Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 7, No.2, July : 2024

SOLAR PANEL CLEANING ROBOT

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Abstract:
About 60% to 70% of the energy demand of the country is met by fuel wood and agriculture residues. Solar energy is a renewable source of energy, which has a great potential and it is radiated by the sun. Renewable energy is important to replace the using of electric energy generated by petroleum. Solar power has become a source of renewable energy and solar energy application should be enhanced. The solar PV modules are generally employed in dusty environments which are the case tropical countries like India. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 50% if the module is not cleaned for a month. The cleaning system has been designed cleans the module by controlling the motorized chain sprocket arrangement. To remove the dust in the PV modules to improving the power efficiency.
IoT-based smart solar panel cleaner is a new sustainable solution for cleaning solar panels and optimizing energy consumption. As solar power continues to grow as a renewable energy source, solar panel maintenance and efficiency have become increasingly important. Dust, debris and other contaminants can accumulate on the solar panel, resulting in reduced efficiency and power.

Keywords:
renewable energy, Internet of Things, sensors.

I. Introduction

Conventional cleaning techniques are costly, time-consuming, and sometimes impracticable, particularly for big solar arrays. This study offers a novel approach to solar panel cleaning with an Internet of things driven by solar energy. The following are the system's primary parts: Solar Vacuum Cleaner Unit: This cleaning device is made up of a brush and a vacuum cleaner that are specifically made to remove dirt and dust off solar panels in a gentle manner without causing any damage to them. Monitoring System for Solar Panels: Solar panel cleanliness and functioning are continually monitored by integrated sensors. For analysis, the data is sent to a central control center. IoT Network: Real-time data interchange and remote control are made possible by the wireless connectivity between the solar vacuum cleaner and central control center. The central control unit processes data from sensors that are being watched over and makes deft judgments. It functions as the body's brain.
It forecasts the best cleaning period for every panel using machine learning techniques. Solar power and batteries: Solar-powered vacuums run on their own energy from the sun. Additionally, a reserve battery is included, ensuring continuous functioning even on overcast days or at night. Because of the sun's tremendous energy output, solar energy is widely available in the natural world. The world's energy needs might be more than met by solar energy if it could all be transformed into useful forms. However, because to atmospheric factors including temperature, dust, and cloud cover, this is not feasible. Solar panels can transform solar energy into more useful energy types. Renewable energy, especially solar energy, which produces power without releasing carbon dioxide into the atmosphere, is gaining attention like never before. Among the several options, the photovoltaic technique for obtaining power from solar radiation is seen to have the most promise for supplying the steadily rising global energy need. Natural circumstances restrict the effectiveness of solar panels; thus, it is crucial to monitor factors like temperature, humidity, and dust. In this context, research has been done to compare

the effectiveness of solar panels with and without dust accumulation on them. The project that was created involves designing and implementing a dust cleaning system that is based on microcontrollers. Fossil fuels continue to be the primary source of power generation in many developed countries. These fuels are highly successful at improving energy quality, but because fossil fuel supplies ultimately run out, they are not suitable for long-term usage. Moreover, fossil fuels represent a significant danger to the equilibrium of the ecosystem can lead to a host of ecological issues, including global warming. As a result, it is imperative to embrace the use of renewable resources as soon as feasible. The endless supply of power produced by renewable sources is a noteworthy characteristic. The environmental impact of renewable electrical energy sources is far lower than that of conventional fossil fuel technology.

Due to the increasing need for renewable energy, solar panel technology is becoming more and more popular as a green means of producing power. China is expected to have 400 GW of solar power by the end of this decade. Based on data from the International Renewable Energy Agency (IRENA), Figure 1 displays the total installed solar capacity in MW between 2012 and 2021.

II. Research & Methodology

- The methodology is divided into three parts.
- The first part is on the design structure, followed by hardware description and the finally
- on the programming design.
- All these three parts were assembled together and experiments were then performed.
- A better method for preserving solar efficiency was sought after by the Solar Panel Cleaning System project.
- The primary goal was to create a machine with an effective control system for
- cleaning solar panels.
- This project is a developed prototype to expand on a new and increasing market.
- This device can be advertised amongst the overall audience as it is very affordable and anybody from distinct backgrounds and tradition can manage to pay for it.

III.Literature Survey

Sr. No.	Paper	Methodology	Remark
1	An experimental study on effect of dust and power loss in solar photovoltaic module, Springer Open.	This study by Ather Hussain et al. analyzes how air dust particles impact photovoltaic (PV) module performance. They examined the composition and topography of dust particles using a scanning electron microscope.	Dust composition & weight impact solar panel power output (studied with rice husk).
2	Impact of dust for solar PV in Indian Scenario	This Research Gate paper by Rashmi Chawla et al. focuses on dust's impact on solar panel efficiency. Dust accumulation varies depending on location, wind direction, panel surface, tilt angle, and exposure time.	Dust impact on solar panels varies depending on location and panel factors.

