AUTOMATIC DUST SENSING AND CLEANING OF SOLAR PANEL BY USING MICROCONTROLLER

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Abstract: solar power has many applications like street lighting, water heating, residence, industrial and agricultural uses. It is available plentiful in nature. Normally to collect the solar energy photo voltaic panels are used. Electrical parameters of solar panel are highly sensitive to dust accumulation and it will have an effect on performance of the solar panel thereby decrease its efficiency. One of the wonderful methods to enhance the efficiency of photovoltaic panel is by removing the dirt collected on its surface. Cleaning of solar panels is challenging task. Normally solar panels are washed manually with water but this way of cleaning is no longer economical and reliable. In view of this an automatic cleaning mechanism is designed and fabricated. The designed automatic cleaning mechanism consists of LDR in order to identify the dust accumulation on solar panel surface. If there is any dirt on the solar panel, light rays continuously falling on the panel reduces for this reason the output of LDR reduces and these signals are fed to AT89S52 microcontroller. By comparing these signals with preset records values the microcontroller will drives the driver circuit and rotate the motor to clean the panel. Power is recorded by taking the number of voltage and current readings of solar panel with dust and without dust on it for various times in day. By calculating this recorded values Power is determined for particular solar panel. This designed automatic cleansing system is an effective and cheap technique for cleansing of solar panels. It will remove irregularities in the power production of a solar panel due to presence of dust. By experimental investigation the average Power of solar panel increases up to 20.5% by regular cleaning.

***Index Terms*–LDR, driving circuit, Microcontroller.**

I. INTRODUCTION

Sun emits extraordinarily large quantity of solar power into the surroundings in each second. It is very easy to produce electrical power directly from sun. If all solar power should be gathered and convert into usable forms, it is more than sufficient to supply all world's existing power demand. However, it is no longer viable due to limitations in the surroundings such as effect of dust, temperature and clouds. Solar power can be at once transformed into electrical power by using photovoltaic cells. There is more interest in renewable power resources, especially in photo voltaic energy, which will affords electrical energy besides rising in the carbon dioxide emission. One of the many options of non conventional energy sources, photovoltaic approach is extracting power from solar energy in nature have been viewed has promising toward meeting the continuously growing world energy demand. The using of solar panels is increasing continually due to large demand for electrical power. The efficiency of photo voltaic panel is very much affected through the natural conditions. So it is very important to take care of parameters like dust, humidity and temperature. To overcome these limitations a work has taken up to find out the efficiency with and without dirt gathered on solar panel.

II. LITARATURE SURVEY

Hottel and Woertz et al. [1]: first studied the effect of dust on solar panel with the help of analyzing solar panels on different places. A 3 months test was done in an industrial area located near to highway road 90 km away from Boston, Massachusetts. They identified that mean of one % losses occur in incident radiation on solar panel because of dust accumulation on solar panel surface. The highest declination in the value of efficiency in the test duration was 4.7%. Researchers discovered correction value defined as the ratio of unclean solar panel to cleaned solar panel.

Ali Omar Mohamed, Abdulazez Hasan et al. [2]: considered the southern area of Libya which usually wind carries the dust and sand in the period from February to May, which is also called as seasonal wind. Because of these seasonal winds small particles of sand, dust, tree leaves, and bird droppings are accumulated on solar module surfaces. Which cause shading of solar panels. This study was done in rural desert, here amount of solar radiation is very large thought year. However this dust accumulation impacts the power generation and overall efficiency of solar panel. Hence after periodically cleaning and maintaining they found that average efficiency increased up to 2.5%.The time period cleaning intervals change from one place to another place, Hence it is very important to schedule such program to have a fully awareness of region environment contamination type and it is occur period.

