

Solar Panel Automatic Cleaning System

**A Project submitted in partial fulfillment of the requirements for the
Award of Degree of
Bachelor of Science in Electrical and Electronic Engineering**

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Certification

This is to certify that this project entitled “**Solar Panel Automatic Cleaning System**” is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on 30 December 2018.

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ABSTRACT

The aim of this paper is to give an innovative concept to handle energy demand around the world is increasing rapidly for many applications. Renewable sources of energy are solar, wind and geothermal which are inexhaustible. Solar energy is abundant in nature and is proving its existence for many applications like street lighting, house hold appliances, water heating, agricultural and industrial purpose. One of the way to harness solar energy is done by using solar panels. Limitation of solar energy is its efficiency for any application due to the factors like dust, humidity, temperature etc. Electrical parameters of solar panel are sensitive to accumulated dust density and will affect the transmittance of the solar panel thereby reduce its efficiency. In order to overcome this problem, it is necessary to clean the solar panels regularly. One of the method is to increase the efficiency of solar panel is by removing the dust accumulated on solar panel. Cleaning of solar panels is difficult task. The normal way to clean the solar panels is washing them manually but it is not reliable and economical. In this regard a work is taken up to design and implement the automatic dust cleaning mechanism for solar panel. The designed automatic cleaning mechanism consists of IR LED, Photo diode arrangement in order to sense the dust accumulated on solar panel. The efficiency of solar panel is determined by taking the readings of voltage and current of particular panel with and without dust for various days, weeks and months. By the recorded values efficiency comparison of solar panel with dust and without dust is made. The designed automatic cleaning system produces an effective, non-abrasive cleaning and avoids irregularities in the generation of power due to the deposition of dust on the solar panel. From the study it is proved that average efficiency of solar panel increases about 1.6% to 2.2% by regular cleaning. Thus developed model maximizes the efficiency.

CHAPTER 1

INTRODUCTION

1.1 Introduction

It's urgent to improve the solar power generation efficiency. In our region, when unwanted obstruction cover the panel surface, those solar panel take a major power loss. Due to this reason we experimented a self-cleaning solar panel. This cleaning system automatically clear the obstruction. It makes the decision from Arduino to clean the solar panel for a certain period. Our mechanism is reliable and easy to use.

1.2 Importance

When more light hits a solar panel that generate more power. Due to angle of upwards solar panel, it's more prone to bird dropping and general dust and dirt. For regional location solar panel covered with air dust when it's unclear for a long period. This reduce amount of hitting light in panels that is in panels that is reduce our output power. So it's important to clean order to project and maintain our investment.

1.3 Objective

1.3.1 Project Goals

- To design a mechanism which will detect obstruction on solar panel that causing significant power loss.
- To design a mechanism of cleaning that runs across the length of the solar panels.
- To improve solar panel overall efficiency.

1.3.2 Features

- This cleaning system require only one-time installation.
- It has effective wiping system.
- The wipers are easily replaceable.

1.4 Overall System Description

1.4.1 Arduino

Arduino an open source electronics based on easy to use hardware and software. It's able to read inputs such as light on a sensor, finger on button or a twitter message and turn it to output such as activating motor, LED or something online.

Arduino has been used in many different project and application because Arduino software easy to use and it runs on all computer operating system, it's also inexpensive and simple.

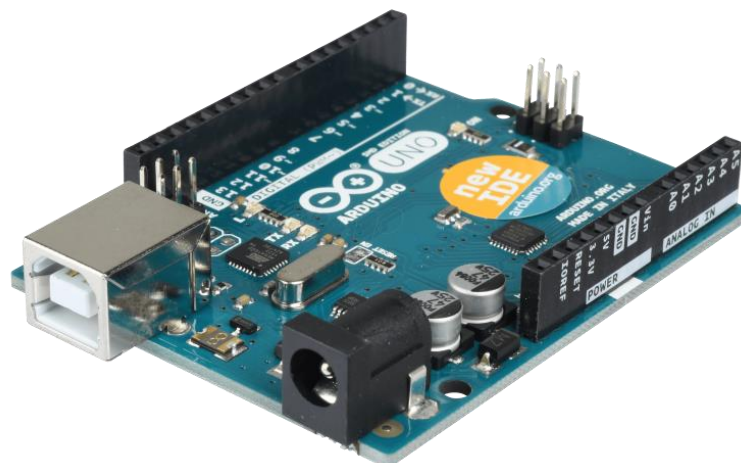


Figure 1.1: Arduino

1.4.2 Power Supply

Power supply is an electrical equipment that supplies power to an electrical load. The primary function of power supply is convert from a source. Sometimes it's referred to converters mean AC to DC.

1.4.3 PV Panel

Photo voltaic solar panels store sunlight as a source of energy. A PV module generally connected 6×10 photovoltaic solar cells. Each module gives DC output.

1.4.4 Motor Controller

A device that distribute to control in some predetermined behavior of an electric motor is called a motor controller. It can control manually or automatically selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overload and fault.

1.4.5 Cleaning Mechanism

The Cleaning Mechanism consists of a wiper, and a nominal 12V DC gear motor. These are the physical components that clean the panel.

1.5 Methodology

In this system the user will have to set a time. The time can be 24 hours or more or less which depends on users. The information will stored in Arduino. The system will automatically clean the solar panel according to the stored information in a continuous basis.

CHAPTER 2

COMPONENT DESCRIPTION

2.1 Introduction

System hardware design composed of Arduino UNO, Transformer, Relay module, DC Gear motor, Capacitor, Diode, Iron Frame, Wiper, Solar Panel, PCB Board, Jumper Wire and etc.

2.2 Basic Description of Controller Unit

In the controller unit, we are using Arduino hardware board with AVR microcontroller. With the help of Arduino 1.6.8 software plate we can easily program our requirement. Arduino is an open source electronics prototyping platform based on flexible, easy to use software and hardware. The microcontroller on the board is programmed using the Arduino programming language (based on Writing) and the Arduino development environment (based on Processing)

The Arduino UNO is a microcontroller board based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, an ICSP header and a reset button. It contains everything needed to support the microcontroller, simply connect it to a computer with a USB cable or power it with AC to DC adapter or battery to get started.

2.2.1 Description of Arduino UNO

The Arduino UNO is a microcontroller board based on the ATmega328. It's Fourteen(14) digital input or output pins, number of analog input is 6 with 16 MHz ceramic resonator, An USB, ICSP and reset button. Everything is important to control the microcontroller. Connect it with a computer via USB cable or AC to DC adapter to start. The UNO differs from all preceding boards in that it does not use the FTDI USB to serial driver chip. Instead, it features the ATmega16U2 programmed as a USB to serial converter.

