate panel shells. also, the need for frequent cleaning to maintain optimal energy product situations further exacerbates these challenges, especially in regions prone to dust, debris, or environmental pollutants. Consequently, the lack of a reliable and sustainable cleaning affect significantly compromises the effectiveness, tractability, and overall performance of solar panel installations, hindering their capability to meet energy product targets and contribute effectively to the transition towards renewable energy sources.

The proposed system has two parts: automated mode and mobility mode.

• An Arduino Uno controls the robot's motors.
• Bluetooth connects the user to the robot via Automation.

The Arduino Uno serves as the central processing unit (CPU) of the robot, controlling and coordinating the operations of various components. It receives commands from the mobile interface via Bluetooth and translates them into actions for the motors and other peripherals. The DC motors drive the movement of the robot, enabling it to navigate across the surface of the solar panel. Each motor is connected to a wheel or a set of wheels, allowing the robot to move forwards, backwards, and turn in different directions. The power supply and battery provide electrical energy to the entire system, including the Arduino Uno, DC motors, and other components. The 12V battery powers the motors and ensures uninterrupted operation of the robot, especially in areas without access to external power sources. The solar panel harvests sunlight and converts it into electrical energy, which is used to charge the battery and power the robot. This component ensures the sustainability of the robot's operation by utilizing renewable energy sources. The brushes are used for cleaning the surface of the solar panel, removing dust, dirt, and other debris. Different types of brushes may be employed for varying degrees of cleaning effectiveness, depending on the type and condition of the solar panel. The Bluetooth HC05 module enables wireless communication between the robot and the mobile interface. It receives commands from the mobile device and relays them to the Arduino Uno, allowing users to control the robot remotely. The TTL live streamer may be used for transmitting real-time data or video feed from the robot to the mobile interface, providing users with visual feedback during operation. H bridges are electronic circuits used to control the direction and speed of DC motors. They enable the Arduino Uno to send signals to the motors, determining their rotational direction and velocity for precise movement control. Edge

detection sensors may be used to detect the boundaries of the solar panel and prevent the robot from falling off. These sensors ensure safe navigation and prevent damage to both the robot and the solar panel. Also known as the Arduino Software (IDE), the Arduino Integrated Development Environment (IDE) comprises a text editor for composing code, a message section, a text console, a toolbar with buttons for frequently used operations, and a number of menus. In order to upload and interact with programs, it establishes a connection with the Arduino hardware. One form of application automation, also known as application service automation, refers to the methods used by IT operations teams to automate the service and deployment of applications across the organization.

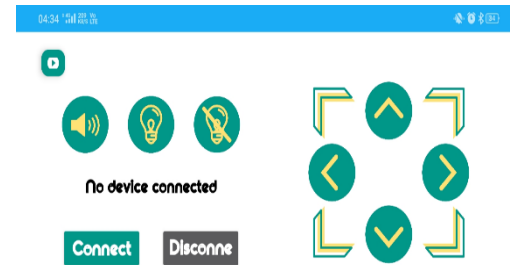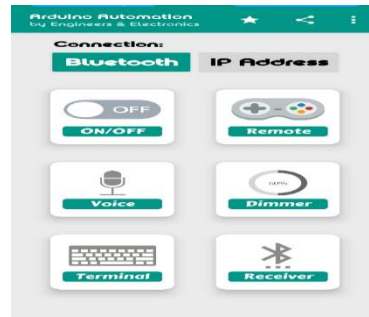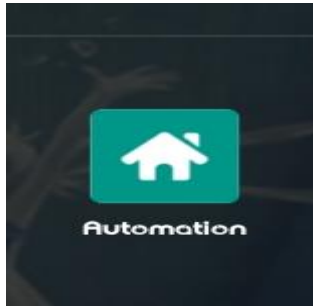Fig 2:Automation app   Fig 3: Arrow method

VI. RESULTS AND DISCUSSION

Upon activation, the solar- powered robot initializes its factors, including the Arduino Uno, DC motors, Bluetooth HC05 module, edge discovery sensors, and H islets. stoners interact with the robot through a mobile operation equipped with an arrow system interface, allowing them to shoot directional commands. Upon entering these commands, the Arduino Uno interprets the inputs and sends signals to the applicable DC motors to control the movement of the robot accordingly. The edge discovery sensors help ensure safe navigation by detecting boundaries, preventing the robot from falling off the solar panel. As the robot moves across the face of the solar panel, it simultaneously activates the cleaning medium, exercising the skirmishes to remove dust and debris. stoners can cover the cleaning progress and adjust the robot's movements in real-time through the mobile operation, enabling effective and precise cleaning operations. This automation streamlines the conservation process, optimizing the performance and life of solar panel installations.
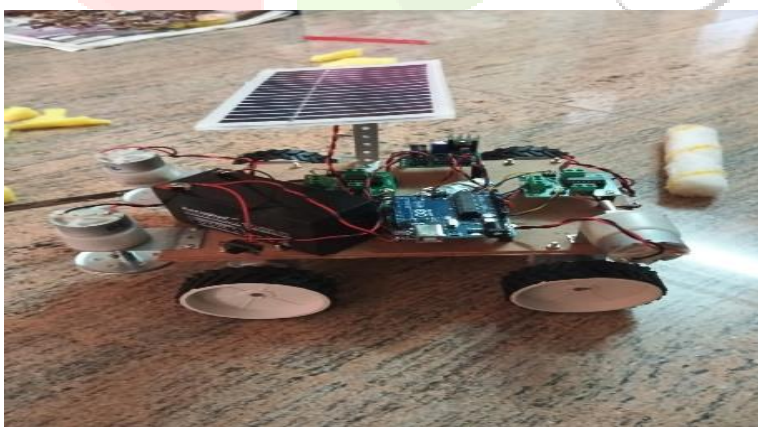

