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RESEARCH ARTICLE OPEN ACCESS

Design and Development of an IoT Enabled Solar Panel Cleaning Robot

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ABSTRACT:

One of the renewable energy sources, solar energy, has a significant impact on the rise in the demand for electrical energy in our overall economy. Researchers have been researching solar energy resources to increase the efficiency and energy extracted from the sun, control and power electronics, and establish many countries' energy policies based on solar energy. The production of electrical energy extracted from sun rays. Due to environmental conditions, dust is affected the solar panel to reduce the amount of electrical power. The proposed system implements the solar panel cleaning robot. Solar electricity is one of the most effective but pure sources of energy we have access to. There are no increased fuel costs or conditions, no ties to contaminants, and it is trustworthy and affordable. Of course, you need access to specific innovations if you want to control solar-powered energy. This technology depends on small-scale solar photovoltaic (PV) systems; however, the fundamental drawback of PV systems is that dirt and dust buildup on photovoltaic (PV) panels reduces the amount of solar radiation in the cells, lowering overall power output. Cleaning PV panels is a subject of tremendous practical technical importance in producing solar PV electricity, which is why we are tackling it. A challenge of significant practical significance in producing solar PV electricity is cleaning the photovoltaic (PV) panels. We are leveraging the Internet of Things (IoT) to solve this issue and explore dust removal system options. We are creating a straightforward and practical dust-cleaning tool and a cutting-edge IoT-based dust-cleaning system architecture. The primary objective of this system is to develop an IoT-based plan for PV system dust cleaning to preserve the effectiveness of clean PV panels.

INTRODUCTION

Solar energy has gained widespread acceptance worldwide as non-renewable energy sources rapidly deplete themselves, and environmental concerns grow. Solar energy has a tremendous potential of all renewable energy sources because it is so widely accessible. Many scientists studying this area have become interested in its utilization because it is safe and pollution-free for the environment. Many different solar-powered applications can be found on the market nowadays. Due to their reasonable prices and increasing market demand, these solar PV-based devices are becoming more popular. These products are solar heaters, blowers, networking tools, coolers, clocks, lights, and calculators. Shortly, it is anticipated that this usage trend for solar PV cells will continue to grow. It will only be one if only a tiny percentage of this energy is used, especially when other sources around the country are running low. It will be one of the most critical energy sources. The global energy demand is 1013 watts.

It is vital to store this plentiful energy so that it can be used when it is most needed. It is crucial to store solar energy because it is time-dependent due to environmental conditions like cloud formation, rainfall, floods, sandstorms in desert regions, etc. There are various ways to gather and store solar energy, but solar cells and the photovoltaic effect allow for the direct conversion of solar energy into electrical energy. As a result, solar energy is increasingly being used, and PV arrays are installed in significant numbers, but maintaining its efficiency is just as crucial. The biggest issue that limits the use of solar energy is the buildup of dust on PV modules, which lowers the efficiency of solar panels. This study primarily concerns how dirt and dust buildup on PV modules impacts their effectiveness, effective operating methods, design, production, and successful installation. PV modules are hindered by the dirt and layers of dust that has built up on solar panels. Due to the local environment, dust forms with varying particle sizes can be found in other places. However, because solar panels are not always easy to access, cleaning them is not always straightforward. It is unsafe and challenging to reach out there to physically clean solar panels because they

are situated in locations with extreme temperatures, such as desert regions. It also takes time to accomplish it safely. Leaving solar panels up might shorten their lifespan and cause irreparable damage to the glass. Therefore, creating a system that can automatically clean the panel array is preferable.

Figure 1.1 Solar Panel Cleaning Robot

LITERATURE REVIEW

[1] Sharvari Nikesh Ghate et al. (2019) proposed designing and fabricating a solar cleaning system to overcome manual solar cleaning. The author introduces the MCU programmed speed of cleaning process, the mechanisms constructed of aluminum, and consists of a frame attached to a solar panel. The frame is made from hollow rectangular aluminum bars bolted together rather than welded to provide flexibility for altering various components. The built structure does not need an additional railing if the solar panels are tightly spaced apart in the array. If not, a bridge connecting them will be necessary for their operation. For cleaning, solar panel systems need to be strong enough to withstand external forces like wind and gravity and internal forces like motor friction and vibrations.

[2] V. Selvaganesh et al. (2017), A buildup of dust and grit on photovoltaic (PV) panels reduces the amount of solar energy that reaches the cells, lowering their overall power production. Therefore, cleaning PV panels is a significant practical engineering issue for producing solar PV energy. This essay reviews the issue and discusses various dust-removal strategies. In this research, a robot with a microprocessor is suggested to clean solar panels. The robot's initial testing has yielded encouraging results, demonstrating the viability of such a system. Robotic cleaning has been proven to be effective in cleaning PV panels.

[3] Rutvij P. Kulkarni et al, (2018), The dust accumulation on the module's front area obstructs the sun's light source. The module's capacity to produce power is reduced. The power output can decrease by up to 50% if the prototype is not cleaned for a period. To regularly remove the dust, a system has been created that automatically needs to clean the module and identify dust on the solar panel. The DC gear motor is controlled by an ATMEGA 328 microcontroller, which is used to build this automated system.

This device includes a sensor (LDR). At the same time, a device with sliding brushes has been devised for cleaning PV modules. This device consists of a sensor (LDR). At the same time, a device with sliding brushes has been designed for cleaning PV modules. PV panels were attached to roofs and could only detect sunlight from the east or west. However, the PV panel with this technology we developed can detect traveling both north and south and east and west. With the aid of a DC motor, the PV panel rotates 180 degrees while the base of the entire system rotates 360 degrees. PV panel cleaning in Heliotex technology was done by hand.

