Solar Panel Cleaning Robot using IoT

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Abstract— The sun is the main source of energy for all the forms of life on the planet earth. The sun gives light and heat; it is also called solar energy. This solar energy is to regulated using numerous technologies such as solar thermal, solar architecture, solar photovoltaic (PV) etc. The most popular technology is solar photovoltaic. Solar panels are affected by various environmental factors like bird spack, dirt, dust etc. This project works on the basic concept of IoT based robot controlling action. Blynk mobile application is used for commanding and operating the whole system. Arduino nano micro-controller controlling the whole action of the system using Blynk mobile application. Arduino nano microcontroller received data from ESP8266 Wi-Fi module and send this data to the L293D motor driver IC. Because of this process DC motors are rotate forward and backward direction and Arduino wheel assembly are also move in any direction on the solar panel surface. The cleaning brush is connected with Arduino nano micro controller and brush motor due to this cleaning brush move horizontally and vertically on the solar panel surface .The reduction of output power is reduced after cleaning the solar panel surface by brush and water sprinkle pump. Dry and wet cleaning both techniques are used in this system. This system increased the efficiency and life of the solar panel. It removes 90-99% dust from the solar panel surface. This robotic cleaning system has increased power generation capacity of the solar panels.

Keywords: Solar panel, Arduino nano controller, IoT, L293D motor driver, Wi-Fi module

I. INTRODUCTION

Energy is the fundamental requirement for the economic growth of a country. The energy present in many forms in nature but the most significant form is the electrical energy. Electricity has become a very important part of our life because modern society depends on electricity. Since electrical energy generated from the energy available in different forms. All these energy forms are divided into two parts first non- renewable energy sources and second renewable energy sources. Non-renewable energy sources are coal, fuel, nuclear energy, etc. and renewable energy sources such as sun, wind, ocean energy, etc. In the earth total world population is increasing day by day and increasing the uses of electric and electronic devices, electric cars, factories, etc. due to this demand for electrical energy is also increased. Rapid depletion of fuel reserves, ever-increasing energy demand, and consideration over global climate change have encouraged power generation from renewable energy sources. Star electrical phenomenon photovoltaic (PV) and wind have emerged as mostly used energy sources are irregular. Hence, it is difficult to produce stable and continuous power using these power sources. This will be self-addressed by a group of action with energy storage components. The solar insulation and wind rate pattern have a semiconductor diode to analyze their integration to develop the hybrid PV-wind systems making them more beneficial. In order to get the working of multiple renewable sources altogether, the standard approach involves using dedicated single input converters for each of the supply, which is connected to a standard dc-dc bus. However, these converters are not utilized effectively as they are irregular. Multiple power conversion stages help in developing the system. A two- way multiple input non-isolated dc-dc converter is used to interface a capacitor and battery for transport applications. The converter is capable of attraction from multiple energy sources to produce the desired power. However, the energy delivered is not flexible. The parallel or series configuration will be used at the output to derive a multi-port dc-dc converter. The circuit is simple and also the power density is improved. The coupled inductors replace two filter inductors and also the power density is improved. The coupled inductors replace two filter inductors within the bidirectional buck-boost converters and also the isolated electrical device within the full-bridge topology is integrated. Further, the pulse width modulation (PWM) and phase shift management strategy are used to attain voltage regulation inside a precise in operation vary.