Mark N. Horenstein et al. [3]: The supplied electro dynamic screen (EDS) for automatic and continuing removing dust particles without using of water or moving components. They find values of excitation frequency, voltage, electrode association this gives most detailed cleaning performance. Solar panel made with semi conductors to make it use efficiently clean the dust on its surface periodically. To clean solar panels there are various techniques advised such as wind blowing, rain fall, wiping, shacking, rotating

the panels, vibrate the surface to move dust. The value of washing might need to be accounted for inside the gross end of the solar panel's financial assistances.

R.Sharma, C.A.Wyatt et al. [4]: by using electro dynamic displays cleaning was performed. In this method efficient cleaning achieved comparing to other cleaning methods. To perform this cleaning 10 kv three phase high voltage required. This cleaning is high cost and consumes more power compare to other cleaning methods.

Chandima gomes et al. [5]: small experimental set up was done with electrical supply to smooth the solar panel surface. Many factors in environment will affect the performance of solar panels. A good way to evaluate the impact of dirt debris from the solar panel two Flat Photovoltaic panels are installed on the college putra Malaysia. The regularly cleaned array is known as "easy array" and the opposite array taken for the duration of in the examine became "dusty array". Statistics become gathered from 1st April – 2013 December for both arrays by using c language every of 30 minutes. Output voltage and power recorded for each array were considered. The overall power decreases because of dust have been settled on solar panel. The results proven that the total electricity generated from the smooth array greater than that of generated electricity from the dusty array.

S. B. Halbhavi et al. [6], added an automated cleansing device, which senses the dirt on the solar panel as a way to easy the dirt frequently. If the panel isn't wiped clean then 50% of the module performance might be reduced. The 8051 microcontroller is used to control the tools motor and to implement the automated gadget. The mechanism consists of a sensor and also consists of the sliding brushes while cleansing the PV modules. The analysis of the dust can be examined in different conditions with the deposition of the unique pollutants like ash, sand, silica, calcium carbonate and crimson soil. The power generation in each instances experimentally determined. Later using of the above said computerized cleaning scheme the power output can be increase approximately 30%, as compared to other cleansing technologies.

Comparative Study of Different Cleaning Methods

Solar panels are exposed to different weather conditions throughout the year. Dust, algae, industrial residues, atmospheric pollutants will settle on surface of solar panel. These elements prevent entering sun rays in to photovoltaic cells. Because of this overall performance of solar panel decrease some time output power decrease up to 50% .Water, chemicals and agents used when cleaning the panels to remove attracted dust particles and improve the speed of cleaning process.

1. Manual Cleaning

In this cleaning process humans are clean the solar panels with help of wipers or clothes with suitable supporting structure. Quality of cleaning is judged by the operator visually himself and he will continuously clean panel until all dust particles wiped out completely or up to satisfactory level. This cleaning process is very challenging and tedious because solar panels are installed at the height of 6 to 10 feet from ground. There is high chance to accident to the humans in this process which cannot be avoided. To clean solar panels water and chemical fluids are normally used. If these are not removed properly from the surface may decrease solar panel transparency. There is also chance of physical damage to the solar panels.

2. Vacuum Suction Cleaning

A vacuum suction cleaner is a machine that makes use of an air pump to create a partial vacuum to suck up grime and dust, commonly from floors, window panes etc. the electrical power is given to the vacuum cleaner motor which creates the suction pressure. The power consumption of the vacuum cleaner is in watts and it does not justify the effectiveness of the cleaner. The input power is converted into airflow at the cease and is measured in air watts. The vacuum cleaner can smooth the panel amazing only on the surfaces other than corners and this has to be handled manually. Over some duration of time scratches will amassed on panel surface which is lead to inefficient absorption of solar radiation.

3. Automatic Wiper Based Cleaning

The automated wiper based cleaning incorporate a rubber wiper .The technique is precisely like car glass cleansing and require a automatic mechanism to operate and complete the task. This mechanism is battery operated using the suitable automatic mechanism for dust identification and cleaning. In automatic cleaning no human are not involved neither dust identification nor cleaning purpose. This cleaning is efficient and less cost compared to other cleaning methods.