[4] Mallikarjun G. Hudedmani et al. (2017), the current energy usage scenario demonstrates how quickly fossil fuel stocks are depleting. The energy consumption index, however, reflects a country's progress. The use of renewable, such as solar, wind, and equivalent substitutes, has considerably expanded recently. Inadequate insulation and dust buildup on the panels or shade has been found to lower the solar PV system's conversion efficiency drastically. This section compares various solar panel cleaning techniques focusing on the ground-breaking concept of electrostatic precipitator dust separation (ESP).

Choose electrostatic precipitators to employ static electricity to clear the panel of dust, concentrating energy just where it is needed. This increases the ability of the solar panels to absorb sunlight. When the sensors

provide thorough feedback, the Arduino controller sends the command to remove the dust. The dust weight on the panel is continuously measured by the weight sensor. The dust on the solar panel's surface is charged by elect electrostatic precipitators, which then hurl it in the direction of the electrodes, which resemble electrical terminals.

While the other electrode is given a positive voltage, one electrode is charged to a very high negative voltage. The dust particles are collected by the positively charged electrode. Particles stuck to positively charged plates are frequently evacuated or removed, either manually or mechanically, to keep the panel dust-free.

[5] Md. Rawshan Habib et al. (2021) A solar panel's surface is sensitive to collect dust. As dust builds up, the solar panel's efficiency progressively declines. This work designs and implements an Arduino-based dust-cleaning system for solar panels. The suggested waterless, automated, and economical solar panel cleaner. This method uses a two-step mechanism comprising an exhaust fan that acts as an air blower and a wiper to clear dust from the panel surface. DC motor power moves the wiper. The technique works well in desert areas and avoids water waste by not using water to clean solar panels. According to experimental findings, the suggested cleaning technique can function with an efficiency of 87-96% for various.

[6] Ram Jatan Yadav et al. (2020), Researchers have already suggested numerous techniques to enhance, categorize, and portray the object in an image., These concepts are expanded upon in this new cleaning method for home solar panel systems. The number of projects that clean homes' solar panels are sparse, though. Because cleaning is inconsistent, particularly in places where using rain as a cleaning agent is not the most efficient solution. Continuous operation of solar panels results in dust particles on their surface, which has the effect of reducing their efficiency by 50%. Regular cleanings help to cut down on this soil loss. Numerous research points to the significance of household solar panel cleaning for future generations.

[7] Rafi Zahedi et al, (2018). One option for using PV panels in a cooler environment, increasing efficiency, and lowering the evaporation of water is floating photovoltaic (FPV) systems, also known as PV panel installations on the water surface. FPV systems offer major new opportunities for increasing solar-producing capacity, especially in nations with dense populations, precious lands, high rates of evaporation, and few water resources.

Being a relatively new idea, the cleaning procedures for the FPV system have not been widely investigated. Even when FPV systems are situated close to water sources and reservoirs, the water quality may make it impossible to employ various cleaning methods. In this essay, various FPV system cleaning methods are examined and divided into water-based and water-free methods. Their financial aspects and cleaning cycles are also covered.

[8] Swapnil Aher et al, (2018). Solar energy use could be quite advantageous in India's current period of electricity deficit. Due to this, photovoltaic (PV) systems are becoming increasingly numerous, impacting investment amounts, associated opportunities, and hazards. The productivity of solar energy must be increased by maximizing the efficiency of solar array systems. Both the maximum light intensity on the panel surface and the presence of dust have been considered concerning assessing PV panels' efficiency. The effects of light intensity and dust on the effectiveness of PV panels have mostly been studied.

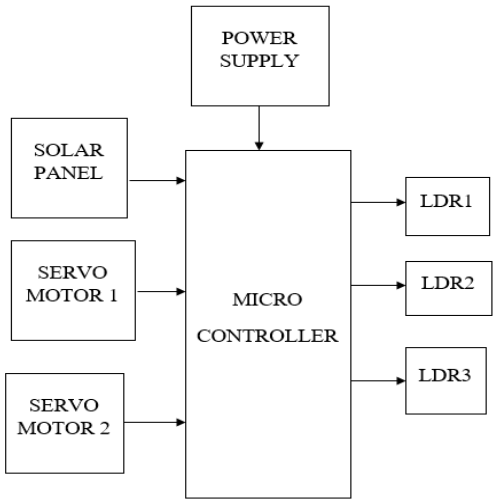
[9] Abhishek Naik et al. (2019). Typically, solar PV modules are used in dusty environments like those in the tropical Southeast. The dust buildup on the module's front surface blocks the sun's incident light. The module's ability to generate energy is diminished. If the module is not cleaned for a month, the power output can drop by up to 50%. A technique that can detect dust on the solar panel and automatically clean the module has been developed to remove the dust periodically. When it comes to generating energy regularly, the automatic cleaning system demonstrated generates around 30% more power than a PV module that has accumulated dust.

[10] Deepak Kute et al, (2019). Photovoltaic (PV) panels' overall power production decreases due to dust and dirt build-up because less. Cells receive sun energy. Therefore, maintaining the PV panels is a significant practical engineering challenge for the

generation of solar PV energy. The problem is evaluated, and dust-reducing methods are presented in this study. This project intends to clean the solar panel and boost its effectiveness using an electromechanical mechanism created on Arduino.

