SUN TRACKING AUTOMATIC PANEL CLEANING MECHANISM & SOLAR PANEL WITH GSM BASED ENERGY BILLING SYSTEM

Rajendra Kodamanchili[1], P Devadass[2]

[1]Assistant Professor, Ramachandra College of Engineering, Andhra Pradesh
[2]Assistant Professor, Ramachandra College of Engineering, Andhra Pradesh

---***---

Abstract - *The solar PV modules are generally employed in dusty environments. The dust gets accumulated on the front surface of the module and blocks the incident light from the sun. It reduces the power generation capacity of the module. The power output reduces as much as by 15% if the module is not cleaned for a month. In order to regularly clean the dust, a sun tracking cum cleaning system has been designed, which not only tracks the sun but also cleans the modules automatically. This automated is implemented by using Arduino.AT mega 2560 which controls the servo motor. In this mechanism, the solar panels make a rotation of 360 degrees in a day, which result in sliding of cleaning brush when the dust accumulation is higher than the reference value. In terms of daily energy generation, the presented tracking cum cleaning scheme provides about 30% more energy output as compared to the flat PV module and about 15% more energy output as compared to PV module with single axis tracking. The technology of e-metering (electronic metering) has gone through rapid technological advancements. This paper proposes a GSM based instant energy billing system, which reduce the man efforts and amount of power Consumption will be sent to the consumer through a SMS without any person involvement.*

Key Words: sun tracking system, automatic panel cleaning, dust deposition, GSM modem

1. INTRODUCTION

In order to maximize the amount of radiation collected by a solar collector, the tracker must follow the sun through the day. But, if the environmental conditions in which the solar PV modules are installed [1], like tropical climate around the equator, significant amount of dust gets deposited on PV modules. The regular cleaning of PV modules [2] is required in tropical climate which adds to the cost of operation and maintenance of the PV systems. The settled dust, if not cleaned, affects the performance of the solar PV module by shading the front surface. It has been observed that the reduction in energy output from a PV panel with dust could be as much as 50%, when the module is not cleared for 30 days. The performance of the modules lowers in the case of dust accumulation even though it is tracked[3]. In order to take care of dust accumulation problem, a simple cleaning mechanism along with tracking system is designed. GSM based designs have developed another innovative and public utility product for mass communication. The purpose of this system is to remote monitor and control domestic energy consumption. This system aims to replace the traditional

energy meter. The main components are integrated with the device board and thus incorporate the wireless features. The GSM modem receives the SMS easily without any another person's involvement.

2. IMPLEMENTATION OF THE SUN TRACKING AND SELF- CLEANING OF SOLAR PV MODULES

2.1 Tracking Mechanism

A dual axis tracking of the solar PV module is implemented along with the automated cleaning mechanism. For tracking the sun, the module is made to rotate 360° angle in a day, i.e. one rotation in 24 hours. The module starts its rotation from vertical position at the time of sunrise facing towards east (perpendicular to ground) and rotates at the rate of 15° per hour. This tracking mechanism is based on the angle of rotation of earth around its own axis. The time for rotation of earth around its own axis is 24 hours which is equal to the tracking time of this system. This system is always in synchronization with the rotation of earth without any extra component because, this system starts at the time of sunrise and goes on and on as earth rotates on its own axis. That is the reason this tracking system does not require any sensor or extra component for synchronization like any other tracking system[1]

Fig-1: Rotation of the panel through the day

2.2 Cleaning Mechanism

The automated cleaning mechanism is implemented using wiper, servomotor. The wiper is fitted in the rod. The rod is fitted with the wheels at both ends, which are fitted in the channel in which they rotate [4]. When panel comes in a vertical position at 6 am and 6 pm the brush fitted on the rod

rotate son the panel from upwards direction due to gravity and cleans the panel two times in a day

Fig-2: Automated cleaning mechanism

2.3 GSM Based Energy Billing System

Global System for Mobile Communication (GSM) is a set of ETSI standards specifying the infrastructure for a digital cellular service. The standard is used in approx. 85 countries in the world including such locations as Europe, Japan and Australia. One of the key features of the GSM is the subscriber identify module card. It is a detachable smart card containing the user's subscription and phone book. This allows the user to retain his information after switching handset [5]. This system is an implementation to the ideas of the wireless communication between a mobile phone and Arduino. Currently the main work that has been done on this proposed system is through serial area and on/off the appliance. The user will send SMS from his phone and he will be able to control the appliance.
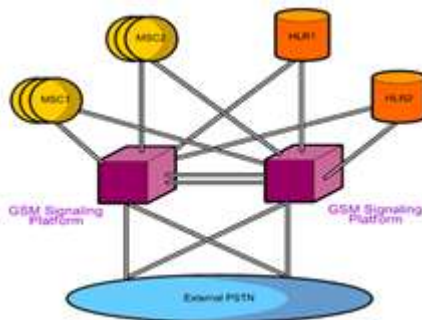

Fig-3: GSM based energy billing system

3. PROPOSED SYSTEM

3.1 Components of Proposed System

A Light Dependent Resistor (LDR) or a photo resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance. There are many different symbols used to indicate an LDR [3].