3	Energy yield loss caused by dust deposition on photovoltaic panels	Arash Sayyah et al. from Boston University discuss dust deposition's impact on energy yield. Soiling reduces energy yield and degrades surface properties, affecting light transmission and reflection.	Dust reduces solar panel efficiency by affecting light & needs cleaning (water with detergent).
4	Effect of dust and methods of cleaning on the performance of solar PV module for different climate regions	Tareq Salmah et al. propose that dust accumulation significantly reduces solar PV performance, potentially decreasing output power by 40%. This research reviews dust deposition processes, influencing factors, and various cleaning techniques.	Dust buildup significantly reduces solar panel output, prompting research for better cleaning methods.
5	Automatic Solar Panel Cleaning System	This source highlights the importance of solar energy and enhancing its applications. Solar panels in dusty environments, like India, collect dust that reduces power generation.	Automatic cleaning systems can address dust issue for solar panels in dusty areas.

IV. RESULTS AND DISCUSSION

- This project presents Solar Panel Cleaning System and it is designed and implemented with ATMEGA 328 Microcontroller in embedded system domain.
- Experimental work has been carried out carefully.
- The result shows that higher efficiency is indeed achieved using the embedded system.
- The proposed system checks for voltage. If Voltage is low then it will start the cleaning mechanism.
- All data taken from the sensors will be stored in cloud and analyzed at regular intervals and notification about the events and the view images captured are uploaded to cloud server.
- The System also displays the message on LCD.

V. Block Diagram

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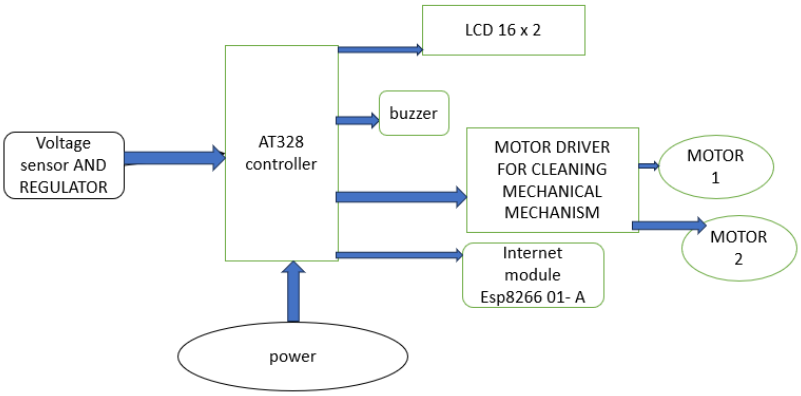

VI. Hardware Requirements:

1) Atmega 328 smd
2) Solar Panel
3) LCD Display
4) IOT Module
5) Buzzer
6) L298N Driver
7) Dc Motor
8) Battery

VII.Component Specifications:

Microcontroller

A microcontroller board based on the ATmega328 is called the Uno with Cable. It contains six analog inputs, a 16 MHz ceramic resonator, a USB port, and 14 digital input/output pins, six of which may be utilized as PWM outputs. ICSP header, reset button, power jack, and connector. It comes with everything needed to support the microcontroller; all you have to do to get it going is use a USB cable to connect it to a computer or an AC-to-DC converter or battery to power it. The future version of Arduino 1.0 will be known by the moniker "Uno," which translates to "one" in Italian. Going future, the Arduino reference versions will be the Uno and version 1.0. The Uno is the most recent in a line of USB Arduino boards and the platform's reference model; view the index of Note: Current versions utilize an ATMega328, although an ATMega8 is depicted in the schematic for
reference. The Uno R3 reference design may use an ATMega8, 168, or 328. Every one of the three processors have the same pin arrangement.

ATMEGA 328:

Microchip makes the high performance, low power ATMEGA328P controller. The ATMEGA328P is an AVR RISC-based 8-bit microcontroller. Because it is incorporated into ARDUINO boards, it is the most widely used AVR controller.

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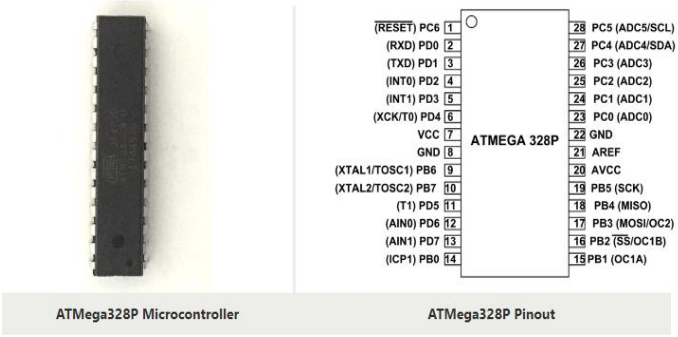

LCD DISPLAY

LCD is an abbreviation for liquid crystal display. This particular type of electronic display module is utilized in a wide range of circuits and gadgets, including TV sets, computers, calculators, mobile phones, and more. Seven segments and multi-segment light-emitting diodes are the major applications for these displays.