Revision 2 of the UNO board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

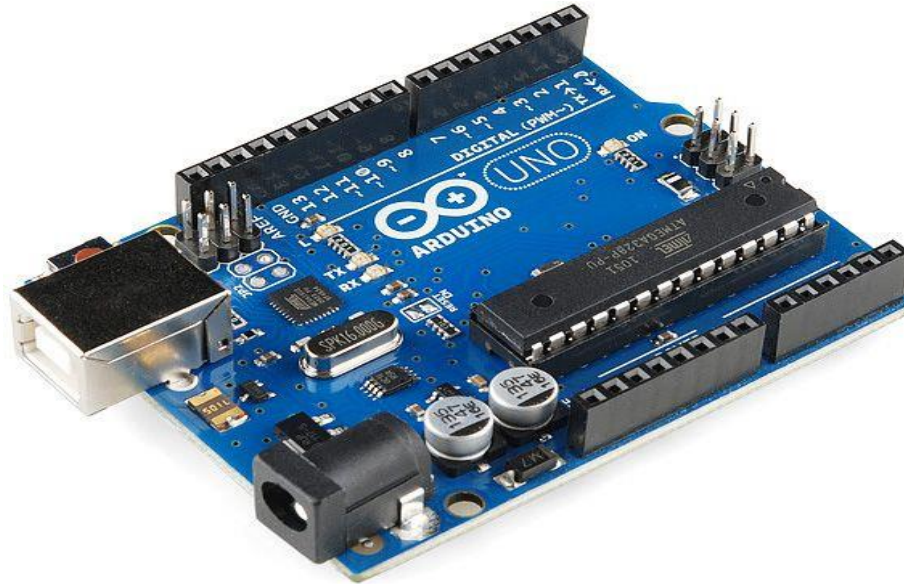


Figure 2.1: Arduino UNO ATmega328

Revision 3 of the board has the following new features:

- * 1.0 pin out: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that follow the shields to adapt to the voltage provided from the board.

In future, shields will be compatible with the both the board that uses the AVR which operates the 5V and with the Arduino due that operates with 3.3. The second one is a not connected pin that is reserved for future purpose.

- * Stronger RESET replace the circuit.

UNO means one in Italian and is named to mark the upcoming release of Arduino 1.0. The UNO and version 1.0 will be the reference version of Arduino, moving forward. The UNO is the latest in a series of USB Arduino boards and the reference model for the Arduino platform for a comparison with previous versions see the index of Arduino.

2.2.2 Specification

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40mA
DC Current for 3.3V Pin	50mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by boot loader
SRAM	2KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

2.2.3 Pin Descriptions

The below gives a description for each of the pins along with their function Fig: 2.2 pins of Arduino UNO.

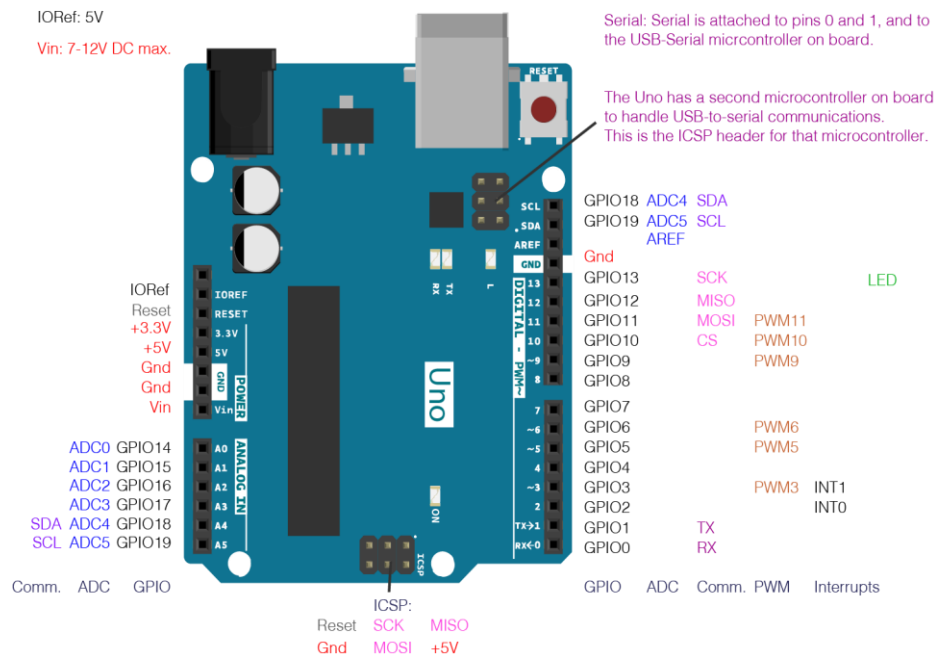


Figure 2.2: Pin description Arduino UNO

2.2.4 Power

The Arduino UNO board is powered by the USB port or an external power supply. It can be selected the power source automatically.

This can be operate on an external supply 6 to 20 volts. If supplied less than 7 volts, the 5 volts pin may supply less than 5 volts and the board may become unstable. If supplied more than 12V, the voltage regulator may overheat and damage the board. So, the recommended range is 7 to 12 volts.

The power pins are as follows:

- **Vin:** The input voltage to the Arduino board when it's using an external power source. Through this pin or if supplying voltage via the power jack access it through this pin.
- **5V:** This pin is regulate 5 volts from the regulator. The board is supplied with power either from DC power jack,USB connector (5V) or Vin pin(7-12). Supplying voltage via the 5V or 3.3V pins bypass the regulator and can damage your board. We don't advise it.
- A 3.3V supply generated by the on board regulator. Maximum current draw is 50mA.
- **GND:** Ground pin.

2.2.5 Memory

The ATmega328 has 32 KB (with 0.5 KB occupied by the boot loader). It also has 2KB of SRAM and 1 KB of EEPROM.

2.2.6 Input and Output

The mapping between UNO pins and ATmega328 ports. The mapping for the ATmega8, 168 and 328 is identical.

Every 14 digital pins on the UNO are used as input or output pin, digital wire read digital functions. They are operated at 5V.

It delivered 20mA as previous command operating condition and an internal pull up resistor of 20k to 50k. Maximum 40mA is the value that can't be exceed input or output pin to avoid microcontroller damage.

That's why, few pins have specific special functions:

- 0 to 1 is used to receive and transmit serial data. They are connected to the ATmega8U2 USB to serial chip.
- 2 and 3 pins are used to trigger to an interrupt on a low value, rising or falling edge or change in value.
- 3,5,6,9,10 and 11 pins are provide 8-bit PWM output with the analog write function.
- 10,11,12,13 pins are help SPI communication.
- It has a built in LED in digital pin 13. When its value is high, LED is on and the value is low, LED is off.

- A4 and A5 or SCL pin support the wire library. The Arduino has six analog inputs, which are A0 to A5, provide 10 bits of resolution. They calculate GND to 5V, it has chance to change upper end of using the AREF pin and an Reference function. Also it has a pair of other pins on the board.
- Reference voltage is used for analog inputs.
- LOW to reset the microcontroller which is used to add a reset button to on the board.

2.2.7 Communication

- The Arduino Uno has many facilities for communicating with computer, another Arduino or other chips. The ATmega328 provides UART TTL communication which is available on digital pins 0 and 1. This serial communication over USB and appears virtual port to software. The '16U2 firmware is standard USB COM drivers and no need external driver. But on windows a file is required. The software include with a serial monitor which allows simple text data to sent from the Arduino board. The RX and TX LEDs will flash when data is transmitted via USB to serial chip and USB to computer.
- A software serial library allows for serial communication on any of the UNO's digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus see the documentation for details. For SPI, communication use the SPI library.

