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Research Article

Fault Detection and Monitoring of Solar PV Panels using Internet of Things

M. Suresh[1]*, R. Meenakumari[1], R. Ashok Kumar[2], T. Alex Stanley Raja[2], K. Mahendran[3], A. Pradeep[4]

[1]Department of Electrical and Electronics Engineering, Kongu Engineering College, Perundurai - 638 060. Tamil Nadu, India.
[2]Department of Electrical and Electronics Engineering, Bannari Amman Institute of Technology, Sathyamangalam – 638 401. Tamil Nadu, India.
[3]Department of Electrical and Electronics Engineering, Jansons Institute of Technology, Karumathampatti- 641 659. Tamil Nadu, India.
[4]Department of Electrical and Electronics Engineering, Vivekanandha College of Technology for Women, Tiruchengode – 637 205. Tamil Nadu, India.

*Corresponding author's e-mail: infostosuresh@gmail.com

Abstract

The most widely available energy throughout the world is solar energy. To minimize the dependence on energy imports, the proper maintenance of solar panel is required. The power generated by the solar panel has to be monitored continuously. Using Internet of Things technology, the power generation can be greatly influenced by means of its performance, monitoring and maintenance. The present paper is based on the implementation of Internet of Things (IoT) monitoring of solar panel for maintenance and for improving the efficiency by detecting the fault.

Keywords: Solar Panel; Internet of Things; Wi-fi module; Current and voltage sensors.

Introduction

Solar energy is widely available throughout the world can contribute to minimize the dependence on energy imports. In 90 min, enough sunlight strikes the earth to provide the entire planet's energy need for one year. Solar PV entails no greenhouse gas emissions during operations and does not emit other pollutants also. According to the International Energy Agency (IEA), Renewable will be the fastest-growing source of electricity, in which wind and solar PV are technologically mature and economically affordable. But still there is increase in world's demand for energy. The latest edition of the IEA's Medium-Term Renewable Market Report now sees renewables growing 13% more between 2015 and 2021 than it did in last year's forecast. The share of renewables in overall electricity generation will rise from over 23% in 2015 to almost 28% in 2021. The Internet of Things (IoT) is a system of related computing devices, mechanical and digital machines, objects, people or animals that are provided with unique identifiers and also the potential to transfer data over a network without requiring human-to-human or human-to-computer interaction. Physical items are no longer disconnected from virtual world, but can be controlled remotely through Internet services, for continuous monitoring of solar panel to satisfy the increasing energy demand. Solar panels create 300 times more toxic waste per unit of energy than do nuclear power plants. If solar and nuclear produce the same amount of electricity over the next 25 years that nuclear produced in 2016, and the wastes are stacked on football fields, the nuclear waste would reach the height of the Leaning Tower of Pisa (52 meters), while the solar waste would reach the height of two Mt. Everests (16 km). Researchers addressed about IoT that allows objects to be sensed and/or controlled remotely over existing network infrastructure, creating opportunities for pure integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention [1]. Implementation of new cost effective methodology based on IoT to remotely monitor a solar photovoltaic plant for

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performance evaluation. This will facilitate preventive maintenance, fault detection, historical analysis of the plant in addition to real time monitoring [2].

Some researchers explained the concept for an IoT device that collects data regarding physical parameters, using a sophisticated microcontroller platform, from various types of sensors, through different modes of communication and then uploads the data to the Internet [3]. It was shown that the design and implementation of an interconnected mechanism of SPU and the measurement of the reliable parameters. The structure of the proposed system is a combination of customized IoT device with information system for data aggregation [4]. Few researchers studied based on implementation of new cost effective methodology based on IoT to remotely monitor a solar photovoltaic plant for performance evaluation. This will facilitate preventive maintenance, fault detection, historical analysis of the plant in addition to real time monitoring. Power generation from Solar Photovoltaic plants is variable in nature due to changes in solar irradiance, temperature and other factors [5].

Proposed system

An up-to-date review of software tools available for the objectives of the proposed system are, for remote monitoring of solar panels and fault detection and to constantly monitor the solar panel and transmit the power output to IoT system through wifi module. The Fig. 1 shows the block diagram of IoT monitoring of solar panel. The power generated in the solar panel is sensed using current and voltage sensor. This sensed value is recorded as a graph using IoT.

