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DESIGN AND ANALYSIS OF AUTOMATIC SOLAR PANEL CLEANING SYSTEM

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Abstract

Solar photovoltaic systems have long been used to produce energy for different applications since the 1990s. The Government of India have revised India's solar power target to 100 GW from 20 GW, by 2022[1]. The Solar panel model efficiency determined by various environmental factors like dust, dirt, rain, snow, etc. This environmental factor decreases the performance of the photovoltaic modules. This paper discusses the introduction of the various technologies used for solar panel cleaning on the factor regarding efficiency due to nature and also discusses the varied problems involved with the solar panel cleaning.

Keywords: Solar Panel Cleaner System; Dust Cleaner; Solar Photo voltaic**.**

I. INTRODUCTION

It is observed and studied that the demand of energy in the world may increase 50% or more till 2030. From past few years, it is observed that the carbon dioxide and other poisonous gases emitting energy sources use is seen to decreased abruptly. For efficient use of renewable energy resources, different technologies are introduced. Governments worldwide are involved in improving their energy sources and turning more towards the renewable energy sources.

Each day earth receives about 1366W of sunlight[2]. An international organization named International Renewable Energy Agency have given a statistic report of people employed in renewable energy sector, this report says 11million[3] people have been involved in this renewable energy sector while in year 2017 there were about 10.3million people in the same sector. The largest chunk is hold up by Asian countries, in figures about 60%. It is concluded that by the technologies, most of the jobs in solar sector are related to solar photovoltaic and bio-fuels. Solar power generation globally is trying to take a good jump and lead. The energy that is withdrawn from solar radiations under standard conditions. It is observed that mono-crystalline solar panel makes use of solar radiations of about 15-18% for electricity generation only when STC are followed. However multi junction concentration P-V systems having efficiency as high as 40% exists but the cost of production still makes them out of reach small businesses and homes[4]. Here STC stands for Standard Test Conditions. Solar panels are improving day-by-day and their efficiency is being worked upon and is being improved in order to withdraw maximum possible output with reduced input, but still there is long way to go and achieve desired results. Deposition of nano particles on the silicon

surface is also an option but again it is a costly affair[13]. Solar panels productivity is affected by multiple factors like high-temperature, intensity of sun, cloud cover in addition with dust, bird poop like undesired outlandish particles[5]. Maximum power point tracking also plays a critical role in order to enhance efficiency of solar panels[6]. Dust is very less acknowledged when considering solar energy[7].

II. OBJECTIVE

- To make solar panel cleaning more effective.
- No human intervention in the system fully automatic.
- Easy to setup and low-cost.
- Easy record keeping of data acquired by panel for checking efficiency.
- Avoid any alien particle collection over the solar panel.
- To make solar panel power generation more efficient.

III. LITERATURE SURVEY

Moshi Meller, Eran Meller patent paper shows that the inventor have generated a cleaning technique without the use of water due to preciousness in currently. The solar panel will have an upper edge and lower edge. Hence, the shaft will be moving in direction from top to bottom of the panel. The system makes use of air stream to get rid of dust accumulated over the panels. It makes use of blower mounted over moving shaft that moves on a rail system-frame attached to array of solar panels array[8].

Malay K, Mazumdaar et al. the inventor, in his paper have described am electro-dynamic shield which is transparent and put over the solar panels. Transparent thin electrodes that conduct are used and when these are energized using 3-phase voltage of frequency in range 5-20Hz. Thus with (DEP) Di-dielectrophoresis concept force push dust at edges thereby cleaning solar panel of any dust particle. Author have made use of electro magnetic waves concept to get the task of cleaning dust off solar panels done[9].

IV. EFFICIENCY OF P-V PANEL

In any kind of system to determine its efficiency we require two parameters that ratio to give out the efficiency of that system. The ration of the output power to the input power is considered for finding the how efficiently a system is working. Here, in the case of solar power the input power refers to the solar radiance falling over the solar panels and the output power refers to the current generated by the ports of this solar panel.Concentrated photovoltaic technology (CPV) sunlight on solar cells for the generating of electricity but these solutions are themselves prone to become dirty over time and less robust[10].

Efficiency formula for solar panel is :

$$Efficiency = (Voc * Isc * FF)/Pin$$

where,
Voc - Voltage at open-circuit
Ioc - Current at short-circuit
FF - Fill Factor
Pin - Input Power
η - Efficiency

Constraints that affect the productivity of a solar panel are of two types namely internal factors and external factors. Internal factors include the type of material with which solar panels is made up of while the external factors are like the amount solar radiance falling over the panel, cloud cover, humidity, temperature etc[11]. MPPT tracking and then panel placement accordingly is extremely helpful for power generation[12].