2.2.8 Programming

The Arduino can be programmed with the specific Arduino Software. Select the Arduino UNO from the Tools bar. The ATmega328 comes preprogrammed by a boot loader that upload a new code without use of an any external hardware programmer. It is using the original STK500 protocol C type header files.

Also, you can use the bypass boot loader and programed the microcontroller through the ICSP header using Arduino ISP.

The code of ATmega16U2 firmware is available in the Arduino repository. It is loaded with a DFU boot loader which can be activated by:

- On Rev1 board: Connect the solder jump on the board and then rising the 8U2.
- On Rev2 or Later boards: There is a resistor that is pulling the 8U2/16U2 HWB line to ground which make it easier to put into DFU mode.

You can then use Atmel's FLIP software for windows or DFU programmer for MAC OS or Linux to load a new firmware. By an external programmer you can use the ISP header.

2.2.9 Warnings

The Arduino UNO has a reset poly fuse which protects computers USB ports from shorts or over current. The most computers has own internal protection but the poly fuse gives an extra protection of layer. If any how 50mA is flowed to the USB port that time the fuse will automatically disconnect the connection until it short or overload is removed.

2.2.10 ATmega328

In this article, we will go over the point of the ATmega328 chip.

The ATmega328 is a very popular microcontroller chip which is produced by Atmel. It's 8 bits microcontroller that's 32K flash memory, 1K of EEPROM and 2K of internal SRAM. The ATmega328 is one of the microcontroller chips that used with the popular Arduino Duemilanove boards. The duimilanove board comes with either 1 of 2microccontroller chips, the ATmega168 or the ATmega328. The ATmega328 is upgraded and more advanced chip. Unlike the ATmega168 which has 16K of flash program memory and 512 bytes of internal SRAM. Other hand, the ATmega328 has 32K flash memory and 2K of Internal SRAM.

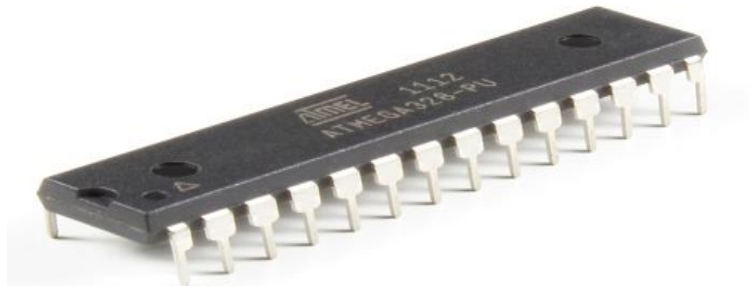


Figure 2.3: ATmega328

The ATmega328 consist with 28 pins.

Among the 28 pins, It's 14 digital input/output pins of which 6 are used as PWM outputs and 6 analog inputs. These I/O pins accounts for 20 of the pins.

The pin out of the ATmega328 is shown below:

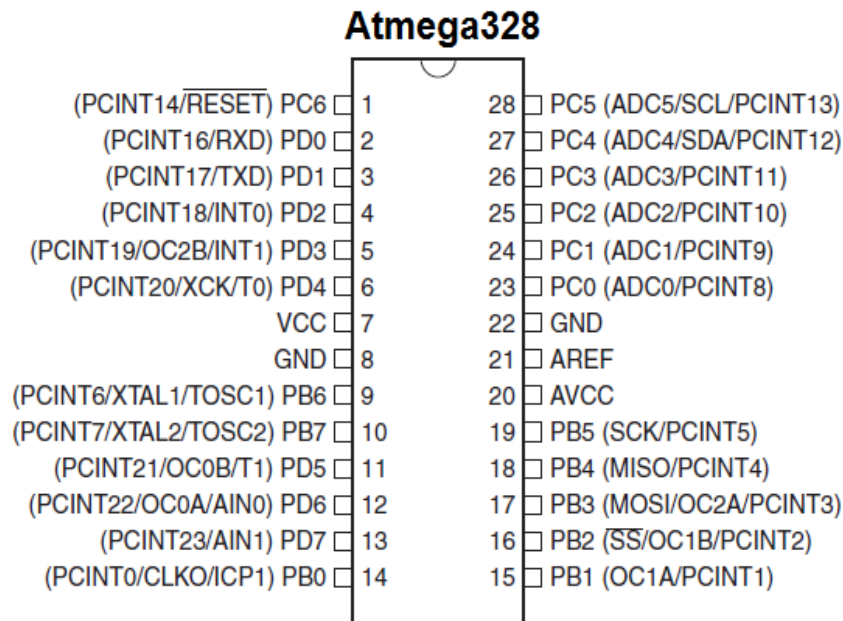


Figure 2.4: ATmega328 pin description

The table below gives a description for each of the pins along with their function:

Pin Number	Description	Function
01	PC6	Reset
02	PD0	Digital Pin (RX)
03	PD1	Digital Pin (TX)
04	PD2	Digital Pin
05	PD3	Digital Pin (PWM)
06	PD4	Digital Pin
07	Vcc	Positive Voltage (Power)
08	GND	Ground
09	XTAL 1	Crystal Oscillator
10	XTAL 2	Crystal Oscillator
11	PD5	Digital Pin (PWM)
12	PD6	Digital Pin (PWM)
13	PD7	Digital Pin
14	PB0	Digital Pin
15	PB1	Digital Pin (PWM)
16	PB2	Digital Pin (PWM)
17	PB3	Digital Pin (PWM)
18	PB4	Digital Pin
19	PB5	Digital Pin

20	AVCC	Positive Voltage for ADC (Power)
21	AREF	Reference Voltage
22	GND	Ground
23	PC0	Analog Input
24	PC1	Analog Input
25	PC2	Analog Input
26	PC3	Analog Input
27	PC4	Analog Input
28	PC5	Analog Input

Table 2.1: Description of ATmega328 Pins

As stated before, 20 of the pins function as I/O ports. This means they can function as an input to the circuit or as output. Whether they are input or output is set in the software. 14 of the pins are digital pin of which 6 can function to give PWM output. 6 of the pins are for analog input/output.

2 of the pins are for the crystal oscillator. This is provide a clock pulse for the ATmega328 chip. This chip needs 2 pins of power, Vcc and GND supply power that it can operate. This is a low power chip so it needs between 1.8-5.5V of power to operate.

This chip has an analog to digital converter inside. That's why the ATmega328 wouldn't be capable to interpret analog signals. Because of ADC, the chip can interpret analog input so the chip has 6 pins for analog input. The ADC has 3 pins set aside for it to function AVCC, AREF and GND.