The primary advantages of utilizing this module are its low cost, ease of programming, animations, and unrestricted display capabilities for unique characters, special effects, and animations, among other things.

LCD 16×2 Pin Diagram

The 16×2 LCD pinout is shown below.

- Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.
- Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.
- Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.
- Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).
- Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).
- Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.
- Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.
- Pin15 (+ve pin of the LED): This pin is connected to +5V
- Pin 16 (-ve pin of the LED): This pin is connected to GND.

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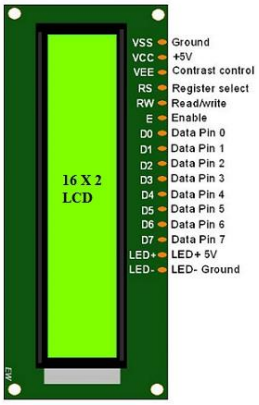

LCD-16×2-pin-diagram

Features of LCD16x2

The features of this LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Is display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters

L293D (MOTOR DRIVER):

This motor driver integrated circuit has the capacity to operate two motors at once. The twin H-bridge motor driver integrated circuit L293D. A single H-bridge may operate a DC motor in both directions. Since the sensor's output cannot power motors on its own, the L293D integrated circuit is utilized to increase current.

DC MOTOR

A device that transforms electrical energy into mechanical energy is an electric motor. Simple electromagnetism underpins the operation of any electric motor. When an external magnetic field is applied to a current-carrying conductor, it produces its own magnetic field and experiences a force that is proportional to both the conductor's current and the intensity of the external magnetic field. Similar polarities (North and South, South and South) repel, whereas opposing polarities (North and South) attract, as you are well know from your childhood experiences with magnets. A DC motor's internal structure is intended to use the magnetic interaction between an external magnetic field and a current-carrying conductor to produce rotational motion.

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BUZZER

A beeper, buzzer, or other auditory signaling device can be mechanical, piezoelectric, or electromechanical in nature. This is mostly used to transform the audio signal to sound. It is often powered by DC voltage and found in computers, printers, alarm clocks. It may produce a variety of sounds, including alarm, music, bell, and siren, according on the varied designs.

Fig. Buzzer

POWER SUPPLY:

The regulated power source provides the circuit's input. The transformer steps down the 230V a.c. input from the mains supply to 12V, which is then sent to a rectifier. A pulsing DC voltage is what the rectifier produces as its output. Therefore, the rectifier's output voltage is sent through a filter to eliminate any remaining a.c components in order to get a pure d.c voltage. To get a pure constant dc voltage, this voltage is now applied to a voltage regulator.

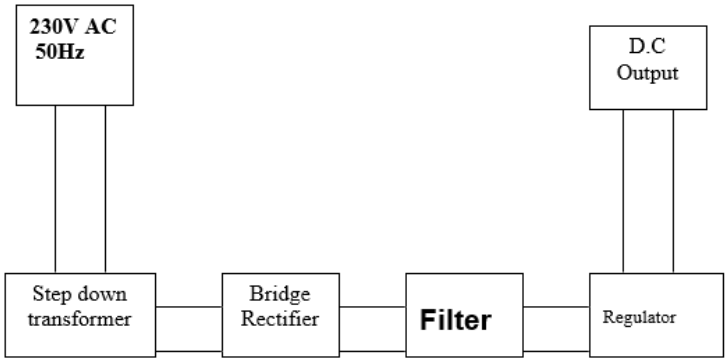

Fig: Power supply

VIII. Flow Chart

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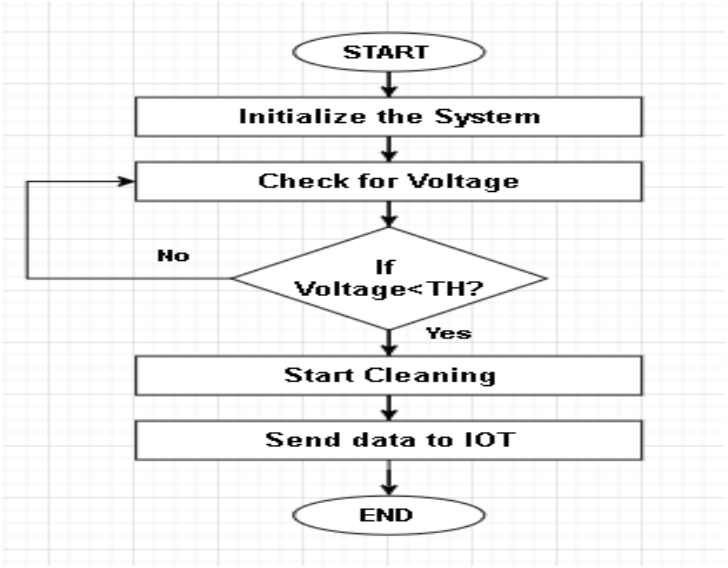