III. OBJECTIVES

1) To record the measured voltage and current for efficiency calculation of solar panel with and without dust.
2) To improve the power production of by solar panels.
3) To compare the calculated efficiency of solar panel with and without dust.
4) The material using for cleaning of solar panel should not damage the solar frames. It should clean the panels automatically.
5) The design should be easy to manufacture, low cost.

IV. FUNCTIONAL BLOCK DIAGRAM

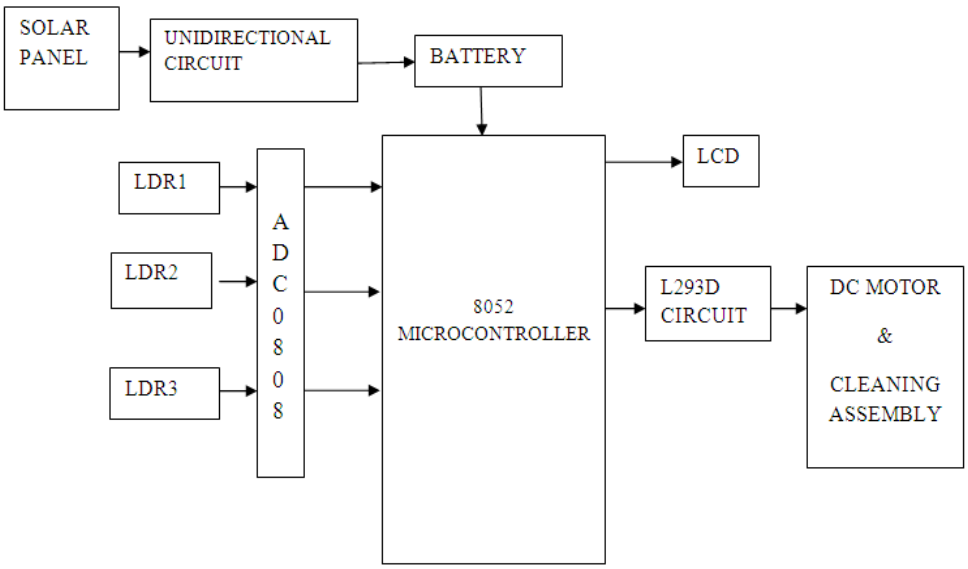


Fig.4.1: block diagram representation of automatic dust sensing and cleaning of solar panel.

Solar panel: solar panel is semiconductor device which convert directly sun rays in to electricity. It is made of small photovoltaic cell connected either series or parallel depending on requirement. The output of this panel only DC, to convert into AC inverter is required.

LDR: photo resistor or LDR resistance is inversely proportional to light intensity falling on its surface. Three LDRs are used in this project to sense dust accumulated on solar panel surface.

ADC: ADC converters are used where an analogue signal has to be processed, stored, or transported in digital form. The output signal from LDR is in the form of analog. For interface this signal to microcontroller ADC is required. 8 bit 0808 ADC is using in this project.

Microcontroller AT89S52: The 89S52 microcontroller contain 4 different ports, in each one this port contain 8 Input/output lines providing total of 32 I/O lines. It receives the signals from sensors and these signals acts input to the microcontroller, and it compares those signals with pre-programmed data.

Motor Driving Circuit: It is a16 pin IC in which pins out1 and out2 connected to the motor. Connect the IN1, IN2, and EN1 pins of L293 with PD0, PD1, and PD2 pins of microcontroller. It runs the motor for the input of 01 and 10.

LCD: liquid crystal display is a thin and flat display device made up of any number of color or monochrome pixels arrayed in front of a small light source or reflector. This LCD will display the 3 LDRs values, average of 3LDRs readings, movement of the motor (up, down).

BATTERY: Rechargeable 12v battery is using supply power to microcontroller, gear motor and other electrical components. The battery will charged by solar panel on daytime.