AVCC is the power supply for the ADC which is supply positive voltage. The ADC needs own power supply to work. GND is supply power to ground. AREF is reference voltage, ADC use it to convert analog to its digital value. Analog voltage is higher than the reference voltage that assigned to a digital value of 1 while analog voltages below the reference voltage will be assigned the digital value of 0. Since ADC for the ATmega328 is a 10 bit ADC, meaning it produces 10 bit digital value, it converts an analog signal to digital value with the AREF value. A reference for digital values are high or low. Thus, a portrait of an analog signal is shown by digital value. It is digital correspondent value. Reset pin is the last pin. This allows a program to be rerun and start over. This is the sum up the pin of an ATmega328

2.3 Transformer

This type of transform widely used in electric power transmission and appliances to convert voltage to power electronic devices. This are available in rating mW to MW. The insulation limitations minimize the eddy current loss in the iron core. This low voltage transform known as magnetic low voltage transfer because use of coupling energy moves from one to another. The amount of power supply is 12 to 24 volts. This low voltage transformer is useful to reduce the possibility of human suffering from electric shock.



Figure 2.5: Transformer

2.4 Relay Module

This is a 5 volt, 10A, 2 channel relay module board. It's generally used to control various types of appliances with large current. It is controlled by 3.3V or 5V from microcontroller as example Arduino.

This pins are noticed on the board:

- GND: Connect this pin to 0V.
- Vcc: Connect this pin to 5V.
- IN1: Control the relay 1.
- IN2: Control the relay 2.

There is 2 LED lights that indicates the relay when it is ON.

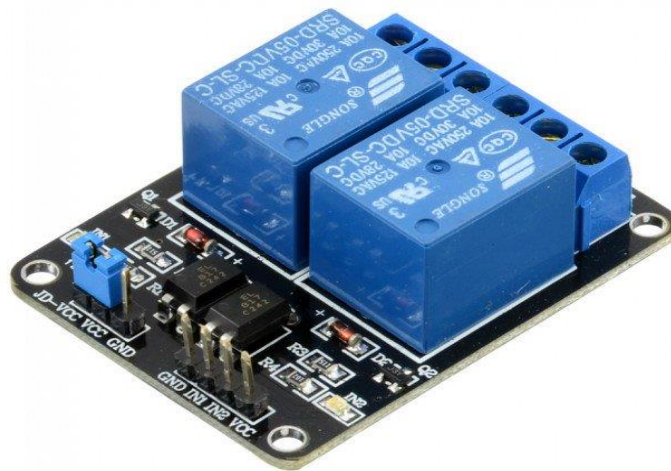


Figure 2.6: 2-channel Relay module

2.5 DC Gear Motor

DC gear Motor convert electrical energy to mechanical energy. By the variable supply voltage can be change the speed of the motor. DC gear Motors are type of DC motor with a gear assembly is attached. The increase of torque and reduce the speed for use in electronics devices that require different speed. There are two types of DC gear motor which one is Brush and another is Brushless. You can use this DC gear Motor in any purpose that require gears.



Figure 2.7: DC Gear Motor

2.6 Capacitor

Capacitor is a component that stores charge. This is made of two close conductors that are separated by a dielectric material. The plates accumulate electric charge when connected to power source. One plate accumulates negative charge. The capacitance is the amount of electric charge that is stored in the capacitor at voltage.



Figure 2.8: Capacitor

2.7 Diode

Diode is an electrical component where current follow in only one direction. The most common types of diode uses a p-n junction. This type of diode, one is n-type that is carrier's charge of electrons and another one is p-type which holes act as charge carrier. A depletion layers is formed when across electrons defuse to fill holes in the p-side. A diode permits flow of electrons from cathode to plate, not from plate to cathode. If an alternating voltage is applied to the plate, current follows only when the plate is positive. The alternating voltage is said to rectified or converted to direct current.



Figure 2.9: Diode

2.8 Iron Frame

This iron frame is the place where the PV board is on. Its size will be depended on the size of PV board. This type of frame is made by welding shop who are works with iron or steel equipment.

2.9 Solar Panel

A PV panels generates electricity from sunlight as a source of energy. A PV module is packaged generally 6*10 photovoltaic solar cells. Each module is rated by its DC output power. The cells are jointed in series one to another.



Figure 2.10: Solar Panel

2.10 Wiper

Wiper is a device that used to remove rain, dust debris from a windscreen or windshield. A wiper is consist of a metal arm with along rubber blade, foam which attach to the other. The arm is powered by the motor.

2.11 Vero Board

This is Vero board. This is a board where the electronic components and electrical components are connected.



Figure 2.11: PCB board

2.12 Jump Wire

It is also known as an electrical wire with a connector or pin at each end side. This is used to interconnect the components of test circuit or proto type system.

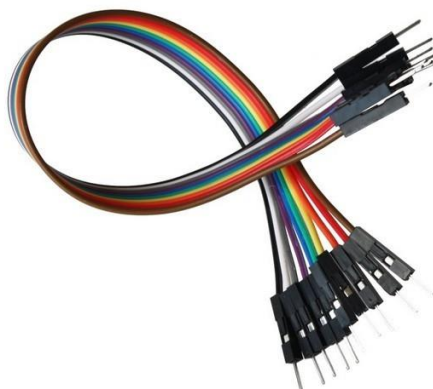


Figure 2.12: Jump Wire

2.13 ETC: (Hard Board, Screw, Soldering Iron)

We used hard board to setup a part of this project. Also we need to use Screw and Iron soldering for decoration and connect the electronics components in PCB board.



Figure 2.13: Iron soldering

2.14 Conclusion

Three main components and some tools are used in this system to make it easy and cost efficient. This project is used to increase the efficiency of Solar Panel output power. Our all components are very simple and available in our country market.

CHAPTER 3

DESIGN & CONSTRUCTION

3.1 Introduction

Arduino based solar panel automatic cleaning system for those area where dust effect on solar panel. By many reason the efficiency of solar energy can be decreased. Such that dust from environment, bird shit or any other small obstruction. The system will clean the solar panel as our preprogrammed schedule. The project designed by using ATmega 328 microcontroller with an Arduino UNO, relay module to control the motor. The design and construction is reliable that it won't hamper for solar power consumption. The whole construction need a little place so it can be attached with solar panel very easily. As this project will operate by automatically so it is designed as user friendly.

As designed, the motor will convert electrical power into mechanical output which will rotate the iron frame and coupling point. By rotating automatically it will clean the solar panel for a certain period of time. For the first step the wiper will move to forward side of the solar panel and after that it will reverse back to the solar panel. Then it will take a delay time of 24 seconds in our prototype project (which will take 24 hours in real implementation). After that the system will again clean the solar panel as follow the above methodology. User can change the delay time of cleaning system after how much of time the system will run. The system will run with some Arduino software based code in which the delay time can be increased or decreased.