V. WORKING OF SYSTEM

The working of the cleaning mechanism has been divided into two units: Sensing and the Cleaning unit, Sensing unit is responsible for getting the information from the sensors involved in mechanism and cleaning unit is involves good quality sponge. Sensing unit comprises of light dependent sensor and voltage sensor. The reading of the sensors are taken as input and guides the cleaning mechanism to act whenever the power production of the solar panel is compromised. These voltage values continuously acquired by sensor is uploaded on cloud and can be observed using internet connected devices.

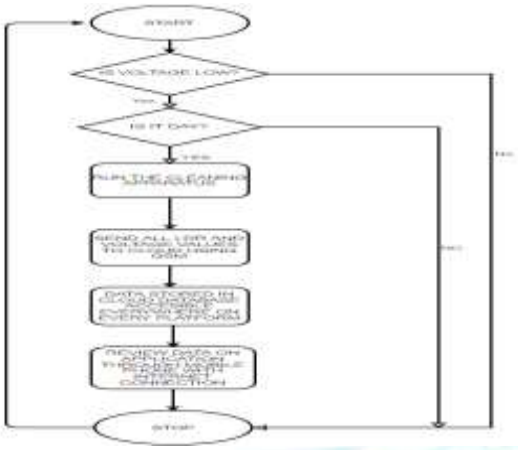

Fig 1: Flow chart of the system

A. Using LDR sensor

An LDR or a Light Dependent Resistor is a device which works on the principle of variation in its resistance value when light falls over it. We made use of 10mm Gl-10538 Photo-resistor. Generally its resistance value is quite high but when light falls over a photo-resistor the resistance value decreases. The value of light dependent resistor is directly propotional to the intensity of light falling on the sensor. It makes use of high resistance semiconductor LDR are quite robust and strong and can be made into use in harsh climatic conditions as well. There replacement can be also easily performed due to low cost.

Fig 2: LDR sensor

Features:

- Resistance:400 ohm to 400K ohm normal resistance variation: 1K ohm to 10Kohm
- Sensitivity: about 3m sec
- Voltage ratings: Available in 3V, 5V and 12V

B. Using Voltage sensor

Voltage sensor(M054) is a sensor that can be used to determine voltage of a circuit. The circuit can be both alternating or direct current circuit. Voltage sensor can determine voltages of either type. It is a small, hefty, cheap device that shows accurate value. It works on the principle of voltage divider circuit.

Fig 3: Voltage Sensor

Features:

- Analog sensor type
- Sensor operation voltage : 3.3-5V
- Sensor detecting range : 0.02V-25V
- input voltage : 0-25V Dc

C. Using GSM module

The sim 900A gsm/gprs module is a device that can be used to establish connection between the communicating devices. This module consists of modem and power supply with communication interfaces for the computer.

Features:

- Quad-Band 850/900/1800/1900MHz
- Controlled via AT commands
- Supply voltage range 3.4 ~ 4.4V
- Low power consumption
- Operating temperature range:-40℃ ~85℃

Fig 4: GSM module SIM 900A

D. Using Think-speak

The Thing-Speak is an open-source Internet cloud data storage application exchange data with the help of use of the internet. It is a very easy mode of data storage and retrieval because of it being a free source and easy visualization of the data in form of graphs. It also adds on multiple features that are not provided in other cloud services. Think-speak make use of the

Thing-view app in out project to fulfill application need and helps us to visualise the data on the mobile devices. It is one of the great cloud inventions that has made the field of iot easy to implement for small time tinkers as well[13].

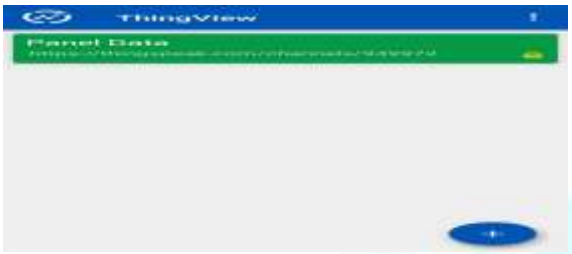

Fig 5: Thingspeak data visualise on thingview

E. Using Internet of Things

The devices connected to the internet o communicate and exchange information comes under this category known as IOT. Internet of things basically refers to communication within devices with the help of the internet in order to make device do tasks allotted to it with commands given over the internet. IOT devices are day by day becoming more efficient in work and pretty effective. Main reasons are due to the increased internet connection speed, good security protocols like IPv6[14]. It is expected that by year 2020 about 5.8billion of devices will be sharing data over internet .Iot have made it ways in agriculture, poultry farms etc.[15]. Multiple areas like information, transportation, utilities make use of the feature availed by internet of things devices. Iot device are good compatible and low-cost which makes them apt for use in daily device applications.

