Autonomous Solar Panel Cleaning System

Nitin P Choudhary[1], Dr. Prashant Debre[2], Anurag Kadu[3], Gaurav Kalbande[4], Harish Bele[5]

Department of Electrical Engineering, Jhulelal Institute of Technology, Nagpur, India
n.chaudhary@jitnagpur.edu, p.debre@jitnagpur.edu.in,

ABSTRACT
Energy generation has been diverse. To meet the rising energy demands various attempts are made.Transition towards solar energy is going on at a rapid pace. The generation is greatly affected by amount of incident light which is decreased by accumulated dust on the solar panels. Therefore need of cleaning solar panel arises. This problem has still many loop holes and has not addressed properly. This article suggests a meachanism with multi domain capabilities to adrees the arising isssues of cleaning.

Keywords— Solar energy, solar panel cleaner, dust cleaning, photovoltaic cells

I. INTRODUCTION

Solar energy has a great potential in its own. It is the type of renewable energy which has minimum effort to harvest and also less irregularities in generation as compared to other natural sources. To harvest this energy sets of photovoltaic cells connected in array commonly know as solar panel are employed. The panels generate energy by incident photos between juctions which develop charges. Thus panels are constantly exposed to sun in bare enviroment. This results in action and effect of various natural entities such as rain strom and wind. This in turn results in accumulation of various foreign particles on the surface of the panels this resul;ts in blockage of the incoming radiation and reduction of incoming energy. Thus the efficiency of the panels is greatly reduced and also the panel experience high temperature which can result in internal dameges if subjected to longer periods. This phenomenon may result in reduction of generation by 30-40%. Thus it is necessary to clean the panels perodically . Thus to address this problem we designed a mechanism top execute various tasks associated with the cleaning.

This paper consists of the methodology employed in designing the mechanism and execution of the assigned tasks . the whole frame is made of high strength aluminium . Our main aim was to combat the reduction in efficiency in a economically feasible way and also environmentally. The whole mechanism works by a 8072 p ic mounted on a open souce board known as Arduino. In this mechanisms various operation are co ordinated and regulated by programing various actions and tasks as required .

II. PROPOSED METHODOLOGY

The designing and making of the mechanism was achieved in three phases
1. Research and concept development
2. Rough ideology and designing
3. Fabrication
4. Installation and testing

Keeping in mind the irregularities in the installation of the panels and the intial costs of cleaner we went on designing on module operation cleaner. Simplifying it means that the meachanism would be able to move itself back on forth on the module itself with out the need of any extra support frame. Thus we used side gripping whells with a adjustment of 2.5 cm each to counter the irregularities in panels.

Weight constrains was the another limitation as the modules are not designed to carry heavy weight and can lead to damage if done so. So we had to design frames with low length to weight ratio thus we used aluminum pipes to make structure and iron joints to reduce bending.

III. COMPONENTS USED.

1.Arduino uno r3 (ATmega328p)

It is an open source microcontroller with a atmega328p ic onboard. It is easily programable and quite efficient in terms of power. It is equipped with sets of digital and analog input/output pins that may be interfaced according to needs.

2. L298N motor drive controller.

It is a driver module with dual H-bridge. H bridge is used to drive inductive loads in reverse and forward direction. It uses a 78M05 voltage regulator to regulate speed and starting operations .

3. Proximity sensor.

Proximity sensor is which executes tasks on the basis of non contact basis detection. It converts movement or presence of object into electrical signals.

4.Dc geared motor (555)

A dc motor is a machine which converts direct current into mechanical energy. Dc motors are known for their high torque performance . A dc motor coupled with a gearbox is known as dc geared motor. Planetary gears and side gears are two types of gears employed.

5.Solar charge controller.

A solar charge controller is a solar powered voltage and current regulator. It is used to charge batteries using solar panels and also reguilate the charging.