Fig 4: Final Project Prototype

Conclusion

The solar- powered robot designed for drawing solar panels represents a advance in renewable energy conservation. By exercising solar energy, it offers an eco-friendly and effective result for maximizing the performance of solar installations. Featuring two encounter types and an edge discovery TTL camera, it effectively removes debris, enhancing energy immersion and panel life. Its perfection navigation around panel edges prevents damage, while remote control via an Arduino app adds convenience. This innovative technology promotes sustainability and effectiveness, making it inestimable for marketable and domestic solar systems, driving the relinquishment of clean energy practices for a greener future.

Future scope

The unborn compass for the solar- powered cleaning robot for solar panels is promising and multifaceted. Integration of advanced detectors and machine literacy algorithms could enable the robot to autonomously identify areas in need of cleaning and acclimate its cleaning strategy consequently, optimizing energy product. also, there's eventuality for incorporating tone- charging capabilities, allowing the robot to recharge using solar energy while not in use, therefore adding its functional autonomy. Collaboration with the Internet of effects (IoT) technologies could enable remote monitoring and operation of multiple robots across vast solar granges, perfecting overall conservation effectiveness. likewise, exploring the use of sustainable accoutrements and manufacturing processes for the robot could align with environmental pretensions and reduce its ecological footmark, AI, renewable energy, and sustainability present multitudinous openings to further enhance the functionality, effectiveness, and ecological impact of solar- powered cleaning robots, shaping a more sustainable future for solar energy conservation.

REFERENCE:

[1] Development of solar panel cleaning robot using Arduino.F. H. M. Noh, M. F. Yaakub, I. N. A. M. Nordin, N. Sahari, N. A. Zambri, Sim Sy Yi, Muhammad Syukri Mohd Saibon . DOI:10.11591/IJEECS.V19.I3.PP1245-1250 . Corpus ID: 219446372

[2] Smart solar photovoltaic panel cleaning system .Nasib Khadka,Aayush Bista,Binamra Adhikari, Ashish Shrestha and Diwakar Bista . Published under licence by IOP Publishing Ltd . Citation Nasib Khadka et al 2020 IOP Conf. Ser.: Earth Environ. Sci. 463 012121 . DOI 10.1088/1755-1315/463/1/012121.

[3] Autonomous robot for cleaning photovoltaic panels in desert zones . Author links open overlay panelMichele Gabrio Antonelli, Pierluigi Beomonte Zobel, Andrea De Marcellis, Elia Palange . https://doi.org/10.1016/j.mechatronics.2020.102372

[4] Design and Implementation of Automatic Solar Panel Cleaning Robot . Dorge, Prabhakar; Kamatkar, Harshada; Sakalkar, Anushka; Dani, Atharva; Bhagat, Nupur; Damahe, Lalit; Doifode, Vaibhav; Titarmare, Abhijit; Nagmote, Sachin . DOI: http://dx.doi.org/10.12785/ijcds/XXXXXX . ISSN: 2210-142X . Date: 2024-03-06 .

[5] R. Priya, K. S. Radha and M. Karthikeyan, "Design of Bluetooth-based Solar Panel Cleaner Robot," 2023 7th International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2023, pp. 1611-1616, doi:10.1109/ICCMC56507.2023.10084178.

[6] S. Barua, A. N. Oishi, M. Shadman Shafkat Tanjim, A. A. Mansur, I. Ahmed and A. Shihavuddin, "Performance Analysis of a Solar Panel Cleaning Autonomous Robot (SPCR) with comparative study," 2023 26th International Conference on Computer and Information Technology (ICCIT), Cox's Bazar, Bangladesh, 2023, pp. 1-6, doi: 10.1109/ICCIT60459.2023.10440987.

[7] John, L.G., Thing, G.T., Ragupathy, J., Chua, H.S., Han, F.P. (2024). Design, Development and Experiment Analysis of Solar Panel Cleaning System. In: Mathew, J., Gopal, L., Juwono, F.H. (eds) Artificial Intelligence for Sustainable Energy. GENCITY 2023. Lecture Notes in Electrical Engineering, vol 1142. Springer, Singapore. https://doi.org/10.1007/978-981-99-9833-3_4