Global System for Mobile Communication (GSM) is a set of ETSI standards specifying the infrastructure for a digital cellular service. The standard is used in approx. 85 countries in the world including such locations as Europe, Japan and Australia.

Liquid crystal displays (LCD's) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in liquid, but are grouped together in an ordered form similar to a crystal.

Servomotor is actually an assembly of four things: a normal DC motor, a gear reduction unit, a position-sensing device (usually a potentiometer), and control circuit. The function of the servo is to receive a control signal that represents a desired output position of the servo shaft, and apply power to its DC motor until its shaft turns to that position. It uses the position-sensing device to determine the rotational position of the shaft, so it knows which way the motor must turn to move the shaft to the command position. The solar panel that attached to the motor will be reacted according to the direction of the motor.

Current Sensor is a device that detects electric current in a wire, and generates a signal proportional to that current. The generated signal could be analog voltage or current or even a digital output.

3.2 Operation of Proposes System

It mainly consists of 4 LDR's for tracking and 2 servomotors for vertical direction & horizontal direction movement. LDR dust sensor is used for cleaning purpose & 2 servo motors for cleaning purpose. Solar tracker is the best solution for receiving maximum radiation[3]. Solar tracker is a device which is used to tracks the sun's movement and tries to ensuring the maximum amount of sun light incident on the panel throughout the day. Here LDR is used to sense the appropriate signal to Arduino then the particular motor starts rotating [2].

When the intensity of light falling on right LDR is more, then the moves right direction. LDR is made up of semiconductor material cadmium sulphide [3]. It works on the principle of photo conductivity (Interaction of light and matter) in which the material conductivity decreases when light absorbed material is decreases. If the photons energy is greater than the band gap energy of semiconductor material therefore electron jump from valance band (V.B) to conduction band(C.B).When light having enough energy is incident on the device, more and more electron are excited to the C.B which result in the large no. of charge carriers, therefore more and more current starts flowing. There by resistance decreases [9].

To improve the solar efficiency, we are using the automatic panel cleaning mechanism also. Here, we are placing the 2 servo motors on adjacent side of the solar panel and a brush is placed in between these 2 motors. When the dust is accumulated more than the reference level, LDR sends the signal to Arduino.[7] Then the Arduino starts the servo motor for cleaning purpose [8]. The panel output is given to load through 16×2 display, which is used to display the no. of consumption units. Without using any bill reader, human effort we are knowing the consumption units through a SMS to the consumer [9][10].
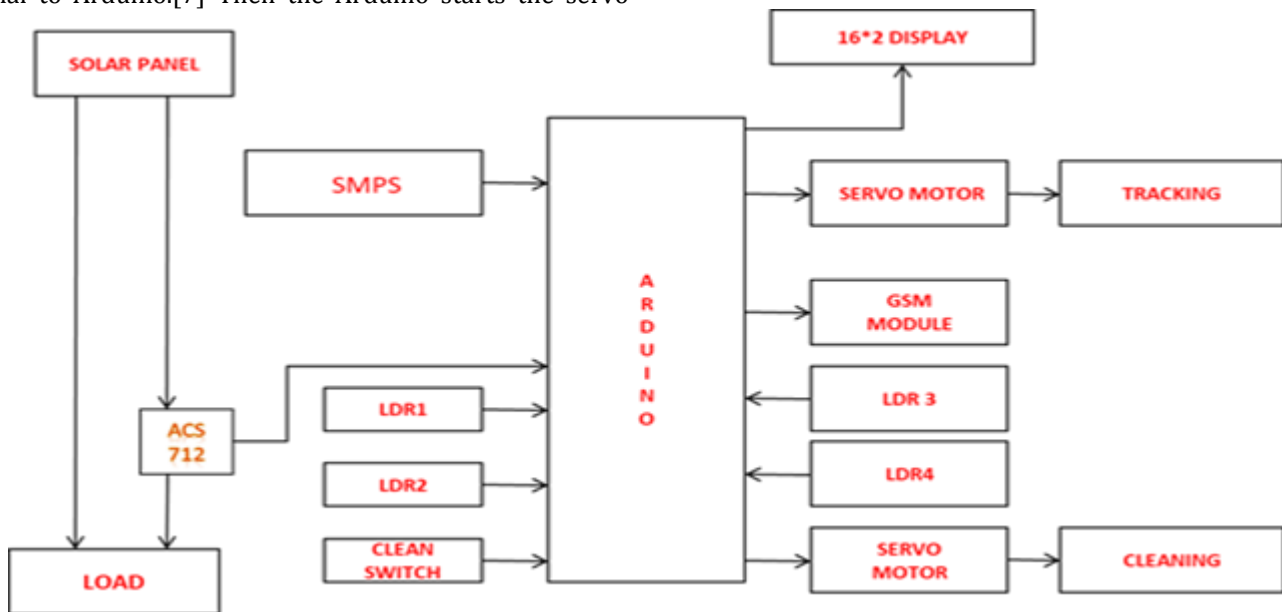