IV. WORKING PRINCIPAL

It is an autonomous solar panel cleaner . It is fed with a definite time delay between cycles thus executing functions autonomously when started. It uses a 8072 p ic mounted on a arduino board as the controller of whole mechanism. The mechanism is 15 ft long and 4.5 ft wide. It moves on the modules parallel to them. It has two drive motor mounted on opposite sides parallel to the module. These are 557 geared motor with maximum weight carrying capacity of 70 kgs each. The whole chasis is divided in between into two separate sections one for each panel. Each of this sections has two brushes parallel to the modules. They are powered by 225 planetary geared
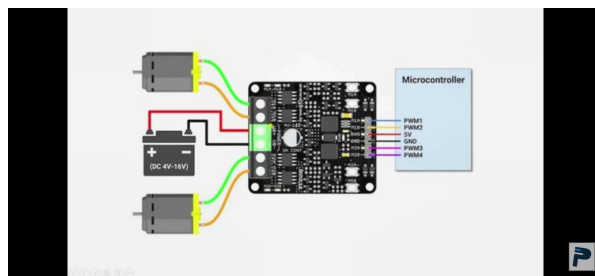
motors of 800 rpm each. They spin in opposite direction to each other. The whole structure is covered by a pvc sheet to ensure all the electronics are protected from direct precipitation . it also allows the system to operate in adverse weather conditions . on the surface ofd the pvc cover three high power exhaust are present they work simultaneously with the system to pull all the cleaned dust out of the system . this doesn't allow the dust to resettle ion the surface of the panels.

The dust from the exhaust is directed into a chamber with a electrostatic precipitator. In it there are two oppositely charged copper plates with around 400 v poterntial difference between them . this results in the charging of the dudt pareticles which then gets attracted by oppositely charged plates. This whole processed Is controlled by the Arduino coupled with motor drivers and real;y boards. The system is powered by two 20 amph batteries with a battery backup og about 120 hrs on a full charge. The system is also provided with individual soalr panel which recharges the batteries simultaneously with the cleaning operations.

The Arduino board is connected through its digital pwm pins with the l298n motor drivers. The schematic diagram of the connections is shown below. The Arduino is a open source microcontrolledr board with a AT mega 328p ic on it.

V. FUTURE SCOPE

This project has extended scope with the integration of user friendly controls. It needs work on the organisation of the various systems in a better and ergonomic way. Various fault detection technology can be employed such as derail detection to stop damage to the modules. We can also integrate remote operation capabilities to make it more autonomous.

VI. RESULT

Sr. no.	Time in AM / PM	Power in Watt
1.	10 AM	315.83
2.	12 AM	317.03
3.	02 PM	325.15

(Without cleaning table no.01)

Sr. no.	Time in AM / PM	Power in Watt
1.	10 AM	359.86
2.	12 AM	374.44
3.	02 PM	394.15

(after cleaning table no.2)

Thus from the analyisi done in experimental environment it can be clearly seen the increase in power generation by upto20% . Thus the mechanism designed executed the given task successfully. There were no software lags experienced and the whole system worked well. Thus with further advancement it can been used in solar farms for on site cleaning application. We tried our best to address problems experienced on site. We also practised on practicality rather than integrating more and more tech thus reducing our costs.

cleaning
03/03/2023

II. CONCLUSION.

The aim of this paper is to design a autonomous solar panel cleaner. There are many options but some are not reliable or others face practicality issue. In some cases initial setup costs are also high so manual cleaning had been preffered which uses lot of water and also sometimes damages the panels.

Thus we were able to design a system with minimum human interference and addressing on site problems occurred.

VIII References

1)M, Mani, R. Pillai, Impact of dust on photovoltaic (PV) performance Research status challenges and

recommendat Renew. Sustain. Energy Rev., vol. 14, no. 9,pp. 3124-3131, 2010.

2) G. Masters, Renewable and Efficient Electric power System. Hoboken, NJ JohnWilley & Sons Inc.,2013

3) Hossein Mousazadeh a. Alireza Keyhani a Arzhang Javadi b. Hossein Mobli a, Karen Abrinia e, Ahmad Sharifi b. "A review of principle and sun- tracking methods for maximizing solar systems output", a Department of Agricultural Machinery Engineering, University of Tehran, Iran.

4) Solarbuzz, www.solarbuzz.com, Portal to World of Solar Energy.

5) Tian Pau Chang "Output energy of a photovoltaic module mounted on a single- axis tracking system", Department of Computer Science and Information Engineering. Nankai University Technology, Nantou 542, Taiwan of

6) "Effect of Dust on Solar Panels". Katz. G. (2008, 27 April 2011).

7) J. Zorrilla-Casanova, M. Piliougine, J. Carretero, P. Bernaola, P. Carpena, L. Mora-Lopez, M. Sidrachde-Cardona. "Analysis of dust lossesin photovoltaic modules" world renewable Energy Congress 2011.Sweden, 8-13 May 2011.