EXISTING SYSTEM

3.1 SYSTEM BLOCK DIAGRAM OF CURRENT SYSTEM



3.2 EXPLANATION OF THE EXISTING SYSTEM

The Sun tracking solar panel is made up of two LDRs, a solar panel, a stepper motor, and a CPU. Two light-dependent resistors are placed on the solar panel's edges in a row. Light-dependent resistors don't create much impedance when confronted with light. The stepper motor linked to the panel causes it to rotate in the position of the Sun. The panel is set up to contrast the illumination from two LDRs. The LDR that is generating the brighter, lower resistance light is then turned in that direction.

A stepper motor rotates the panel at a particular angle. When the right LDR's brightness is larger than the left LDR's, the board gradually travels to the right, and when the left LDR's intelligence is greater than the right, it gradually goes to the left. The brightness of both panels is identical when the Sun is overhead at noon. In this case, the conversation is static rather than spinning.

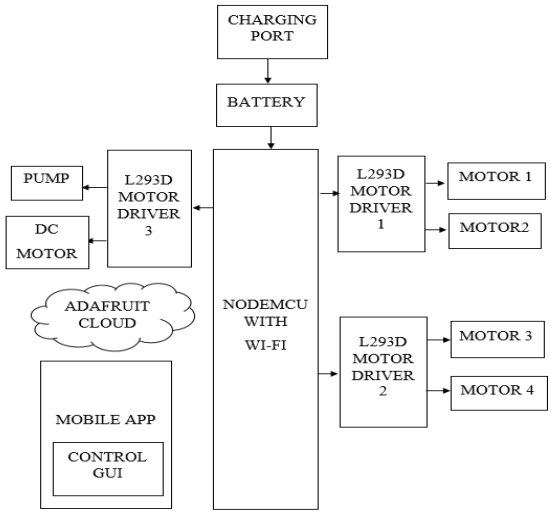
An illustration of the prototype cleaning and monitoring system for solar panels for greater output efficiency in this prototype, there are two DC motors: one rotates at 1000 revolutions per minute (rpm) for cleaning, and the other revolves at 10 rpm for tracking panel's collected dust particles are

3.3 PROBLEM STATEMENT

Due to the more sophisticated technology and moving components required for their operation, solar trackers cost a bit more than their stationary counterparts. Despite reliability improvements, solar trackers still require more maintenance than conventional fixed racks, albeit the solar tracker's quality can affect how much and how frequently this maintenance is required. These dc motors are under the microcontroller's control. A 1000 rpm DC motor is connected to the threaded rod and is used for cleaning. When the motor advances, the threaded rod turns, which causes the wiper that is attached to the road to decelerate. The wiper rises upward as the threaded rod circles when the motor moves the other way.

PROPOSED SYSTEM

4.1 BLOCK DIAGRAM PROPOSED SYSTEM



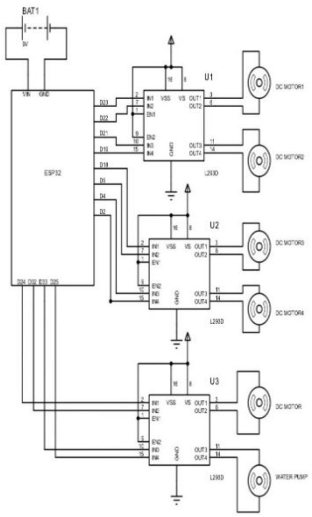
4.2 EXPLANATION OF THE PROPOSED SYSTEM

A cleaning robot is a mechanical system that synergistically integrates mechanical systems to clean solar panels. One of the world's most innovative and well-known products for robotic solar panel cleaning systems. PV module cleaning involves using a cleaning robot, which is expensive. This robot uses intelligent technology, such as a mobile application and data-

driven programming, to perform the cleaning task. A base circuit-controlled automatic drive system that works with the solar panels' length and uses switches to turn on the cleaning system for them. As a result, it helps solar panels return to being as effective as they were at generating solar electricity for usage at work. Three motor drivers, five motors, a relay, a pump, and Internet of Things apps make up the solar panel cleaning robot.

Motor driver1 control the two motors (i.e., motor1and motor2), motor Driver 2 contains the two motor (Motor3 and Motor4), and motor driver controls motor 5 and the pump. During the operation, the commands through by mobile application move the robot in directions such as forward, reverse, left and right. The purpose of the pump is to spray the water and DC motor to clean the solar panel. The nodemcu controls all processes and information through Wi-Fi. The Ad fruit io receives the commands and transmits them to the chain robot.

4.3 CIRCUIT DIAGRAM FOR SOLAR PANEL CLEANING ROBOT

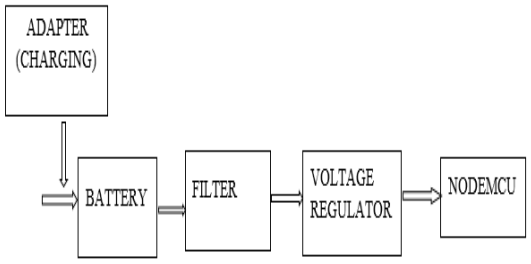


HARDWARE DESCRIPTION

5.1 POWER SUPPLY

Rechargeable batteries, storage batteries, secondary cells, or accumulators are types of electrical batteries that may be charged, discharged into a load, and recharged repeatedly, as opposed to main or disposable batteries that are provided fully charged and are disposed of after usage.

5.1.1 POWER SUPPLY BLOCK



5.1.2 VOLTAGE REGULATOR

A voltage regulator is a device designed to automatically maintain a constant voltage. A voltage regulator may have a simple feed-forward design or negative feedback. It could employ an electromechanical mechanism or electrical components.