3.2 Overall System Block Diagram

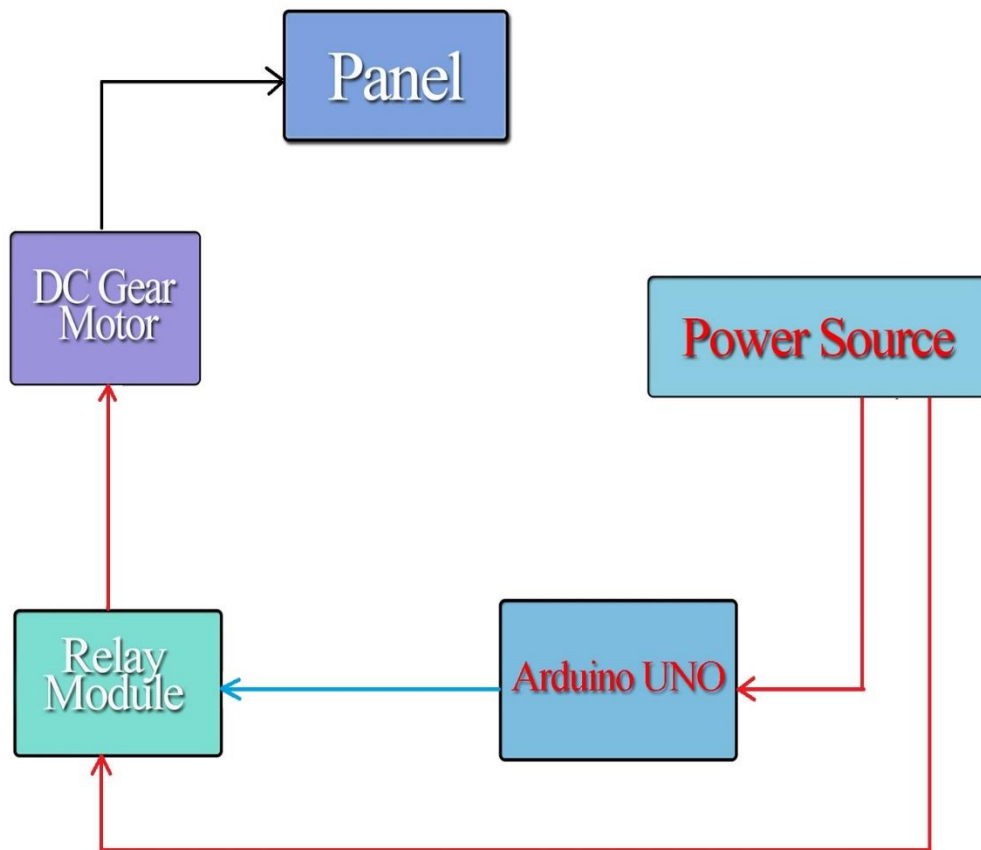


Figure 3.1: Overall System Block Diagram




Electrical Power	
Mechanical Action	
Data	

Table 3.1: Overall System Block Diagram symbol

Panel: A 5W solar panel was chosen because it is a prototype project of a solar panel automatic cleaning. So we used this minimum power solar panel.

Power Source: A transformer is used as a DC power source. Cause if we use a battery then we have to use an extra battery charging controller also. The transformer converts 220 volt into 12 volt dc.

Arduino UNO: It is the main part of the project. The Arduino is chosen because of this future implementation.

Relay Module: A two channel relay module is used which will control the motor.

Wiper: Some brushes are used for the cleaning component. These are physical component of the system.

DC Gear Motor: A 12 volt high efficiencies DC gear motor is used to run the brush shaft.

The overall system is designed by above components. As following by the overall system block diagram these components are connected.

The overall block diagram can be expressed as the power source supply power to the Arduino UNO and relay module. The Arduino UNO send data to the relay module. Relay module control the gear motor and rotate its shaft which can be presented as mechanical output. The whole design and constructed as some specific rating equipment which are already mentioned.

The overall project require also an iron frame. That iron frame for the solar panel made in welding shop.

3.3 Circuit Design

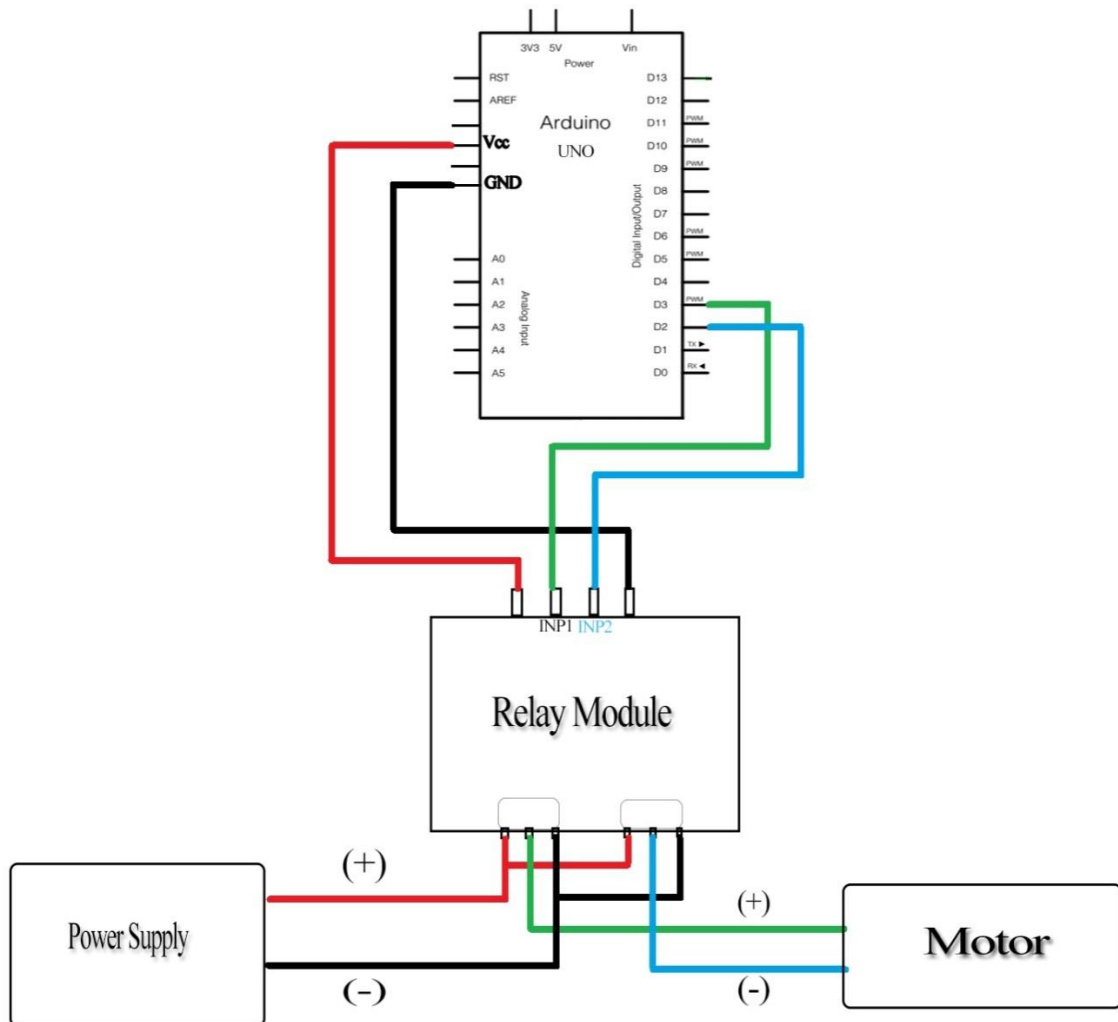


Fig. 3.2: Circuit Design of the System

As above circuit diagram the equipment are connected by the wire. The procedure are as follows-

- At first, power supply 5 volt output is connected to Arduino input.

