Automated Solar Panel Tracking Cum Cleaning System

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Abstract

Accumulation of dust on the surface of the solar panels is a natural phenomenon. These accumulated dust particles act as an obstrucle and obstruct the rays from reaching the panel. These particles act as external resistance. The amount of accumulated dust on the surface of the PV module effects the overall energy. Environment is one of the main contributing factor which affects the functioning of the panel. Shading of the panel can decrease the output reducing the overall solar photovoltaic performance of the cell. Hence by cleaning the module periodically can improve the efficiency by increasing the output by almost 50%.
Keyword- Dust, Photovoltaic, PV Module, Shading, Soiling Losses, Tracking

I. INTRODUCTION

The energy from the sun is an abundant renewable resource and can be directly converted into electricity. The process is done with the help of photovoltaic semiconductor cell that converts the irradiance into electricity.

The solar panel system is made up by one or more panels, a battery, a charge control and the load. Solar PV panels are normally mounted on roofs and wired into a building by an inverter, which converts the direct current energy received from solar panels into alternating current. The energy obtained is clean and sustainable. Amount of irradiance is the main factor that determines the amount of output of the PV module. Dust is a thin layer that covers the surface of the solar array, and the typical dust particles are less than10 mm in diameter but this depends on the location and environment. Dust is generated from many sources such as pollution by wind, pedestrian volcanic eruptions and vehicular movements. The accumulated dust on the surface of photovoltaic solar panel can reduce the system's efficiency by up to 50%. Environment is one of the contributing factor that directly affects the output of the cell. It was also proved that under greater irradiation, the effect of dust became slightly reduced but not negligible. Hence, in practice, dust must be removed from the surface of solar PV panel in order to ensure highest performance.

II. LITERATURE SURVEY

A. Sun Tracking System

A solar tracker is a device that orients a payload toward the sun. Payloads are usually solar panels, parabolic troughs, Fresnel reflectors, lenses or the mirrors of a heliostat.

For flat-panel photovoltaic systems, trackers are used to minimize the angle of incidence between the incoming sunlight and photovoltaic panel. This increases the amount of energy produced from a fixed amount of installed power generating capacity. In standard photovoltaic applications, it was predicted in 2008-2009 that trackers could be used in at least 85% of commercial installations greater than one megawatt from 2009-2012.

In concentrator photovoltaic (CPV) and concentrated solar power (CSP) applications, trackers are used to enable the optical components in the CPV and CSP systems. The optics in concentrated solar applications accept the direct component of sunlight and therefore must be oriented appropriately to collect energy.

Sunlight has two components, the "direct beam" that carries about 90% of the solar energy, and the "diffuse sunlight" that carries the remainder – the diffuse portion is the blue sky on a clear day, and is a larger proportion of the total on cloudy days. As the majority of the energy is in the direct beam, maximizing collection requires the Sun to be visible to the panels for as long as possible.

The purpose of a tracking mechanism is to follow the Sun as it moves across the sky. The complex path of the Sun is simplified by considering its daily east-west motion separately from its yearly north-south variation with the seasons of the year.

1) Single Axis Tracking

Single axis trackers have one degree of freedom that acts as an axis of rotation. The axis of rotation of single axis trackers is typically aligned along a true North meridian. It is possible to align them in any cardinal direction with advanced tracking

algorithms. There are several common implementations of single axis trackers. These include horizontal single axis trackers (HSAT), horizontal single axis tracker with tilted modules (HTSAT), vertical single axis trackers (VSAT), tilted single axis trackers (TSAT) and polar aligned single axis trackers (PSAT). The orientation of the module with respect to the tracker axis is important when modelling performance.

The control of tracking system is mainly performed by using a dc motor which is controlled using an internal timer. The dc motor is made to rotate after a specified time delay as programmed in the internal timer. The motor is made to rotate throughout the day in steps based on the delay given.