F. *Using Mobile application*

The ThingView- ThinkSpeak viewer by Cinetica application is an open source free app available on play store which can be used to communicate with think-speak using internet connection. It shows all the data that is being uploaded on the think-speak channel to itself. This is a very effective application that serves it function extremely well as it shows all data accurately and with no delays as it is connected directly to the internet.

Fig 6: Thingview showing readings as graph

G. Using Servo motor

This motor is being used for its compact size and easy usage. This motor(SG90) is very compact in size and have good torque in it that helps it to rotate effectively. The servo motor can be easily coded to rotate hundred and eighty degrees clockwise and anti-clockwise in direction. This movement with connection to shaft will result in smooth cleaning motion for the solar panel. This motor is very robust and has great longevity. The motor is well popular among electronics enthusiasts, hence easily available in the market as well.

Features

- Weight is 9gm
- operating voltage is 3.0V~7.2V
- Torque at 4.8V will be 1.2Kg-cm
- Torque at 6.6V will be 1.6Kg-cm

H. Using Sponge

This apparatus we are making use for the whole system have the sponge playing a very crucial role. The sponge will be the critical component here that will be responsible for cleaning up all the mess off the solar panel. The panel may be covered up with contaminants like dirt, water droplets, bird poop,leaves etc. These all contaminants could be easily removed with the help of 3M sponge we are making use in the apparatus. The great thing about the material used is that it is dirt cheap, easily replacable, easily available, also it is reinforced with plastic mesh within it that helps the cleaning material to keep itself intact and not give up soon under typical working conditions.

VI. SYSTEM ALGORITHM

The workflow of the project can be explained as:-
A. Algorithm
The steps involved are:
Stage 1- Start
Stage 2- Gather the sensors values from each of the sensors naming photresistor and voltage sensor
Stage 3- If the values display the panels are dirty and the sun is shining bright then switch-on the cleaning mechanism or else keep it off.

Stage 4- GSM continuously uploads reading obtained from sensors on cloud.
Stage 5- These readings can be easily accesed and analysed according to our needs using internet at any platform mobile or computer.
Stage 6- Recheck for values of sensors in real time and repeat step-1.
Stage 7- Stop

VII. RESULTS AND ANALYSIS

The observations obtained after experimentations done on the apparatus are represented by graphs and data tables respectively :

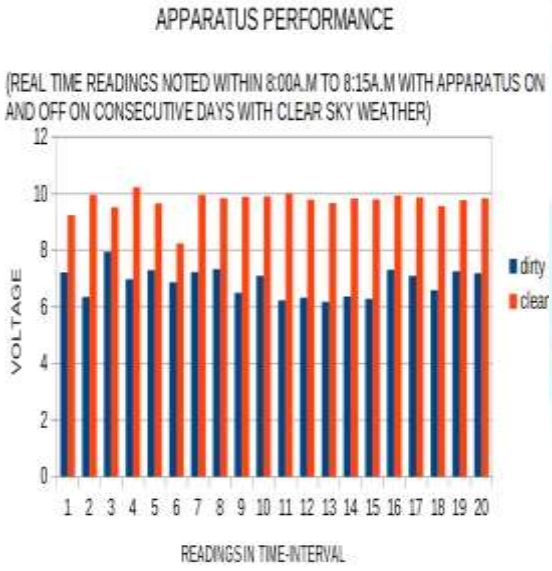

Fig 7: Apparatus voltage performance

Voltage without cleaning(V)	Voltage after cleaning(V)
7.21	9.24
6.35	9.96
7.95	9.52
6.98	10.22
7.3	9.65
6.87	8.24
7.23	9.96
7.33	9.84
6.5	9.89
7.1	9.91
6.23	9.99
6.33	9.78
6.18	9.66
6.36	9.82
6.29	9.8
7.31	9.93
7.09	9.87
6.59	9.56
7.25	9.77
7.19	9.84