Fig-4: Propose system

3.3 RESULTS

To observe the effectiveness/performance of tracking system some experiments were conducted. The experiments consisted of measuring the performance of the solar PV modules which are (case1) dusty(case2) cleaned and (case3) tracked as well as cleaned modules. The energy output performance of PV modules has been measured under following three cases

Case 1: Kept stationary without cleaning (Dusty) Vs Kept stationary but manually cleaned regularly (Cleaned)

Case 2: Kept stationary but manually cleaned regularly (Cleaned) Vs Kept in this tracking system with automatic cleaning (Tracked as well as cleaned)

Case 3: Kept in this tracking system with automatic cleaning (Tracked as well as cleaned) Vs Kept stationary without cleaning (Dusty). The comparison of energy output for three different cases is presented in

Table -1: Percentage Gain in Energy Output

CASE 1	CASE 2	CASE 3
14.7	15.8	30.6

4. CONCLUSION

The proposed system is mainly used to improve to the efficiency of the solar panel. Individually By using tracking system the efficiency is increased in the range 10-25% and by cleaning mechanism the efficiency will be increased by an amount of 15% per month. But by using the solar tracking and automatic cleaning mechanism we can improve the efficiency of the solar panel by an amount of 30%-50%. The mentioned tracking cum cleaning system is most suitable for today's industrial need.

The proposed GSM based display electronic notice board was efficiently designed. This proposed system has facilities to be integrated with a display board thus making it truly mobile. The toolkit accepts the SMS, stores it, validates it and then display it in the LCD module. The SMS is deleted from the mobile each time it is read, thus making room for the next SMS. By using the 16*2 LCD display, we can easily know the no. of unit consumption by consumer easily through the program which is inbuilt in Arduino. The energy consumption details are sent to the consumer through a SMS by using GSM modem. The man power is minimize by using these techniques and efficiency of the solar panel is improved.

REFERENCES

[1] HOSSEIN MOUSAZADEH A, ALIREZA KEYHANI A, *, ARZHANGJAVADI B, HOSSEIN MOBLI A, KAREN ABRINIA C, AHMAD SHARIFI B," A REVIEW OF PRINCIPLE AND SUN-TRACKINMETHODS FOR MAXIMIZING SOLAR SYSTEMS OUTPUT", A DEPARTMENT OF AGRICULTURAL MACHINERY ENGINEERING, UNIVERSITY OF TEHRAN, IRAN

[2] TIAN PAU CHANG, "OUTPUT ENERGY OF A PHOTOVOLTAIC MODULE MOUNTED ON A SINGLEAXIS TRACKINGSYSTEM", DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION ENGINEERING, NANKAI UNIVERSITY OF TECHNOLOGY, NANTOU 542, TAIWAN

[3] CENTRAL ELECTRICITY REGULATORY COMMISION WWW.CERCIND.GOV.IN, INDIA

[4] SOLARBUZZ, WWW.SOLARBUZZ.COM, PORTAL TO WORLD OFSOLAR ENERGY.

[5] CEMIL SUNGUR, "SUN-TRACKING SYSTEM WITH PLC CONTROLFOR PHOTO-VOLTAIC PANELS", SELCUK UNIVERSITY, TECHNICALSCIENCE COLLEGE, KONYA.

[6] YUJUN BAO AND XIAOYAN JIANG, "DESIGN OF ELECTRIC ENERGY METER FOR LONG-DISTANCE DATA INFORMATION TRANSFERS WHICH BASED UPON GPRS", ISA 2009. INTERNATIONAL WORKSHOP ON INTELLIGENT SYSTEMS AND APPLICATIONS, 2009.

[7] H.G. RODNEY TAN, C.H. LEE, V.H.MOK, "AUTOMATIC POWER METER READING THE WHICH INCLUDES THE LOST CONTENT. AND WHILE PREPARING BILL THE SYSTEM USING GSM NETWORK", THE 8 CONFERENCE (IPEC 2007).

[8] VIVEK KUMAR SEHGAL, NITESH PANDA, NIPUN RAI HANDA, "ELECTRONIC ENERGY METER WITH INSTANT BILLING", UKSIM FOURTH EUROPEAN MODELLING SYMPOSIUM ON COMPUTER MODELLING AND SIMULATION.

[9] BHARATH P, ANANTH N, VIJETHA S, JYOTHI PRAKASH K. V., "WIRELESS AUTOMATED DIGITAL ENERGY METER", ICSET 2008

[10] SUBHASHIS MAITRA, "EMBEDDED ENERGY METER- A NEW CONCEPT TO MEASURE THE ENERGY CONSUMED BY A CONSUMER AND TO PAY THE BILL", POWER SYSTEM TECHNOLOGY AND IEEE POWER INDIA CONFERENCE, 2008.