Figure 5.1 Voltage Regulator

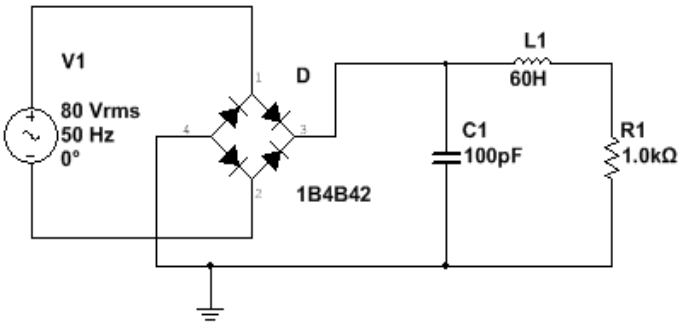


Figure 5.2 Schematic Diagram of Voltage Regulator

5.1.3 JUMPER WIRES

To evaluate circuit problems or replace the circuits, jumper wires transport electricity between two places in a challenging course.

Figure 5.3 Jumper wire

5.2 SOLAR PANEL

Figure 5.4 Solar panel

Solar energy can be generated by the sun. Solar panels, commonly called "PV panels," absorb the sun's light, made up of tiny energy particles known as "photons," to create electricity that may be used to run electronic devices.

In addition to producing electricity for domestic and commercial solar electric systems, solar panels can also be utilized for remote power systems for apartments, network equipment, satellite communications, and other objectives.

5.2.1 Working of solar panel

With the help of an inverter, solar panel arrays may be designed to meet even the most demanding electrical load requirements. The AC can be used to power loads in residential or commercial buildings, mobile homes and boats, distant cabins, cottages, and homes, remote traffic control devices, communication devices, oil and gas flow monitoring, RTU, SCADA, and many other things. A common motor driver, also known as a motor driver electrical device (IC), the L293D enables DC motors to run in either direction. Users may use the 16-pin IC L293D to simultaneously control two DC motors. Therefore, a single L293D IC is capable of managing two DC motors.

Sunlight from solar panels is captured as clean, renewable energy and transformed into electricity, which is then used to power electrical loads. The individual solar cells that make up solar panels are made of layers of silicon, phosphorous (which gives the negative charge), and boron (which provides the positive control). Photons are absorbed by solar panels, which then start an electric current. Electrons can be thrown out of their atomic orbits and released into the solar cells' electric field, which pulls these liberated electrons into a directed current. This process is made possible by the energy produced when photons strike the surface of the solar panel.

The entire procedure is known as the photovoltaic effect. A normal home has more than enough roof space for the necessary amount of solar panels, which could then produce enough solar electricity to completely power the residence. Any extra energy generated is sent to the main power system, which helps with electricity usage at nighttime.

A well-balanced solar array connected to the grid generates electricity during the day that the home consumes at night. If a power bank produces more energy than is needed for a residence, the owner may be compensated through net metering schemes.

In most cases, inverters, battery banks, and charge controllers are necessary components for off-grid solar setups. The voltage regulator transmits direct current (DC) power from the solar array to the battery bank. Power is then obtained from the battery bank after the inverter converts the direct current (DC) into alternating current (AC), which may be used for devices that do not function on DC.

5.3 MOTOR DRIVER (L293D)

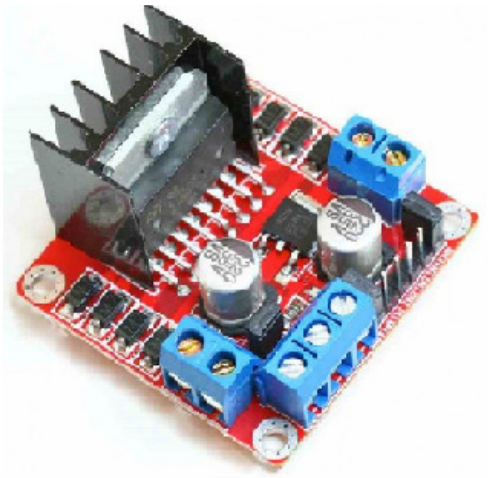


Figure 5.5 Motor driver module

5.3.1 Working of motor driver

The H-bridge idea underlies how it works. A voltage may go in either direction thanks to a circuit design known as an H-bridge. Since voltage must change its direction to rotate a DC motor correctly or anti - clockwise direction, an H-bridge IC is ideal for this task.

A single L293D chip contains two h-Bridge circuits that may independently rotate two dc motors. It is increasingly utilized in robotic applications to operate DC motors due to its size.

5.3.2 Pin diagram of L293D

According to the pin diagram, the l293d has 4 input pins: pins 2, 7, which are on the left, and pins 15, which are on the right. Right input for the motor on the right-hand side and left input for the motor connected across the left will control rotation, respectively. The inputs sent across the input pins as LOGIC 0 or LOGIC 1 are used to rotate the motors.

To rotate the motor, you must provide Logic 0 or 1 across the input pins.