IX. Conclusion:

• The ATMEGA 328 Microcontroller is used in the design and implementation of this embedded system project. Carefully considered experimental work has been done, and the outcome demonstrates that employing an embedded system does, in fact, result in improved efficiency. The primary conclusions may be summed up as follows: At a tilt angle of 35, the fixed solar panel's output power losses amount to around 25% of the rated yield, with the possibility of larger losses contingent upon the type of dust present.

• A hotspot caused by dirt and bird droppings might cause a momentary failure in the panel. Although dry cleaning can only remove the dust's upper layers, it cannot completely remove all of the filth from the solar panel's surface.

• By eliminating the bulk of the dirt that has been accumulated on the panel, cleaning solar panels with water improves cleaning effectiveness. Since the self-cleaning system draws its power from the solar panel's battery, no extra power source is needed. Because it is composed of lightweight material, this gadget uses very little electricity. When comparing the expenses of cleaning by manual and automatic means, it is found that automatic cleaning is more cost-effective and considerably less labor-intensive,especially for systems with a high number of solar panels. Additionally, regular periodic cleaning guarantees that the solar panel maintains a high transmittance at all times. predictions on the appropriate temperature, humidity, and soil moisture levels for optimally managing the development of crops in the future.

Kamlesh Lakhwani et al [33] Researched and analysed have been conducted on the uses of IoT on agricultural and forestry practises. In addition, this article offers a concise introduction to the Internet of Things (IoT) technology, IoT in agriculture, a list of some potential applications domains where IoT is applicable in the agriculture sector, the benefits of IoT in agriculture, and a review of some relevant literature.

K. Lova Raju et al [34] provided an overview of the Internet of Things, as well as agricultural Internet of Things, new wireless technologies of Internet of Things, Internet of Things structures, and Internet of Things applications.

KutilaGunasekera et al [35] offered a description of the design and execution of the Internet of Things solution that focuses on software. The authours give the specifics of the system that was produced, talk about the things that they discovered while working on the project, and also point out the ways in which they want to go on working. Education in agriculture must create experts who are able to take advantage of the possibilities offered by the internet of things (IoT). In order to accomplish this

objective, they are constructing an infrastructure for the internet of things (IoT) to support university education in agriculture and science.

Mahammad Shareef Mekala et al [36] described a (t, n) sensor selection mechanism as well as a soil temperature, humidity, air- but also water-quality measurement (THAM) index for node stipulation, based on a smart decision-making system for such agricultural domain that takes into consideration the temperature quotient, an NPK fertiliser regulatory model, and the agronomy function. This should be done in conjunction with a soil temperature, humidity, air- but also water-quality measurement (THAM) index. The (t, n) node stipulation index determines the ideal number of sensors that should be used to keep an eye on the field. When determining the rate of growth, the temperature quotient takes into account both the temperature and the moisture of the soil. The agronomy function determines the production yield rate of the field by taking into account the pH level of the water and the SO_2 concentration level in the air.

X. Future Scope:

- Wireless transmission: By employing radio frequency to move the tool, which the ATmega328 controls, it is possible to achieve wireless transmission at a lower cost and with less complexity during system maintenance.
- Swapping out the rack and pinion mechanism with a different kind, such as a track system, in larger power plants. Using variable-frequency drive (VFD) interfaces to optimize the system's power use.
- It assists in detecting the quantity of dust on the panel and automatically cleans the module using an LDR sensor.

XI. Acknowledgement:

It is our great pleasure in expressing sincere and deep gratitude towards my guide Mr. Sachin .R. Kokane Electronics & Telecommunication Engineering Department for his/her valuable guidance and constant support throughout this work and help to peruse additional studies in Safety and Maintenance by Implementing the Embedded System.We take this opportunity to thank head of the department Dr.M,P.Sardey and project coordinator Mrs. A. A. Randive and all staff members of department of electronics & Telecommunication Engineering AISSMSIOIT, Pune for cooperation provided by them in many ways. The motivation fact or for this work was the inspiration given by our honorable principal Dr. P.B.Mane. Lastly we are thankful to those who have directly or indirectly supported for our work.

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