II. PROPOSED METHODOLOGY:

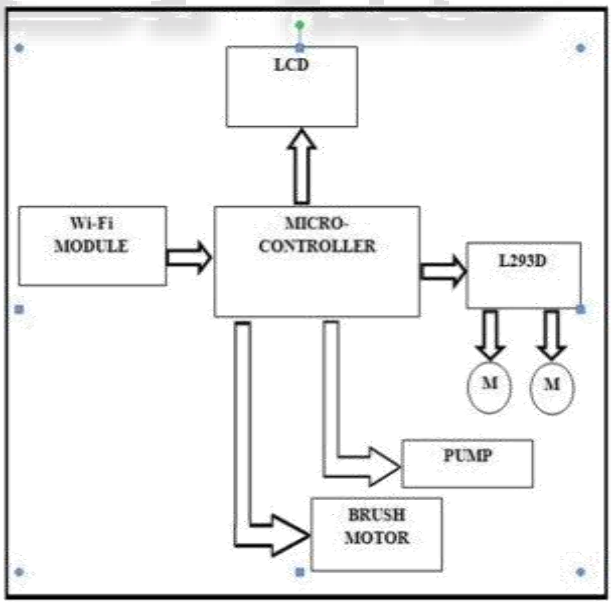

Fig. 2.1: Block diagram of the solar panel cleaning robot using IoT

The cleaning brush is connected with a brush motor and Arduino nano controller because of this the cleaning brush is moved horizontally or vertically on the surface of the PV panel by pushing a button in mobile application and clean the surface of the solar panel. LCD displays the error of the system or gives the indication that reset the system.

Fig. 2.2: Working model of solar panel cleaning robot using IoT

As the accumulation of dust, dirt, snow, bird particles on the surface of the PV panel reduces its transmittance which results in the reduction of the efficiency and power output due to this loss of power generation. The solar panel efficiency reduced 30% when adding in falling leaves and the dust particle reduces its efficiency 7% because of this the life of solar panel is also decreased and resulted in huge losses for the solar power plant operators which suffer from less power output.

In this case the most widely used method of cleaning the surface of the PV panel by manual labor. This method is time-consuming and cumbersome. If the unskilled labor is involved in this process then there is a risk of damage to the expensive PV panel. Many other solar panel cleaning methods are used some are performed manually which takes huge time and human efforts. Some cleaning methods are done by a semi-automatic mechanism. The semi-automatic mechanism takes less time as compared to manually. The purpose of this project is to develop a solar panel cleaning bot using IoT. It is a semi-automatic self-cleaning mechanism for cleaning the surface of the solar panel so that the process can become more fast, reliable, thus increasing the power output, efficiency, and life of the solar power panels and also increase the total power generation of the solar power plant.

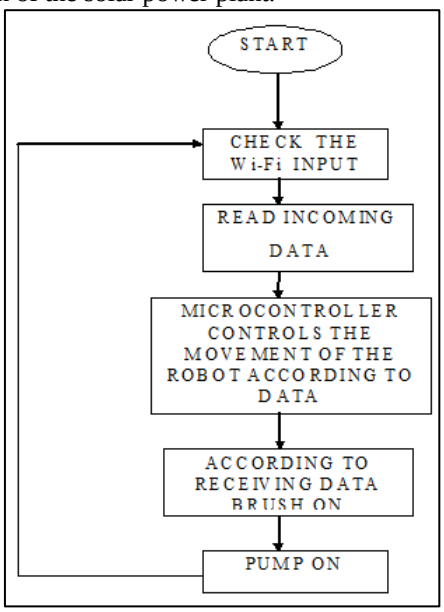

Fig 2.3: Flow chart of System process

The main objective of this paper is the development of a semi-automatic solar panel cleaning robot using IoT techniques which will remove the dust particles on the surface of solar panel and enhance the stability, efficiency, power output and life of solar power plants. Analyzing the operation of solar panel cleaning bot using IoT designing and controlling the system is an important issue. Hence the designing and controlling are also part of this thesis work.