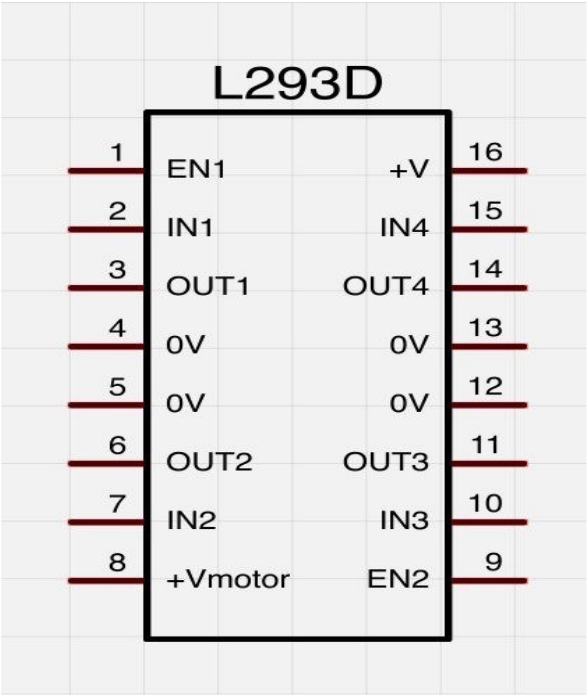


Figure 5.6 Pin description of the L293D module

5.4 WATER PUMP (12V DC)

Figure 5.7 Water pump

Micro Submersible Pump DC 3-12V DIY project: Mini water pump for a water feature in the garden. This compact, inexpensive submersible pump motor can be powered by a 3 to 6 V power source. It can use up to 120 litres per hour and only use 220 mA of current. You only need to attach a tube pipe to the motor output, submerge it in water, and then power it. Make sure the motor is never submerged beneath the water. A dry run will make noise and could heat-relatedly damage the engine.

5.4.1 Working principle

The definition of a water pump is a pump that combines both mechanical and hydraulic principles to move water through a piping system while producing enough force for subsequent usage. Because of early civilization, they have existed in one structure or another. These pumps are currently used for various residential, agricultural, governmental, and industrial purposes.

The definition of a water pump is a pump that combines both mechanical and hydraulic principles to move water through a piping system while producing enough force for subsequent usage. They have existed roughly in one structure or another since the dawn of civilization.

5.5 DC GEAR MOTOR

A DC motor is an electrical machine that converts electrical energy into mechanical energy. In a DC motor, the input electrical energy is the direct current transformed into automatic rotation.

Figure 5.8 DC Gear motor

When exposed to a magnetic field, a current-carrying conductor suffers a torque and an inclination to move. In other words, a mechanical force is created when an electric field and a magnetic field interact. Based on this theory, a DC motor, also known as a direct current motor, operates.

5.5.1 Principle of Motor

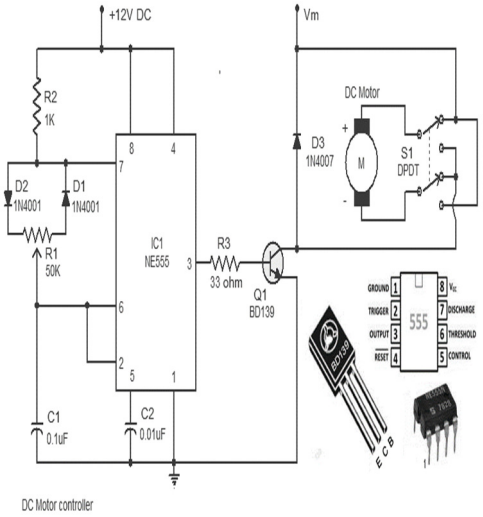


Figure 5.9 Circuit diagram of DC motor

When the coils are turned on and off in sequence, a rotating magnetic field is created that interacts with the different areas of the stationary magnets in the stator to create torque, which causes it to rotate.

5.6 LITHIUM-ION BATTERY

In contrast to other battery chemistries, lithium batteries stand out due to their high energy density and low cost per cycle. However, the term "lithium battery" is ambiguous. There are six widely used lithium battery chemistries, each of which has unique advantages and disadvantages.

The most prevalent substance utilized in applications for renewable energy is lithium iron phosphate (LiFePO4). High current ratings, extended cycle lives, excellent thermal stability, and abuse tolerance all contribute to the chemistry's high level of protection.

Figure 5.10 Lithium Iron Battery

Compared to practically all other lithium chemistries, lithium iron phosphate (LiFePO4) is the most stable form of lithium. A naturally safe cathode material is used to assemble the battery (iron phosphate).

Compared to other lithium chemistries, iron phosphate encourages a strong molecular connection that can tolerate high charging temperatures, extend cycle life, and retain chemical integrity over numerous cycles.

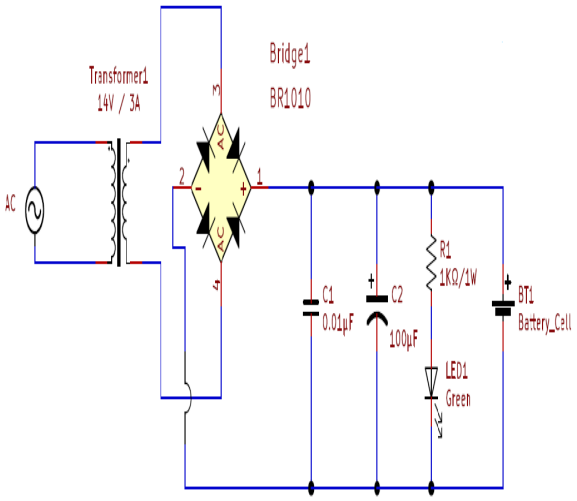


Figure 5.11 Circuit diagram of battery

IOT (INTERNET OF THINGS)

6.1 INTRODUCTION

The IoT is a network of connected computing devices, mechanical and digital machinery, items, animals, or people that may exchange data across a network without requiring human-to-human or human-to-computer interaction.