GEAR MOTOR: Two 12v gear motors are used for driving the cleaning assembly. Depending upon output signal from the microcontroller this motors start to rotate in clock wise or anti-clock wise direction as per cleaning assembly requirement.

V. WORKING PRINCIPLE AND OPERATION

The main components in above circuit diagram are AT 89S52 microcontroller, LDR, ADC, motor driver circuit, Dc motors, and voltage regulator. To interface microcontroller and LCD one 8-bit data bus required and this interface achieved in to different modes 8-bit mode or 4-bit mode. In this circuit 8-bit mode of interfacing was used. This mode sends data to microcontroller with help 8-data lines from D0 to D7. The data lines can be connected any port of microcontroller. Output data from LDRs connected to ADC, this ADC convert analogue signal in to digital signal. This digital signal directly connected to any one port of microcontroller. Drive Circuit L293D is commonly used and less expensive device constructed in H-bridge structure in small integrated circuit. This circuit is used to control the direction of two motors at a time either clock wise or anti clock wise by giving 01 and 10 as output.

The objective of this project is automatic dust sensing and cleansing of a solar panel surface. In order to experience accumulation of dust three LDRs are used. Hear three LDRs are using to enhance the accuracy of dust sensing. In this project usually dirt sensing is carried out at night time only. Real Time Clock (RTC) is used in order sensing dust at particularly night time only. If there is any dust existing on the panel, light rays falling on the solar panel and LDR is decrease therefore the output of LDRs decrease and these signals are fed to microcontroller. Depending upon input signal to the controller compares these signals with pre-programmed information. Driver circuit drives motor in clock wise, anti-clock wise direction as per requirement. Wiper or brush type cleaning assembly attached to motor. The motor rotate in clockwise and anti-clockwise direction and dirt on the panel will be removed. 12v will battery provides necessary DC voltage for the electronic components. Solar panel will continuously charging the battery during daytime and battery supply power to all components during nighttime. 12v battery is widely used in power supplies that provide necessary DC voltage for the electronic components.