1) Brush: The high standard spherical brush settled into the robot body and made of microfiber. It gives a guarantee that the solar PV panel surface will not be scratched. The main responsibility of the brush is scrubbing and dusting away of the dust accumulated on the solar panel surface The brush is rotated with the help of a 12V brush motor.
2) Arduino: "Arduino" itself is not a specific board type or microcontroller. Rather, Arduino refers to a whole family of boards that have different advantages and disadvantages[34]. Arduino is an open-source microcontroller board developed by Arduino.cc in Italy and based on ATmega328P /Atmega168[21]. While there are many types of Arduino boards on the market such as Arduino Pro Mini, Arduino Mega, Arduino Uno, Arduino YUN, Arduino Lilypad, Leonardo, etc. , there is a handful that is most commonly seen. Arduino is used for constructing and programming of electronic devices.
3) L293D motor driver IC: This is a typical motor driver IC that allows DC motor to drive in either direction. It is a 16 pin IC that can control a set of two motors in any direction. A single L293D IC is capable of running two DC motors at the same time. Also, the direction of these motors can be controlled independently. So if we have motors which have an operating voltage less than 36V and operating current less than 600mA, which are to be controlled by digital circuits such as 555 timers, Op-Amp, digital gate or even micron rollers like Arduino, ARM, etc. this IC will be the right choice for us
4) IoT (Internet of things): has been progressed hugely over the past decade and still, IoT is an arising trend for the industry and academic researchers. So that we can say that IoT is more relevant in today's practical world. Imagine a world where no. of objects can share the information sense and communicate with each other. All these objects are interconnected through public or private internet protocol (IP) network. The internet of things or IoT is a system of interrelated computing devices, mechanical and digital machines, objects, animal or people that are provided with unique identifiers (UIDS) and the ability to transfer data over a network without requiring human to human or human to computer interaction between real or physical and the digital or virtual worlds. It permits people and things to be connected anytime, anyplace with anything and anyone by using any path or network and any service.

III. RESULTS:

When the robot moves on the solar panel surface the direction of the robot displayed on LCD.

Fig. 3.1: Solar panel cleaning robot is in normal condition

Fig. 3.2: System moves in the forward direction on the solar panel

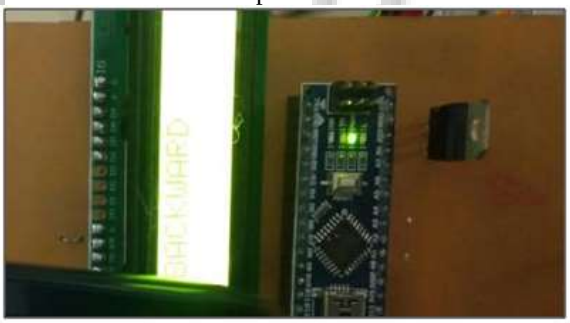

Fig. 3.3: System moves in the backward direction on the solar panel

Fig. 3.4: System moves in the left direction on the solar panel

Fig. 3.5: System moves in the right direction of the solar panel

Fig. 3.6: System movement is stop on the solar panel

The semi-automatic robotic solar panel cleaning system is an innovative technology used to clean the accumulated dust or dirt on the solar panel surface during day or evening time. The dust particles like bird drop, dirt are the reasons for losing power. This system is operated through an IoT controller using a mobile application.

The reduction of output power is reduced after cleaning the solar panel surface by brush or water sprinkle pump. Dry cleaning and wet cleaning both techniques are used in this system. This system increases the efficiency and life of the solar panel. It removes 90-99% of the dust from the solar panel surface.

S.NO.	ADVANTAGE	DISADVANTAGE
1.	This system requires low maintenance and easy to construct.	This system needs to be scaled for a larger project.
2.	It is powered by a rechargeable battery.	It is not powered by a direct PV cell.
3.	This system maximizes the efficiency of the solar panels.	Dust detecting sensors are not used in this project.
4.	Arduino wheel assembly makes that system moves any direction on the solar panel surface.	Less human effort is required.

Table No.3.1 Advantage and Disadvantage of the system

IV. CONCLUSION:

The dust has a major impact on the performance and efficiency of the solar panels. This system removes 90-99% of dust particles from the solar panel also it is operating from anywhere. The device is lightweight because the structure frame is made of alluminium. This robotic cleaning system has increased power generation capacity of the solar panels, low cost, less power uses and easy maintenance are a few advantages of this process. Finally, the losses in the peak power generation can also be reduced by using this

cleaning system. The next focus will be on diversifying the robot's functionality by including self-diagnosing, communication, and auto inspection feature. This project not only focuses on simple cleaning but extra efforts like using a different type of sensors and leads to smart cleaning.

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