Table 1: Apparatus voltage performance readings

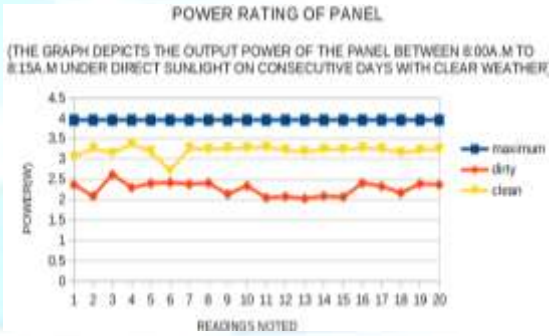

Fig 8: Graphical power representation

Maximum power of panel(W)	Dirty panel output power in watts at 1000w/m^2,1.5 AM, 25deg C	Clean panel output power in watts at 1000w/m^2,1.5 AM, 25deg C
3.96	2.37	3.0492
3.96	2.09	3.268
3.96	2.62	3.141
3.96	2.3	3.37
3.96	2.4	3.184
3.96	2.42	2.71
3.96	2.38	3.268
3.96	2.41	3.24
3.96	2.14	3.26
3.96	2.34	3.27
3.96	2.05	3.29
3.96	2.08	3.22
3.96	2.03	3.18

3.96	2.09	3.24
3.96	2.07	3.23
3.96	2.41	3.27
3.96	2.33	3.25
3.96	2.17	3.15
3.96	2.39	3.22
3.96	2.37	3.24

Table 2: Power ratings observed from apparatus

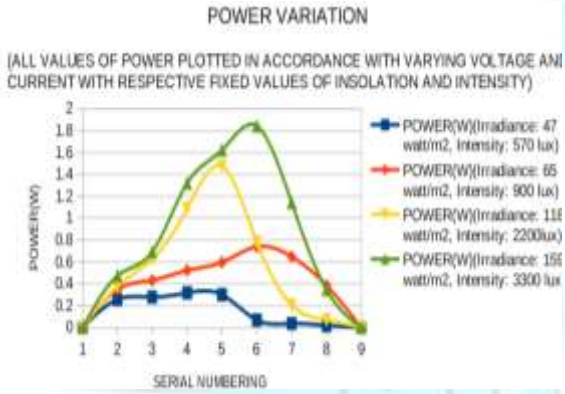

Fig 9: Power variations observed

First Data	Voltage(V)	Current(mA)	Power(W)
Irradiance:47 watt/m2 intensity: 570lux	15.5	0	0
	13.8	23	0.257
	13.9	25	0.279
	12.8	29	0.317
	10.3	35	0.3
	2.5	38	0.068
	1.7	38	0.0368
	0.4	38	0.0185
	0	38	0
Second Data	Voltage(V)	Current(mA)	Power(W)
	16	0	0
Irradiance:65 watt/m2 intensity: 900lux	15.8	25	0.349
	15.5	31	0.4321
	15.2	37	0.5232
	14.8	43	0.5969
	14	55	0.74
	1.0.1	67	0.6485
	5.2	69	0.384
	0	69	0
Third Data	Voltage(V)	Current(mA)	Power(W)
Irradiance: 118 watt/m2 intensity: 2200lux	16.6	0	0
	16.4	27	0.38
	16	45	0.628
	15.2	67	1.0894
	14.9	73	1.475
	7.6	95	0.7844
	1.4	97	0.2501
	0.3	97	0.071
	0	97	0
Fourth Data	Voltage(V)	Current(mA)	Power(W)
Irradiance: 150 watt/m2 intensity: 3300lux	17.2	0	0
	16.8	28	0.473
	16.6	41	0.6923
	16.1	70	1.321
	15.9	85	1.623
	12.9	127	1.844
	8.4	131	1.142
	2.9	131	0.346
	0	131	0

Table 3: V-I, Power readings at different insolation

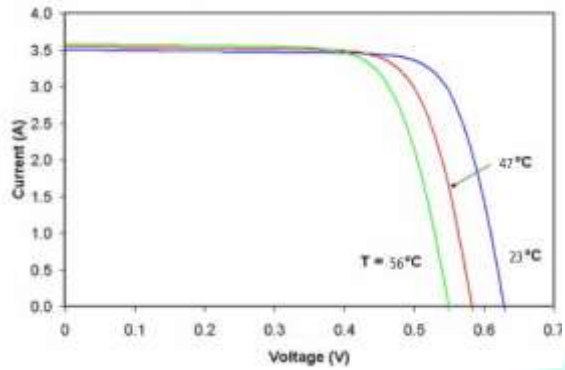

Fig 10: V-I value variation with temp

First Data	Voltage(V)	Current(A)
Temp:23 deg C	0.69	0
	0.62	0.2
	0.48	1.2
	0.3	2.3
	0	3.5
Second Data	Voltage(V)	Current(A)
Temp:47 deg C	0.58	0
	0.56	0.3
	0.39	1.5
	0.31	2.7
	0	3.6
Third Data	Voltage(V)	Current(A)
Temp:56 deg C	0.54	0
	0.42	0.9
	0.35	1.4
	0.23	2.4
	0	3.7