- We choose Arduino pin number 2 and 3 as output pin to connect the relay module input pin number 1 and 2.
- Then Arduino Vcc is connected to relay module Vcc and Arduino GND is connected to relay module GND.
- In relay module the pin number 1 of channel 1 relay is shorted with the pin number 1 of channel 2 relay. After that the pin number 3 of channel 1 relay is shorted with the pin number 3 of channel 2 relay.
- Then two common point of the relays will be connected to the motor.
- At last, the positive end of power supply connected to the pin number 1 of channel 1 relay.
- And, the negative end of power supply connected to the pin number 3 of channel 1 relay.

3.4 Flow Chart

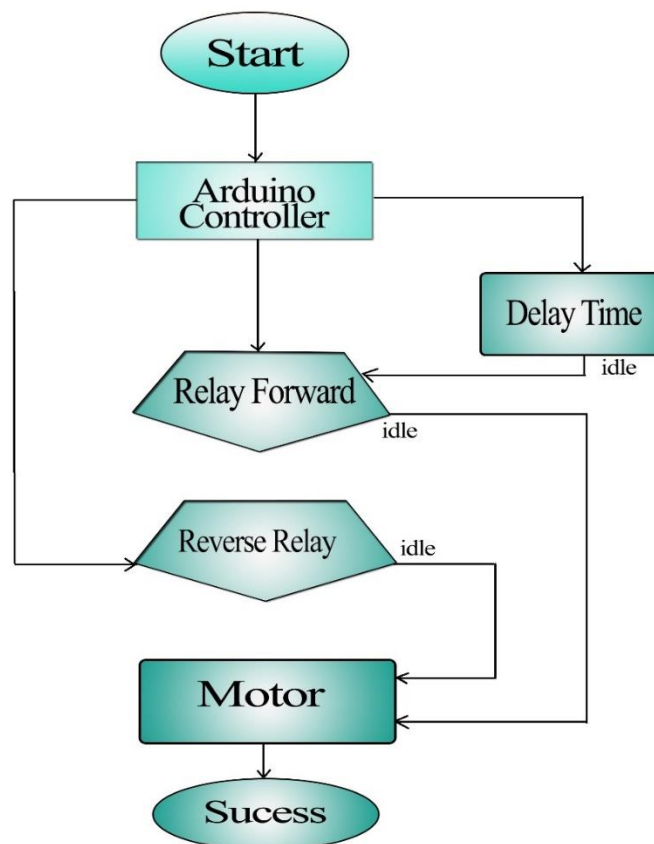


Figure 3.3 – Flow Chart of the System

This flow chart gives us a clear concept of working procedure of our project.

The above flow chart can be expressed as follows-

1st step: The system starts with Arduino controller check the first step forward relay work through as the controller programming. If the forward relay is idle then the motor will rotate and first step will be success.

2nd step: As preprogramming the controller will check the second step and attempt to reverse relay. If it is idle mode again then it will rotate the motor and successfully done the step.

3rd step: Now the Arduino controller check delay time for the next relay forward mode to work. When the delay time is clear it will operate as like the first step.

3.5 Description of Arduino Software

We used Arduino nightly for programming to complete the system.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – we can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

CHAPTER 4

COST ANALYSIS

4.1 Cost Sheet

No.	Equipment	Quantity	Price
1.	Transformer	1	170
2.	Capacitor	1	18
3.	Diode	2	10
4.	Arduino Uno	1	450
5.	Relay Module	1	250
6.	DC Gear Motor	1	600
7.	Solar Panel	1	400

No.	Equipment	Quantity	Price
8.	Iron Frame	1	850
10.	Brush	4	40
11.	PCB	1	20
12.	Wire		100
13.	Other		200
		Total	3108

Table 4.1: Cost Sheet

4.2 Cost Comparison

Solar panel auto cleaning system can be found hardly in our country. We have justified in the market price before making our project. There are many type of solar panel cleaning system which can be brought from other country which are more expensive than our cleaning system. Basically our designed cleaning system is operated and total cost is Tk.3108. Above table 4.1 shown the cost of the cost material per unit cost and total cost.

So, we say that the cost involved in constructing our cleaning system is cheaper and the materials needed for replacement are also available in the local market.

CHAPTER 05

EXPERIMENT OF THE PROJET

5.1 Introduction

The project presented here is based on Arduino and more simple and reliable than microcontroller based solar panel automatic cleaning system. In this experiment we have an additional advantage that the user can change the delay time to operate the cleaning process. In this chapter we will explain about the experimentation and result about the project.

5.2 Experimental Setup

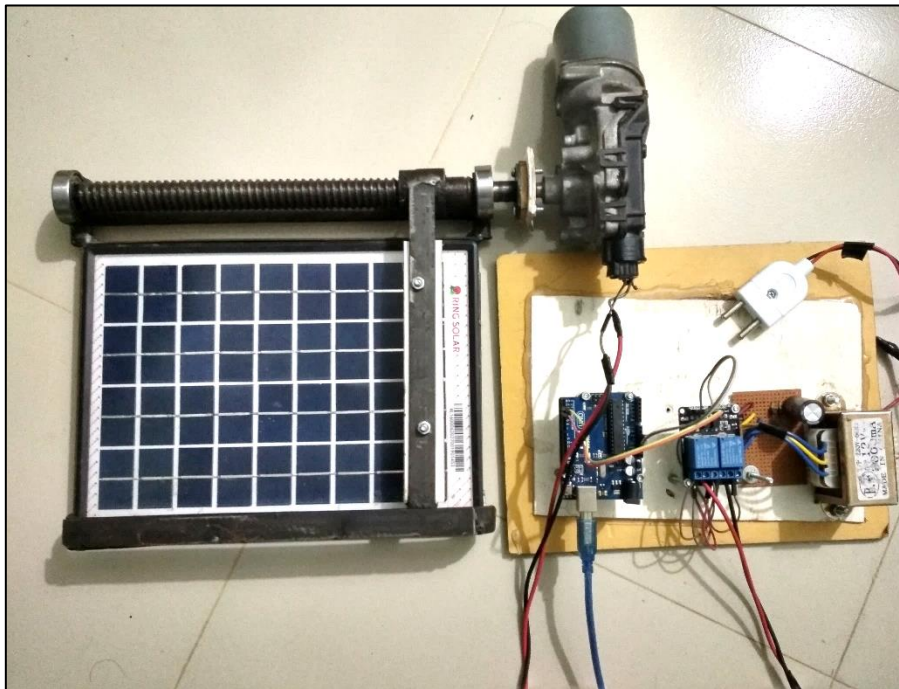


Figure 5.1: Experimental Setup

5.3 Testing Our Project

After developing the circuit on the board, then completing the design of the system we can be seen the output.

In experiment all the process worked properly. As a matter of fact the wiper on the solar panel moved for cleaning and finishing this it reverse back on the solar panel.