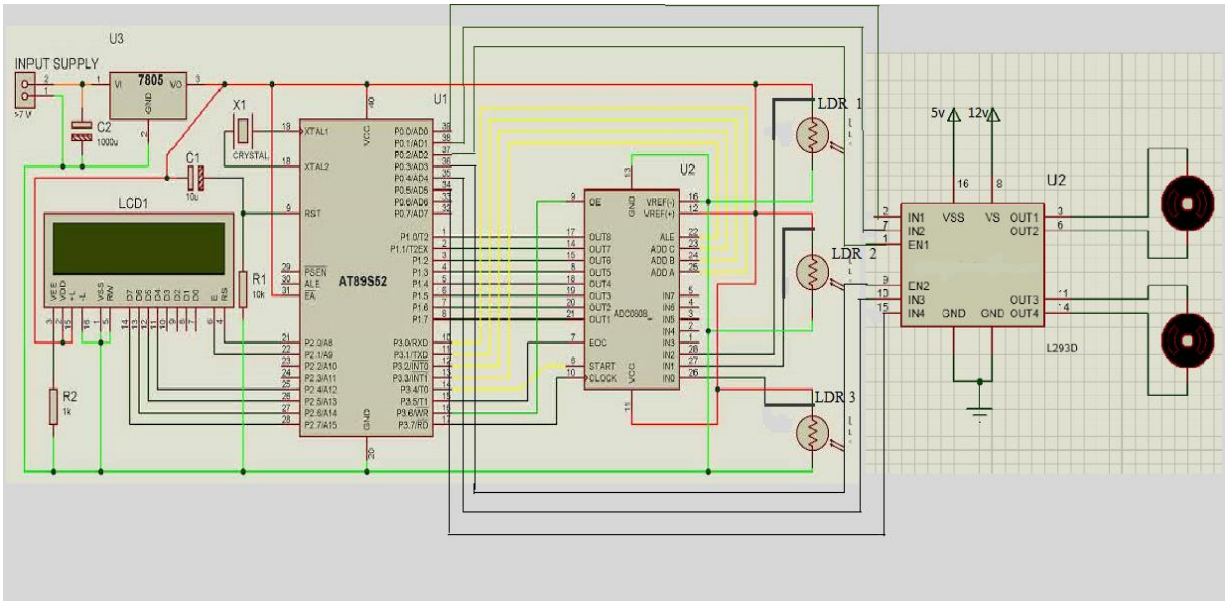


Fig.5.1: Circuit diagram of the designed prototype.

VI. EXPERIMENTAL SETUPS AND RESULT

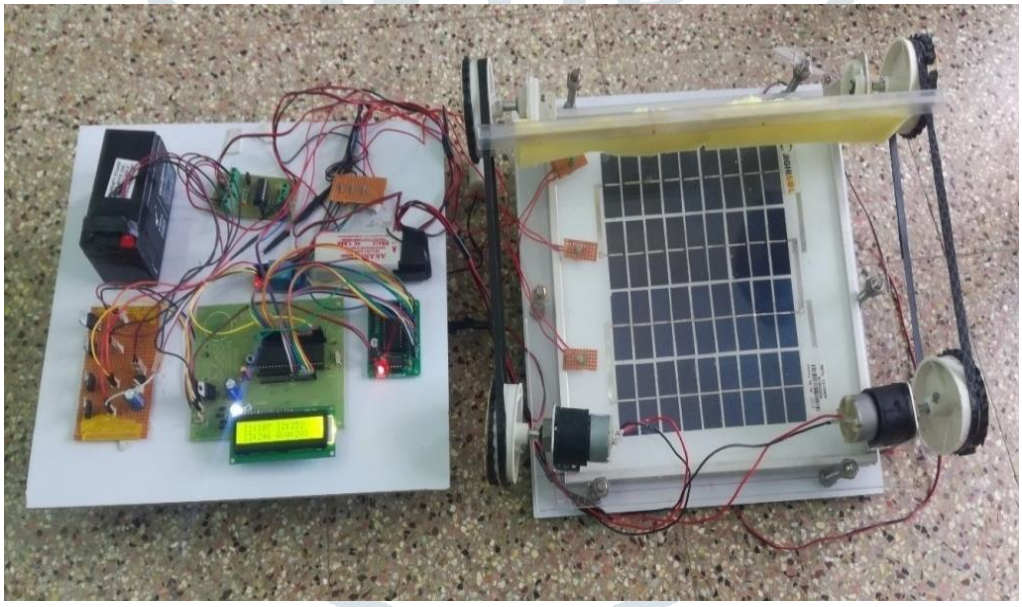
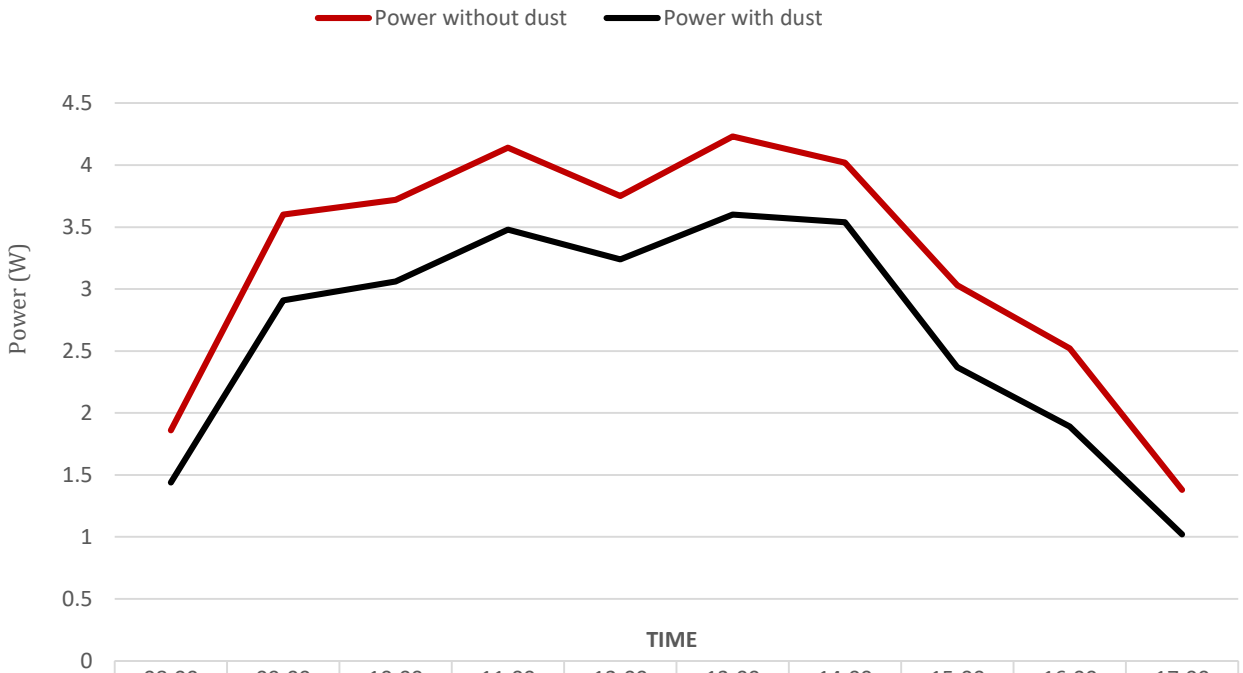