Table 4: V-I values with varying temperature

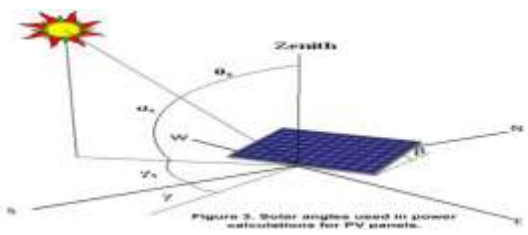

Fig 11:The angle of incidence of sun on P-V panel

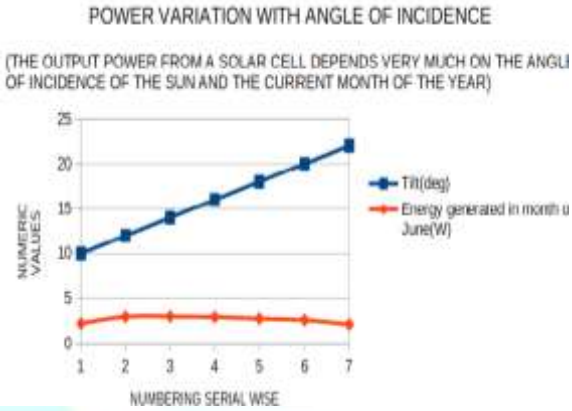

Fig 12: Power change with incidence angle

Tilt(deg)	Energy generated in month of June(W)
10	2.17
12	2.91
14	2.95
16	2.88
18	2.71
20	2.54
22	2.07

Table 5: Tilt and energy table

VIII. CONCLUSION

Currently existing solar panel cleaning systems in the market are focussed on large arrays and are henceforth industry suitable. These are not suitable for use in general installation on small arrays namely residential and shop roofs. Those with limited surface area of the panels and limited space requires better options, henceforth our project serves a perfect, advantageous applicable example. Our system can be installed on panels fitted on roof-tops. The whole cleaning system is critically designed with all the affecting parameters taken into proper consideration. The mechanisms involved are working perfectly. This apparatus serves its function very well and effectively the parameters that were kept in mind like cheap components, easy assemble, less complex, data storage, visualisation of data etc. before making of the project are being served very well.

REFERENCES

[1]The Government had revised India's solar power target to 100 GW from 20 GW, by 2022 by-Divya R et al(2018)

[2]A Review Paper on Electricity Generation from Solar Energy Mohd Rizwan Sirajuddin Shaikh , Santosh B. Waghmare , Suvarna Shankar Labade , Pooja Vittal Fuke, Anil Tekale,(2017)

[3]Solar Photovoltaic Panels Cleaning Methods A Review Saravanan V. S. 1, Darvekar S. K.(2020)

[4]Efficiency Improvement of a Typical Solar Panel with the Use of Reflectors GDM Pathmika1 and MV Gamage2 ,(2016)

[5]An experimental study on effect of dust on power loss in solar photovoltaic module, Athar hussain, ankit batra, rupendra pachauri(2017)

[6]MPPT methods for solar P-V systems: a critical review based on tracking nature Amit Kumer Podder, Naruttam Kumar Roy, Hemanshu Roy ,(2019)

[7]Impact of dust on solar photovoltaic(PV) performance: Research status, challenges and recommendations by Monto Mani, Rohit Pillai(2010)

[7]Solar panel cleaning system and method,Moshi Meller, Eran Meller(2013)

[8]Self-cleaning solar panels and concentrators with transparent electrodynamic screens, Malay K Mazumdaar et. al(2013)

[9]Improvement in solar panel efficiency using solar concentration by simple mirrors and by cooling Rizwan Arshad;Salman Tariq;Muhd. Umar Niaz;Mohsin Jamil,(2016)

[10]Solar Cells Performance Reduction under the Effect of Dust in Jazan Region .Rachid Karmouch and Hamid EL Hor ,(2017)

[11]A Low-cost Solar Farm Monitoring System Based on Cloud Database Fawzi Al-Naima, Abdullah Hamad(2018)

[12]MPPT methods for solar PV systems: a critical review based on tracking nature Amit Kumer Podder, Naruttam Kumar Roy, Hemanshu Roy (2019)

[13]A survey of IoT cloud platforms-Partha Pratim Ray,(2017)

[14]The Internet of Everything through IPv6: an analysis of challenges, solutions and opportunities by Antonio J Jara, Antonio Skarmeta, Latif Ladid(2013)

[15]Review paper on "Internet of Things" (IOT) by Tabish mufti, Nahid sami, shahab saquib sohail(2019)