6.1.1 Working of IOT

Despite the fact that users can interact with the devices to set them up, give them commands, or get data, the devices handle the majority of the work without their assistance.

Web-enabled intelligent devices that use network applications, such as processing units, sensors, and telecommunications equipment, to gather, send, and respond to the information they receive from their surroundings make up the Internet of Things (IoT) environment.

By connecting to an Access point or other edge device, which either evaluates personal data or transmits it to the cloud to be analyzed IoT devices communicate the sensor information they gather. These gadgets converse with other similar devices on occasion, acting on the information they exchange.

6.1.2 Important of IoT

People that use the internet of things can lead more intelligent lives, do jobs more effectively, and have complete control over their destinies. In addition to offering intelligent compatible smart home devices, IoT is essential to business.

IoT enables businesses to monitor the performance of their systems in real time and receives insights into everything from equipment performance to supply chain and logistics operations.

6.1.3 Benefits of IOT:

- Save time and money
- Information can access from anywhere at any time
- Improved communication
- Transferring the data packets
- Improve the quality of business service

6.1.4 Application of IOT

- Connected vehicles
- Traffic management
- Smart grids
- Environmental monitoring
- Intelligent homes/smart buildings
- Smart cities
- Industrial, agricultural and commercial management

6.2 NODE MCU ESP 8266 WIFI MODULE (IOT HARDWARE)

The ESP8266 Node MCU CP2102 board contains the well-integrated ESP8266 chip, which was developed to meet the needs of a newly linked world. Thanks to its complete and independent Wi-Fi networking solution, it can either host the application or assign all Wi-Fi networking responsibilities to another application processor.

Figure 6.1 Nodemcu with wifi module

The ESP8266 can be connected to sensors and other application-specific devices through its Operating system with little to no setup required and with minimal runtime impact on its strong internal processing and storage resources. It only needs a tiny amount of external circuitry because to its high level of on-chip integration, and the complete solution—including the front-end module—is designed to occupy a modest amount of PCB space.

The ESP8266 Node-MCU development board is a great plug-and-play choice for low-cost Wi-Fi applications. The breadboard-friendly ESP-12 Lua Node-MCU WI-FI Board Internet of Things board comes with a full ESP8266 Wi-Fi module with all the Outputs isolated, a full USB-serial connection, and a power source.

The module has a pre-flashed Node-MCU code. This board features a multi-with with Node-MCU, firmware for the ESP8266 that is based on Lua and offers simple control using that interface. The ESP-12 Lua Node MCU WI-FI Board Information technology with ESP8266 is an all-in-one controlling Wi-Fi architecture that makes it simple to construct solutions with Wi-Fi and IoT (Internet of Things) solutions.

6.2.1 ESP8266 NODEMCU PIN CONFIGURATION

The ESP8266 NodeMCU has 30 pins that interface it to the outside world.

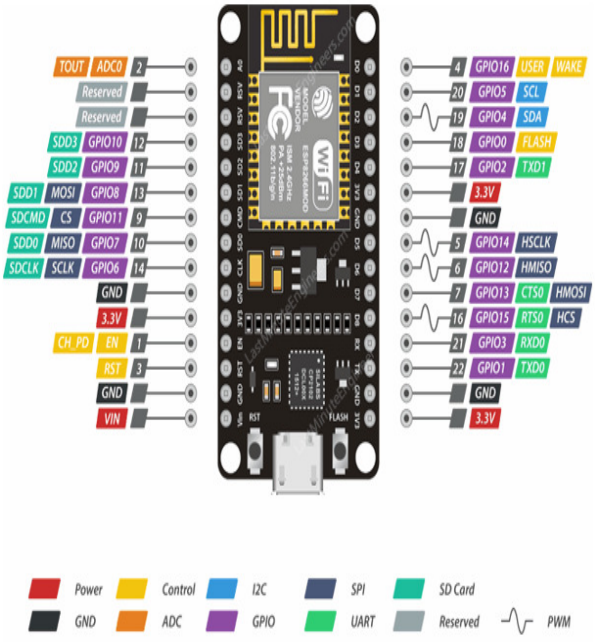


Figure 6.2 Pin configuration of NODE-MCU

Power pins:

One VIN pin and three 3.3V pins make up the four power pins. If you have a consistent 5V voltage supply, the ESP8266 and its accessories can be powered straight from the VIN pin. The output of an inbuilt voltage regulator is connected to the 3.3V pins. These pins are suitable for external component power.

GND pins

It is a ground pin on the development board for the ESP8266 Node MCU.

Pins I2C

I2C pins in your software can be used to connect numerous I2C sensors and devices. Both the I2C Enslaver and Slave protocols are supported. The I2C interface's maximum clock frequency is 100 kHz, and it can be implemented programmatically. It should be remembered that the I2C clock frequency should be greater than the slave device's slowest system clock.

GPIO Pins

The ESP8266 Node-17 MCU's GPIO pins can be flexibly assigned to a number of functions, including I2C, I2S, UART, PWM, IR remote control, LED light, and buttons. A GPIO's internal pull-up or pushes, low impedance, or both can be selected for each one that has digital capabilities. When configured as an input, it can also be set to edge-trigger or level-trigger in order to generate CPU interruption.

ADC Channel

The Node-MCU has a 10-bit precision SAR ADC. Both assessing the input voltage at the TOUT pin and the power supply voltage at the VDD3P3 pin may be done using an ADC. However, they cannot be applied concurrently**.**

UART Pins

The ESP8266 Node-MCU has two UART terminals, UART0 and UART1, which support asynchronous (RS232 and RS485) communication and have a maximum data rate of 4.5 Mbps. Users can communicate with UART0 by using the TXD0, RXD0, RST0, and CTS0 pins. It encourages flexible control. It is usually used to display logs since UART1 (TXD1 pin) only carries data transmitted in the signal.