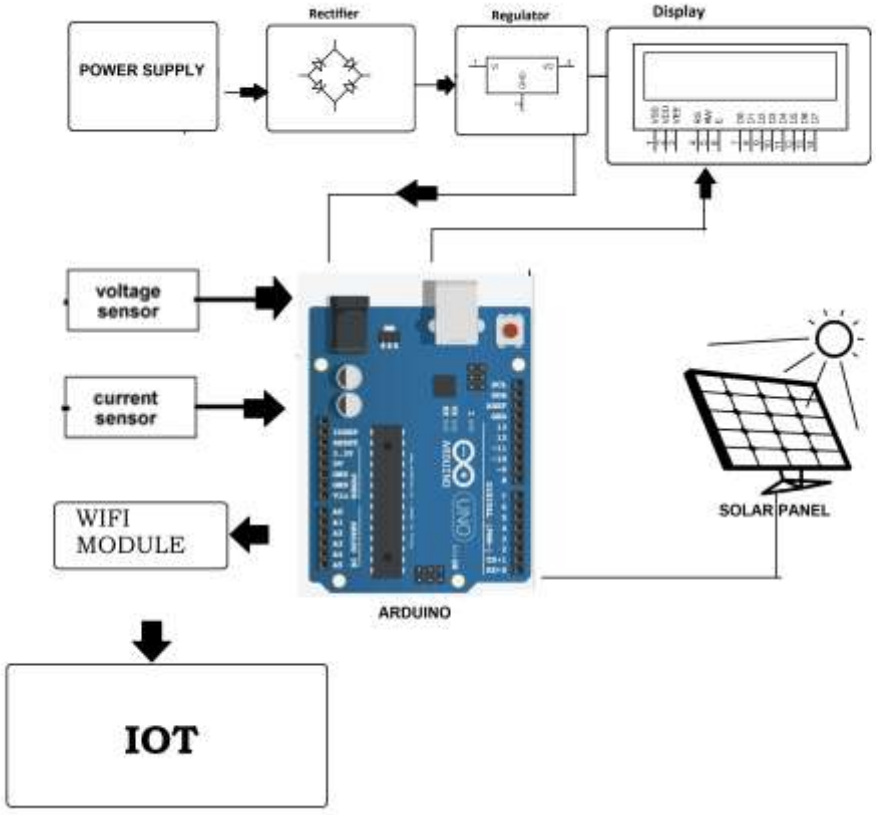

Fig. 1. block diagram of IoT monitoring

Control circuit

The main objective is to monitor the solar panel generation. An IoT channel is created in Thing speak. The IoT programming is dumped in the microcontroller where the ATP key of the channel is used in the program. The arduino is connected with the sensors like voltage and current. The output of the voltage and current sensor instantly is recorded after certain time duration. These values are plotted as a graph in IoT. The control circuit consists of Arduino which is connected to the voltage and current sensors (Fig. 2).

The solar panels are connected in parallel so that the voltage generated will be constant. The current value may vary according to the

illumination on the solar panel. The voltage and current sensors sense the value of voltage and current generated in solar panel. A relay is connected in series with each solar panel. The solar panels remain in parallel connection if the current generation is proportional to the illumination on solar panel. If the illumination on the solar panel is higher and the current generation is low, then the relay of the corresponding panel gets tripped. So that the solar panel which have to be maintained is disconnected from the parallel path. To bring back the position of solar panel reset button is pressed. These values are recorded in the graph format using Internet of Things through wifi module.

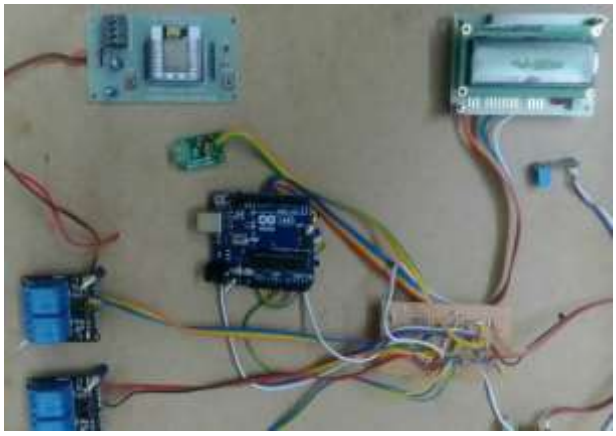

Fig. 2. Control circuit hardware connection

Results and discussion

The values of current, voltage and illumination are recorded in Internet of Things through wi-fi module. So that the maintenance of solar panel is done effectively. This fig. 3 shows the intensity on the solar panel with respect to time. The illumination level is measured using LDR and these values are as a graph against time.

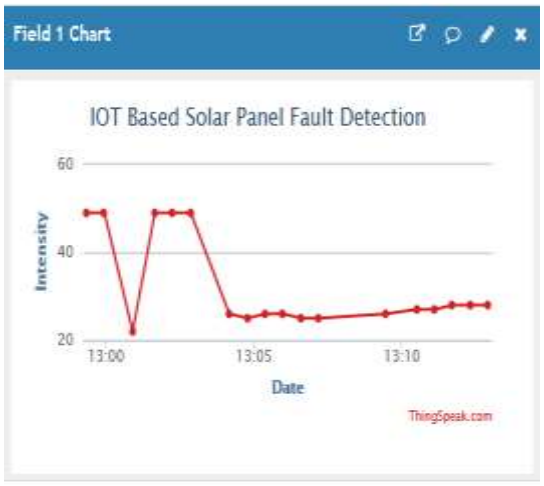

Fig. 3. IoT graph of illumination

This fig. 4 shows the voltage level generated in the solar panel. The voltage level is constant for all the solar panels as they are connected in parallel. The voltage level generated after certain duration is recorded as graph with respect to time.

