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Research Article

Smart Monitoring and Controlling of PV System Using IoT

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Abstract

In order to analyse the performance of photovoltaic (PV) systems, we have developed a real-time expert system based on a central microcomputer used as a micro server and can be easily consulted from different automatic stations. The developed system is able to ensure the monitoring, supervision, and control of PV systems installed over a wide area, on one hand, and to create a general PV systems database, on the other. This system presents a design of a universal data acquisition system with available components and which is easily accessible through a server. This system presents a novel procedure for fault diagnosis in PV systems with Internet Of Things (IoT).This work describes the development of a system designed for renewable power generation integration. It continuously acquires solar and temperature, current, voltage, irradiance which is automatically correlated with energy parameters, obtained from renewable energy systems. The developed system was installed in a photovoltaic power generation. The developed application allows, in addition to the acquisition of weather and energy data, their continuous monitoring and correlation through a graphical user interface, providing a friendly interactivity with the user.

Keywords: PV Systems; Wireless Sensor Network; Cloud; Internet Of Things; Global System for Mobile communication; Controller.

Introduction

A wireless sensor network (WSN) is a computer network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations [1]. The development of wireless sensor networks was originally motivated by military applications such as battlefield surveillance. However, wireless sensor networks are now used in many civilian application areas, including environment and habitat monitoring, healthcare applications, home automation, and traffic control [2].

In addition to one or more sensors, each node in a sensor network is typically equipped with a radio transceiver or other wireless communications device, a small microcontroller, and an energy source, usually a battery. The size a single sensor node can vary from shoebox-sized nodes down to devices the size of grain of dust. The cost of sensor nodes is similarly variable, ranging from hundreds of dollars to a few cents, depending on the size of the sensor network and the complexity required of individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and bandwidth. In computer science, wireless sensor networks (Fig. 1) are an active research area with numerous workshops and conferences arranged each year [3-5].

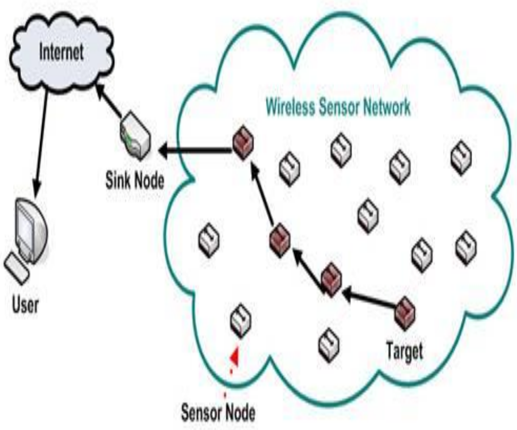

Fig. 1. Wireless sensor network

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Wireless sensor network is now used in many fields like environmental monitoring, habitat monitoring, acoustic detection, seismic detection, military surveillance, inventory tracking, medical monitoring, smart spaces and process Monitoring.

Area monitoring is a typical application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. As an example, a large quantity of sensor nodes could be deployed over a battlefield to detect enemy intrusion instead of using landmines. When the sensors detect the event being monitored (heat, pressure, sound, light, electro-magnetic field, vibration, etc), the event needs to be reported to one of the base stations, which can take appropriate action (e.g., send a message on the internet or to a satellite). Depending on the exact application, different objective functions will require different data-propagation strategies, depending on things such as need for real-time response, redundancy of the data (which can be tackled via data aggregation techniques), need for security, etc. Unique characteristics of a WSN are Small-scale sensor nodes, Limited power they can harvest or store, Harsh environmental conditions, Node failures, Mobility of nodes, Dynamic network topology, Communication failures [2-6].

In order to make a web based monitoring system, we have to use the following technology; HTML, Java and web server. In order to observe and control the system while working one computer has been used and already present and LAN line is connected to the internet. HTML - which stands for Hypertext Markup Language, is the predominant markup language for web pages. HTML elements are the basic building-blocks of webpages.HTML is written in the form of HTML elements consisting of tags, enclosed in angle brackets (like html>), within the web page content. HTML tags normally come in pairs like

The first tag in a pair is the start tag, the second tag is the end tag (they are also called opening tags and closing tags). In between these tags web designers can add text, tables, images, etc. Java - is a programming language originally developed by James Gosling at Sun Microsystems (which is now a subsidiary of Oracle Corporation) and released in 1995 as a core component of Sun Microsystems' Java platform. The language derives much of its syntax from C and C++ but has a simpler object model and fewer low-level facilities. Java applications are typically compiled to byte code (class file) that can run on any Java Virtual Machine (JVM) regardless of computer architecture.