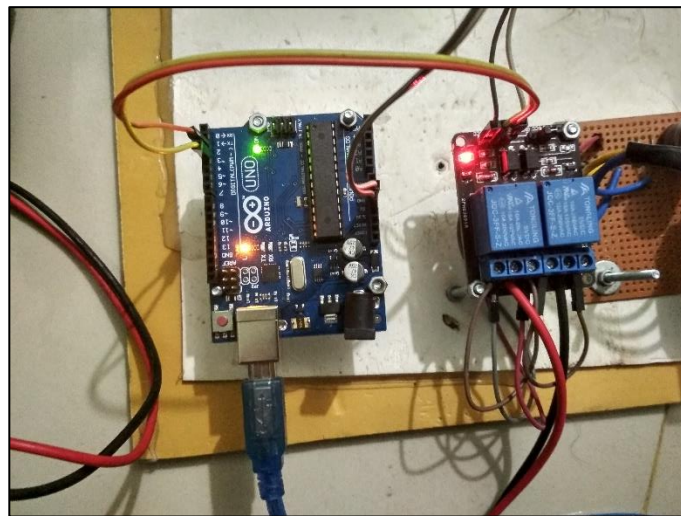


Figure 5.2: Project Test

5.4 Results & Discussion

In following figure some experimented data of PV panel efficiency vs. time exploration, current & voltage vs. time exploration through dust and no dust graph is shown. The sunshine duration can be seen reducing in a day in fall because the sun is not seem too bright in the sky. Which is normally seem too bright in the summer. In Dhaka city we found the maximum and minimum temperature rate of 22 degree Celsius to 33 degree Celsius.

Temperature Graph November 2018



Figure 5.3: Temperature Graph

There are some electrical parameter such that voltage, current, efficiency which are required to relate with the solar panel performance. Due to various type of environmental and atmosphere condition which is influenced by the fact of complicated phenomenon of power the solar panel effect of statement of dust should be considerable. From the experiment we can realize that if the solar PV's can be cleaned regularly it can be possible to receive the maximum rate of radiation. Except that the output power can be increased to maximum limit.

In setup of experiment it's already shown that a schematic representation which are the factors to explain the installation of through dust which appears on PV panel. Through this project we tried to analysis that how dust on solar panel influences to PV panel performance. The following factors have been taken into account during the study of the performance.

- Voltage vs. days through dust and no dust
- Current vs. time through dust and no dust
- Time exploration vs. efficiency of panel through dust and no dust.

5.4.1 Voltage and Current Values of with & without Dust

A 5w solar panel is used to conduct of the experiment which was placed on a high stand. Voltage and current which are considered as electrical parameters have been surveyed for the dust effect of the environment. Voltage and current rate in average is generated by the panel noted down different days and time exploration is considered through dust and no dust. A multimeter is used for measuring the parameters which are already maintained in the table as shown.

Date	With Dust (Volt)	Without Dust (Volt)
06.11.18	1.67	2.02
08.11.18	2.05	2.62
10.11.18	1.96	2.15
12.11.18	1.56	2.15
15.11.18	1.20	1.33

Table 5.1: Measured Voltage Values with Dust and without Dust

5.4.2 Graph of Voltage vs Days

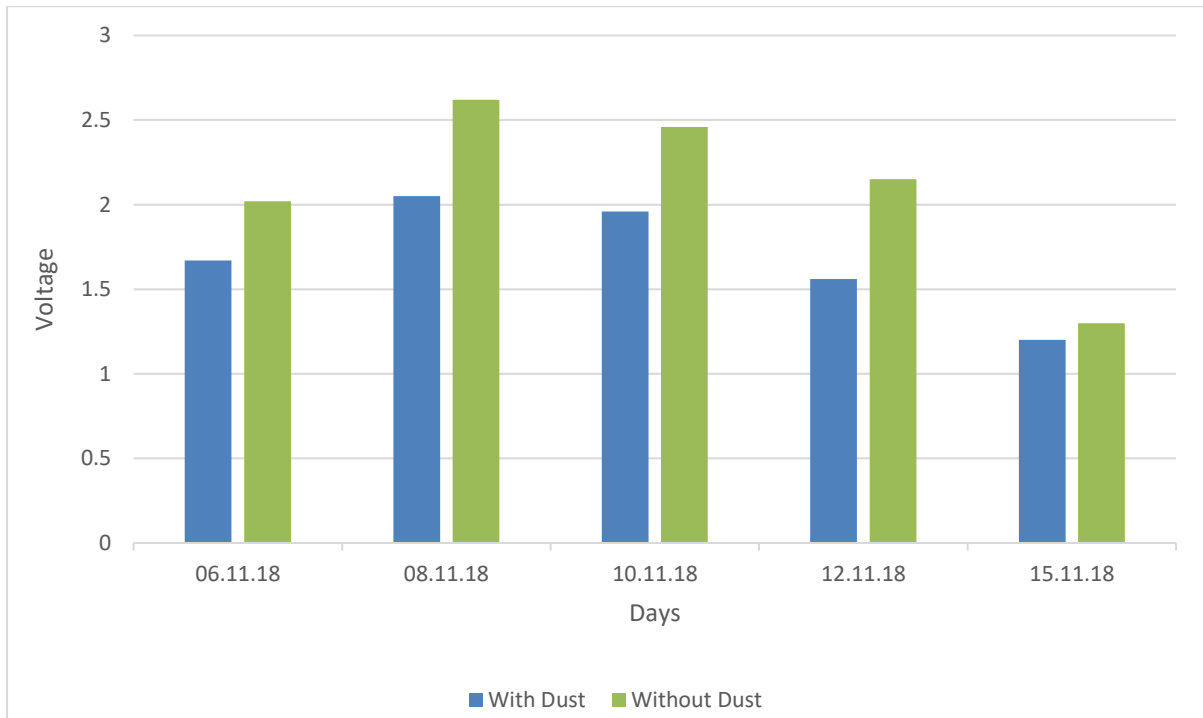


Figure 5.4- Graph of voltage variation for days

Above graph displays that the change of voltage which appeared in different days. It represent that the relearning of shorter period is better with the values. With regular cleaning the voltage increases regularly which supposed from the above graph.

5.4.3 Current Values vs Time exploration through Dust and without dust

We collected some data of the date of November 8th of 2018 which is shown in following table.

Time	With Dust (A)	Without Dust (A)
10.00 AM	0.0125	0.025
01.00 AM	0.0375	0.070
04.00 AM	0.025	0.0525