B. Cleaning System

Dust has an effect on the performance of solar PV panel. The reduction in the peak power generated can be up to 18%. It was also shown that under greater irradiation, the effect of dust became slightly reduced but not negligible. The power output delivered from a photovoltaic module highly depends on the amount of irradiance, which reaches the solar cells. Many factors determine the ideal output or optimum yield in a photovoltaic module. However, the environment is one of the contributing parameters which directly affect the photovoltaic performance. Electrical characteristics of PV (Voltage and current) are discussed with respect to shading due to soiling. Shading due to soiling is divided in two categories, namely, soft shading such as air pollution, and hard shading which occurs when a solid such as accumulated dust blocks the sunlight. Shading loss occurs when PV modules are shaded by buildings, trees or other objects in proximity to PV modules. Since the output current of the PV module is a function of solar irradiance, a reduction in solar irradiance as a result of partial or complete shading will affect the performance of the PV module. The PV system is troubled with a weakness of nonlinearity between current and voltage under partially shaded condition (OSC). According to statistic studies the power loss can vary from 10% to 70% due to shading.

C. Soiling Losses

Soiling losses refer to loss in power resulting from snow, dirt, dust and other particles that cover the surface of the PV module. Dust is a thin layer that covers the surface of the solar array, and the typical dust particles are less than10 mm in diameter but this depends on the location and its environment. Dust is generated from many sources such as pollution by wind, pedestrian volcanic eruptions, and vehicular movements among many others. The accumulated dust over time aggravates the soiling effect. In fact the amount of accumulated dust on the surface of the PV module affects the overall energy delivered from the PV module on a daily, monthly, seasonal and annual basis.

There are two interdependent parameters that effect on characterization of soiling accumulation on solar panels, the property of dust and the local environment. Dust property consist of size, components, shape, and weight. If the surface is not smooth, and instead is rough, fury, sticky, and etc.it allows more soil to accumulate. The position of the panel which depends on the sunlight direction and wind is also important in soiling process. The more horizontal the surface is, the more dust can be accumulated. Besides, slow breeze also can result in dust accumulation whereas strong wind can clear the panel surface. However, airflow due to wind is able to effect the dust accumulation or dissipation at particular places of the solar panel. The air speed is and pressure are not constant over the solar panel surface. In presence of wind, wherever the airspeed is higher, there is lower pressure which can result in less soil accumulation and vice-versa. Dust properties such a type, size, weight, and shape also play important role in dust scattering.

There are two methods of cleaning:

1) Manual Cleaning: This method follows the same procedure that is used to clean windows of buildings. To scrub the soil off the surface, brushes with special bristles are designed to prevent scratching of the modules. Some brushes are also connected directly to a water supply to perform the washing and scrubbing concurrently. Out of reach, a ladder and a scrub with long handle might be needed.
2) Mobile Cleaners: this method utilizes machinery to perform the task and a storage for water supply or Sprinkler system is one of the best ways to clean the surface of the PV module.

Here cleaning is accomplished with wiper which moves back and forth the panel. The wiper is moved using a motor. A water jet is used to clean the surface. The water jet is provided with the help of a spray motor.