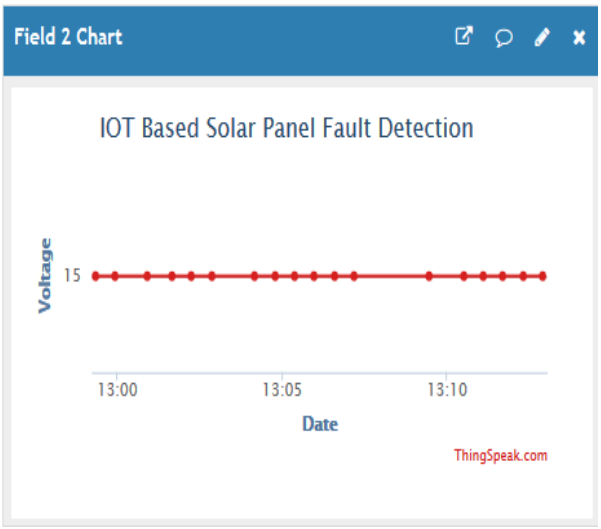

Fig. 4. IoT graph of voltage

This fig. 5 shows the current sensor value 1 which is connected across the solar panel 1. The current level increases and decreases according to the illumination level. The current generated by solar panel 1 is plotted as a graph with respect to time.

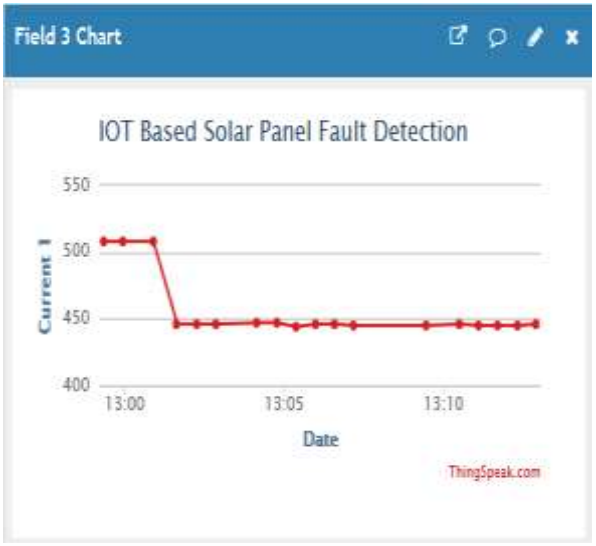

Fig. 5. IoT graph of current sensor 1

This fig. 6 shows the current sensor value 2 which is connected across the solar panel 2. The current level increases and decreases according to the illumination level. The current generated by solar panel 2 is plotted as a graph with respect to time. All these graphs are recorded in IoT using Think speak. By creating a channel in Think speak the field charts are recorded according to our requirement.

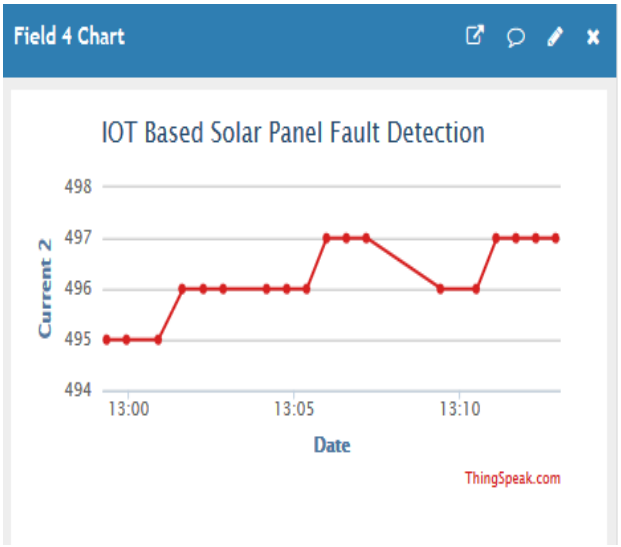

Fig. 6. IoT graph of current sensor 2

Conclusions

Implementing Renewable Energy technologies is one recommended way of reducing the environmental impact. Because of frequent power cut it is important to use renewable energy and monitoring it. Monitoring guides the user in analysis of renewable energy usage. This system is cost effective. The system efficiency is about 95%.

Conflicts of interest

Authors declare no conflict of interest.

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