Table 5.2: Measured Current Values with Dust and without Dust

5.4.4 Graph of Current vs Time

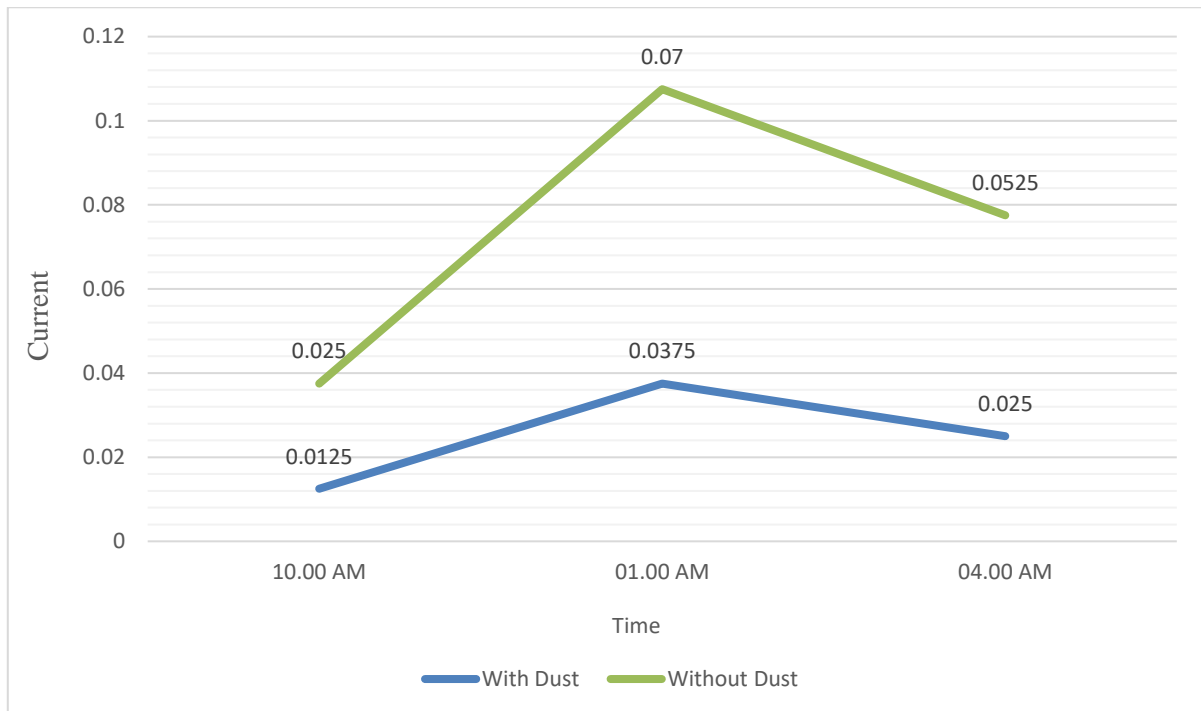


Figure5.5: Graph of Current variation for time

These plots from above graph displays that the shift of current due to time. It can be represented as the current values comparison which are noted for a cleaned solar panel. After cleaning PV panel the current increases which is proved by the clarification of the graph.

5.4.5 Comparison of Efficiency with and without Dust

Formula to find efficiency of solar panel

Where,

A= Area of solar panel in m²

P= Power in watts (V × I)

Efficiency (η) = {(Output power in watts / (Input power × Area)} × 100%

Average voltage from 5w solar panel which is already measured-

Average Voltage for with dust = 1.68 V

Average Current for with dust = 0.025 A

So, average output power = 0.02 w

Input power = 4.8 w

Efficiency (η) = 10.41 %

Now,

Average voltage for without dust = 2.11 V

Average current for without dust = 0.04 A

So, average power = 0.084 w

Efficiency (η) = 43 %

So the overall efficiency increased = (efficiency of without dust solar panel – efficiency of with dust solar panel)

$$= (43 - 10.41) \%$$

$$= 32.59\%$$

5.5 Advantages

- Increases efficiency of solar plate.
- Sometime dust or other particles remains long time on a solar panel, so it damages the aluminium strip of solar plate. So we avoid these damages by this system.
- Increases the gain as much as 5 to 30% in output from your solar panels.
- Eliminate build-up of dirt and debris and potential damage to solar panels.
- Automatic self-cleaning mechanism that can be attached to solar panels and operated without human operation.
- Minimise the cost of cleaning as compared to manual.
- Remote control is possible.

5.6 Disadvantages

- The iron frame and wiper shaft become rusty due to environment. For this reason the wiper can be slow.
- Require experienced person to install.

CHAPTER 06

CONCLUISON

6.1 Conclusion

We were Comprehensive Successfully. It is perfect solution to cleaning a panel from dust. These project are capable to cleaning any types of dust from the panel. This is time based recognition system can shortly complete the work. This is hard ware based but logically they perform by controller direction. This is a great project to increase our energy source from sun to panel. We use this system in our home, office, solar power plant etc.

This hardware project has performed forward cleaning & reverse Cleaning. We used Arduino-UNO board but we can straightforwardly use any Arduino-UNO or Nano well-suited board for this project. The main part to overcome in this project is to the Arduino-Uno board with hardware components. We can easily enhance a few elements to improve our project more forward-thinking in future. This is very beneficial to use in sonar system project to get more power from sun. Cause if we us that it is more efficient. We use 2 channel relay module for controlling motor to forward & revers.

It is consistent. It 95% working.

6.2 Application

- This simple system can be used at residential, office, power plant to ensure better efficiency.
- If we slight modification this Project can be used to control water tank.
- We can install any types of panel &its operating process is so smooth.

6.3 Limitation of the work

There are few limitation in our project that's are-

- It installation process is complicated
- We need to use grease to running smoothly
- It has friction losses

6.4 Future Work

- First of all, we would like to deal with reducing the friction losses in our project.
- We can add spray system in our project to wash with water
- We can add dust detector to cleaning the panel.

Reference

1. https://www.youtube.com/watch?v=IueNtFN_7rc
2. <https://www.wikipedia.org/>
3. <http://www.bluebuildenergy.com/products/solar-panel-cleaning/improve-solar-panel-efficiency.com>
4. https://ijasre.net/uploads/1/3659_pdf.pdf
5. <https://www.arduino.cc/>
6. https://www.youtube.com/watch?v=EclIomn_3dI
7. https://www.youtube.com/watch?v=zVuRLLKP2_o
8. <https://www.engineersgarage.com/insight/how-geared-dc-motor-works>
9. <https://www.electrical4u.com/>
10. <https://www.energymatters.com.au/suntech-solar-panel-5watt-12volt-monocrystalline-p-41.html>

Appendix

The code is given below:

```
void setup() {  
  
  pinMode(2, OUTPUT);  
  
  pinMode(3, OUTPUT);  
  
  pinMode(4, OUTPUT);  
  
}
```

```
void loop() {  
  
  digitalWrite(2, HIGH);  
  
  digitalWrite(3, LOW);  
  
  delay(40000);
```

```
  digitalWrite(4, HIGH);  
  
  digitalWrite(2, LOW);  
  
  digitalWrite(3, LOW);  
  
  delay(500);
```

```
  digitalWrite(2, HIGH);  
  
  digitalWrite(3, LOW);
```

```
delay(40000);
```

```
digitalWrite(4, HIGH);
```

```
digitalWrite(2, LOW);
```

```
digitalWrite(3, LOW);
```

```
delay(500);
```

```
digitalWrite(2, LOW);
```

```
digitalWrite(3, HIGH);
```

```
delay(40000);
```

```
digitalWrite(4, HIGH);
```

```
digitalWrite(2, LOW);
```

```
digitalWrite(3, LOW);
```

```
delay(500);
```

```
digitalWrite(2, LOW);
```

```
digitalWrite(3, HIGH);
```

```
delay(34000);
```

```
digitalWrite(4, HIGH);
```

```
digitalWrite(2, LOW);
```

```
digitalWrite(3, LOW);
```

```
delay(24000);
```

```
}
```