III. BLOCK DIAGRAM

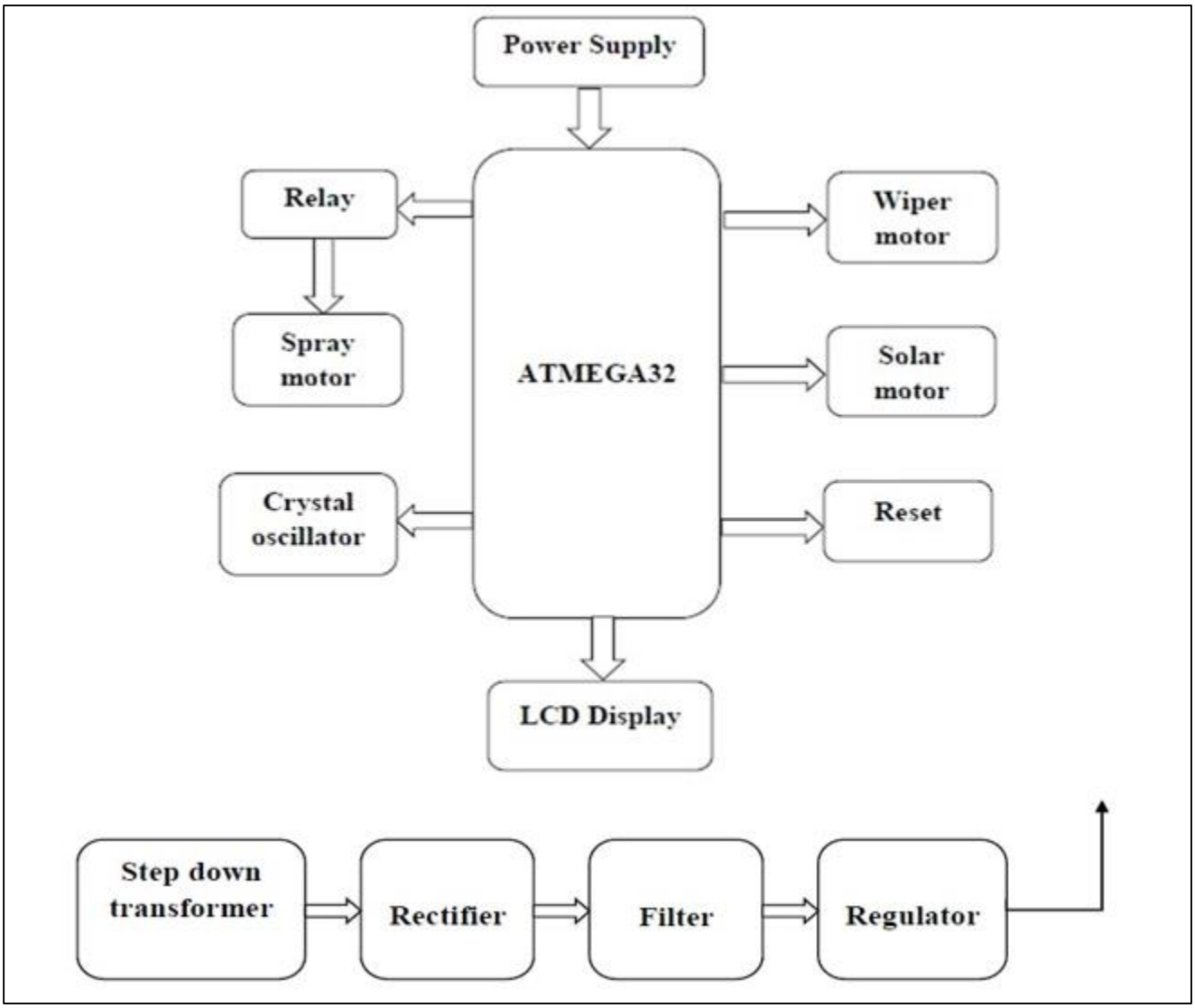

Fig. 1: Block Diagram

IV. HARDWARE DETAILS

The major heart of the device is microcontroller. Microcontroller ATMEGA32 is used to control the movement of the motors that is used to track the panel and used for controlling the wipers. The wiper movement and tracking system are controlled by controlling a motor and an internal timer. The power supply used for the controller is 5V dc. A LCD module is used to display the status of the device. The cleaning is done using a water jet and wiper.

V. CONCLUSION

The automatic cleaning system used in the solar panel increases the power output of the panel by about 15% to 30% and hence the overall efficiency of the panel is also increased. The system also decreases the soiling and shading losses in the panel.

The solar power generation is increasing day by day and hence the tracking cum cleaning system is very useful for todays need. As the increased initial cost is high for a solar panel, the increased efficiency compensates for this cost as the power output increases and hence more power is available for the load. The PV modules are kept in such a way to obtain the best energy generation from the module of the given wattage ratings.

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