Fig6.1: Experimental Setup of Proposed prototype

In the system we use LDR, which identifies the dust accumulation on photo voltaic panel. The output from LDRs is fed to the microcontroller via ADC. In this system we have programmed in such a way that, the LDR output is greater than 120 indicate regular condition. For cleaned and dirt free solar panel output will be 255 for each LDR. If there is no dust on panel out of all LDRs always grater then 120 (near to 255) and wiper stays stationary at this movement. When dust is depositing slowly on solar panel average output signals of LDRs are decreasing. When LDRs average output is reach 120 it indicates that more dust was accumulated on solar panel. Now microcontroller give signal to driver circuit to drive motors, one motor in clock wise and another motor rotate in anti clock wise direction then stationary wiper will begin to work, cleansing the solar panel. The wiper will move forward and backward. This will continue until the average of LDRs output reach above 120. The cleaning mechanism improves the efficiency of solar panel. The wiper motion is controlled using a dc gear motor. A 12v battery is used for the perfect working of this dc motor. Another function of the project is that, 12v battery is charged by using of same solar panel.

The Following are the Result Obtained after Analyzing

1) Single cleaning assembly for single row (row length doesn't matters)
2) Brush length can be adjusted according to panel width.
3) Cleaning assembly itself is solar powered.
4) Designed to run fully autonomous (No human is required)
5) Efficiency of solar panel increased.



	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00
Power without dust	1.86	3.6	3.72	4.14	3.75	4.23	4.02	3.03	2.52	1.38
Power with dust	1.44	2.91	3.06	3.48	3.24	3.6	3.54	2.37	1.89	1.02

Fig.6.2 Plot of Power v/s Time

Inference: From above graph Power v/s time describes about the small value of Power was varied. The calculated average Power increases nearly 20.5% after cleaning the solar panel. From the above graph we can understand that average Power of solar panel is increased with regular cleaning.

Increased Power = ((avg. Power without dust)-(avg. Power with dust)\ avg. Power with dust)*100
= ((3.2-2.65)/2.65)*100
= 20.5%

VII. FUTURE SCOPE

The power consumed by cleaning assembly reduced by using efficient motors. By improving design cost of the project can be reduced. Instead of using LDR another effective dust sensing device can make this project more reliable.

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