SPI Pins

SPI and HSPI are supported by the ESP8266 in both master and enslaved person modes. Additionally, these SPIs have the following all-purpose SPI functionality:

The SPI format has four different transfer time modes.

• Up to 64-byte FIFOs and divided clocks of up to 80 MHz.

SDIO Pins.

The ESP8266's Secure Digital Input/ Output Connect (SDIO) functionality is employed to directly connect SD cards. It supports both the 4-bit 50 MHz and 4-bit 25 MHz SDIO variants.

Pins PWM

Four pulse width modulation channels are included on the PCB (PWM). Digital motors and LEDs can be powered by PWM outputs that have been programmed into a system. Programmable PWM frequency ranges extend from 100 Hz to 1 kHz, or 1000 s to 10000 s.

C ESP8266 is managed through control pins. The WAKE pin, Chip Enable pin (EN), and Reset pin are some of these pins (RST).

EN pin: The ESP8266 chip is switched on when the EN pin is pushed HIGH. When pushed LOW, the semiconductor requires hardly any power.

RST pin — The RST pin is used to reset the ESP8266 chip.

WAKE pin — The wake pin is used to jolt the chip out of deep slumber, Control Pins

SOFTWARE DESCRIPTION

7. ADAFRUIT IO.

ADAFRUIT IO developed the Ada fruit IO platform to display, respond to, and engage with the data from your project. Ada Fruit also keeps your data secure and confidential (data feeds are private by default) (ADAFRUIT will never sell or give this data away to another company).

7.1.1 Use with apple IO

Using our IoT platform, the esp32-s2 from ADAFRUIT IO is an affordable, all-in-one option for integrating your ideas to the internet.

For further information and instructions, see the ADAFRUIT IO basics series.

Create libraries. In the Arduino IDE, go to sketch > include library > manage libraries. Type Ada fruit IO Arduino into the search function and choose to install on the Ada fruit IO Arduino library selection to install version 4.0.0 or a later edition.

7.1.2 SETUP FOR ADAFRUIT IO

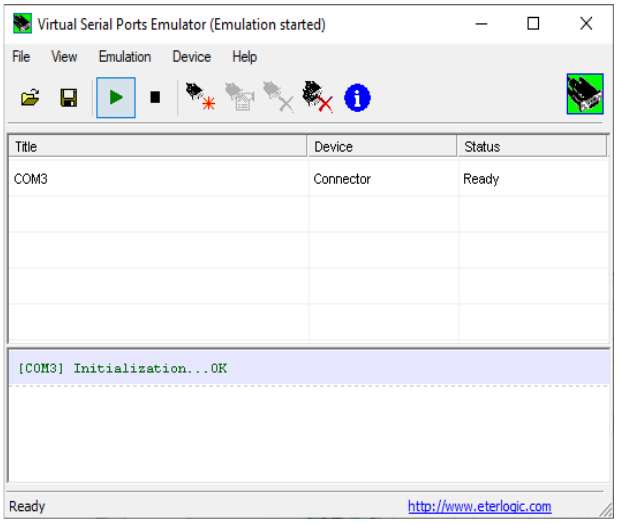
If you don't already have an account, sign up for one right now at Adafruit.io. Next, navigate to the Ada fruit IO displays site.

- To observe and interact with the data exchanged between two of your esp32-s2 board and Ada fruit IO, we'll develop a dashboard.
- To access the new dashboard, flip the switch.
- My esp32-s2 is the name of the dashboard.
- Your new dashboard should appear on the list.
- To view your brand-new dashboard, click the link.
- From Ada fruit io, we'll want to switch the board's LED on or off. We must have a switch on our monitor in order to do this.
- On your dashboard, click the cog in the top right corner.
- Select Create New Block from the Dashboard Settings dropdown menu.
- Choose the switch block.
- Enter lead as the feed name under my feeds. select "create"
- To connect the toggle block to the led feed, select it. Next is selected by clicking.

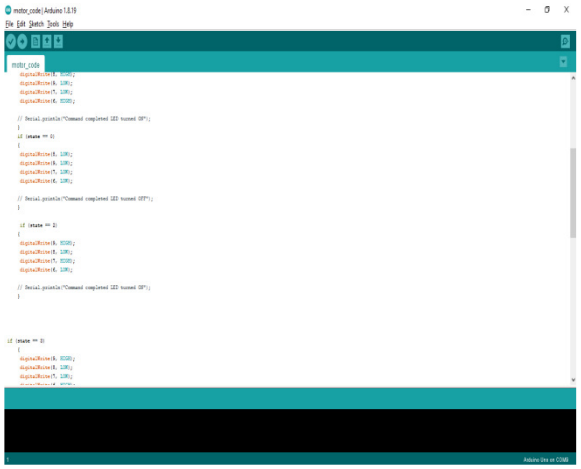
Change the button on the text to 1 and the reader to 0, then click the Create Block button under Block Settings.

RESULTS

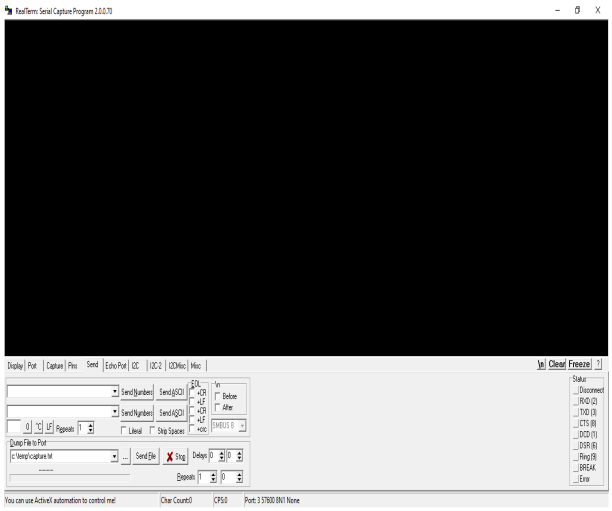
Com port connecting software



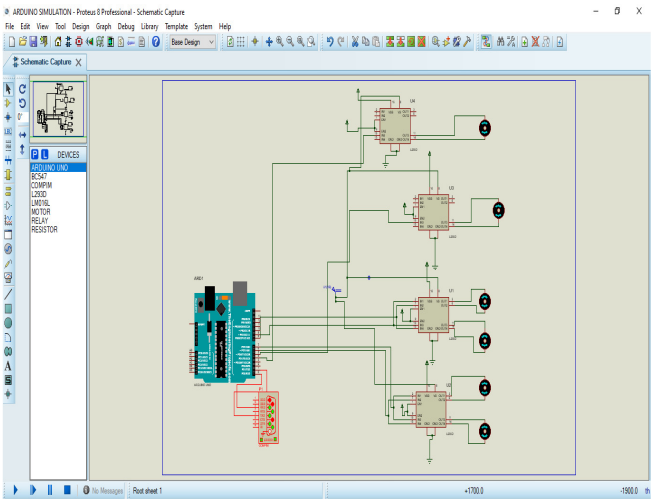
Arduino programming Software



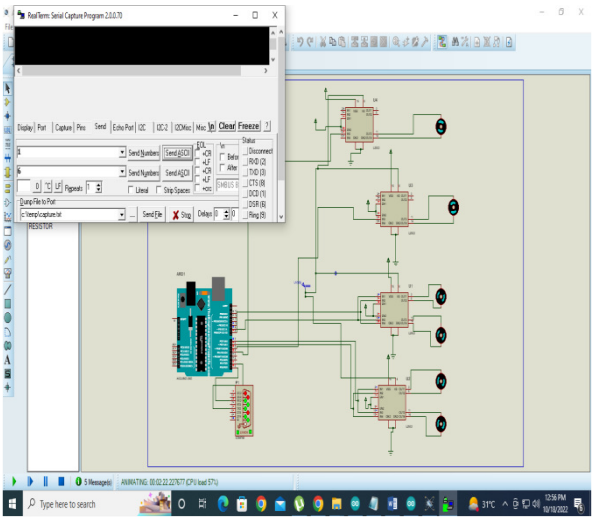
SERIAL PORT INPUT VALUE SOFTWARE

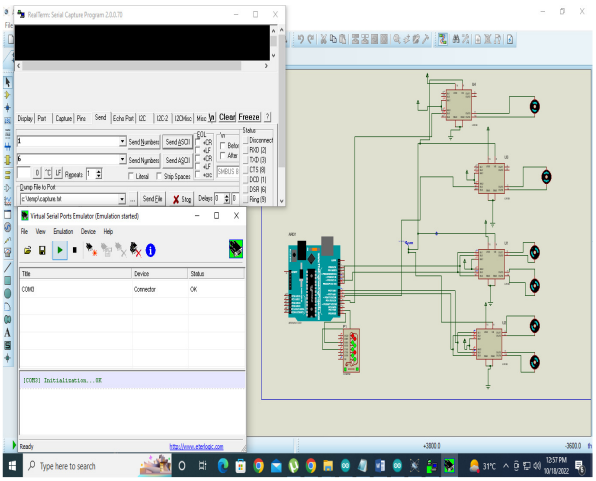


SIMULATION OUTPUT SOFTWARE



Output





CONCLUSION

People developed a system to deal with the following problems that appear after installing solar panels: decreased power from dust accumulation; lower cost for overall solar panel cleaning; avoidance of manual work for cleaning, which invariably causes physical harm; and shorter cleaning times. To simplify the working mechanism and make it a mechanical device rather than an electronic one, a novel technique for cleaning solar panels is being developed using a lead screw as the working mechanism.

Humans can retain efficiency without compromising the solar panel's effectiveness by automating the cleaning process. Dust must be regularly removed to ensure the solar panel operates at its peak efficiency. The solar panel cleaning system was first built, considering the design criteria. The evaluation of our model led to the following conclusions. Power loss was caused by dust accumulation on the panels, which may be fixed by implementing.

By automating the cleaning procedure, manufacturers can maintain efficiency without sacrificing the solar panel's efficacy. The solar panel must be frequently cleaned to maintain maximum performance. The original solar panel cleaning system was constructed with the design objectives in mind. The analysis of our model produced the following findings. Dust buildup on the panels caused power loss, which may be remedied by following.

Robotized cleaning methods. As an outcome, the solar panels' capacity to produce energy has increased. This method has a few benefits, including simple maintenance, low cost, and minimal power use. Using this methodology may also lessen the fall in peak power generation. Because of its numerous uses and heterogeneous mix of multiple communications and embedded technologies in its design, the Internet of Things is a fresh Internet revolution and a crucial study area for academics in integrated computer science and information technology. They all expect to offer this process a new dimension and usher in the concept of anytime, anywhere, any media, anything for communications by allowing communication with and among intelligent gadgets.

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