In existing system we have developed a SCADA system for monitoring & accessing the performance of parameter such as voltage, current, humidity on real time basis. For this we have used the infrastructure of the existing industrial network, which is based on Programming Logic Controller (PLC), Supervisory Control and Data Acquisition (SCADA) is a field of constant development and research. This paper investigates on creating an extremely low cost device which can be adapted to many different SCADA applications via some very basic programming, and plugging in the relevant peripherals. Much of the price in some expensive SCADA applications is a result of using specialized communication infrastructure. The application of infrastructure, in the proposed scheme the cost will come down. Additionally the generic nature of the device will be assured. A SCADA deals with the creation of an inexpensive, yet adaptable and easy to use SCADA device and infrastructure using the industrial network, in particular. The hardware components making up the device are relatively unsophisticated, yet the custom written software makes it re-programmable over the air, and able to provide a given SCADA application with the ability to send and receive control and data signals at any non-predetermined time. From the SCADA system which is proposed in setup the battery voltage of 12v could be sufficiently recorded from remote location. The properly designed SCADA system saves time and money by eliminating the need of service personal to visit each site for inspection, data collection /logging or make adjustments.

Methodology

In the present work, the authors show a new methodology for automatic supervision and fault detection of PV Systems, based mainly on the analysis of the power losses. This methodology includes parameter extraction techniques to calculate main PV system parameters from monitoring data taking into account the real irradiance and module temperature, allowing simulation and evaluation of the PV system behaviour in real time. The ability to remotely monitor data about the power output of solar panels and the state of battery banks is of critical importance to the proper long-term maintenance of solar energy systems. Unfortunately, existing remote monitoring technologies are expensive, limited in their application, and in general require paying service fees to third parties above and beyond the cost of basic communication. In places where solar energy systems are employed as a replacement for a lack of electrical grid infrastructure, this cost may lead to the abandonment of the idea of remote monitoring altogether. Thus, the reality of expensive and proprietary remote monitoring technologies holds hostage the viability of renewable energy systems in developing countries [6]. The working of our proposed system is shown in figure 2 and 3.

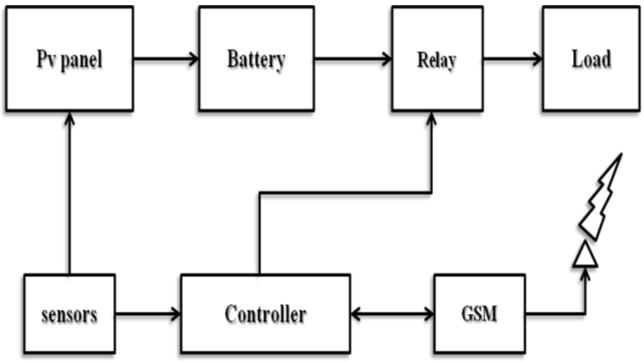

Fig. 2. Transmitter block diagram

Photovoltaic cell

A photovoltaic cell or photoelectric cell is a semiconductor device that converts light to electrical energy by photovoltaic effect. If the energy of photon of light is greater than the band gap then the electron is emitted and the flow of electrons creates current. However a photovoltaic cell is different from a photodiode. In a photodiode light falls on n-channel of the semiconductor junction and gets converted into current or voltage signal but a photovoltaic cell is always forward biased [8-10].

Global System for Mobile Communication

Global System for Mobile Communication (GSM) is a digital mobile telephony system that is refers to second-generation wireless telecommunications standard for digital cellular services. First deployed in Europe, it is based on TDMA (Time Division Multiple Access) technology. GSM uses three frequency bands: 900 MHz, 1800 MHz and 1900 MHz Dual-band phones operate on two out of three of these frequencies, while tri-band phones operate on all three frequencies.

It is a standard set developed by the European Telecommunications Standards Institute (ETSI) to describe protocols for second generation (2G) digital cellular networks used by mobile phones. The GSM standard was developed as a replacement for first generation (1G) analogue cellular networks, and originally described a digital, circuit switched network optimized for full duplex voice telephony. This was expanded over time to include data communications, first by circuit switched transport, then packet data transport via GPRS (General Packet Radio Services) and EDGE (Enhanced Data rates for GSM Evolution or EGPRS).Further improvements were made when the 3GPP developed third generation (3G) UMTS standards followed by fourth generation (4G) LTE Advanced standards. "GSM" is a trademark owned by the GSM Association.

Temperature sensor

These sensors use a solid-state technique to determine the temperature. That is to say, they don't use mercury (like old thermometers), (like in some home thermometers or stoves), nor do they use (temperature sensitive resistors). Instead, they use the fact as temperature increases, the voltage across a diode increases at a known rate. (Technically, this is actually the voltage). Temperature sensors are the devices which are used to measure the temperature of an object. These sensors sense the temperature and generate output signals in one of the two forms: change in voltage or change in resistance.

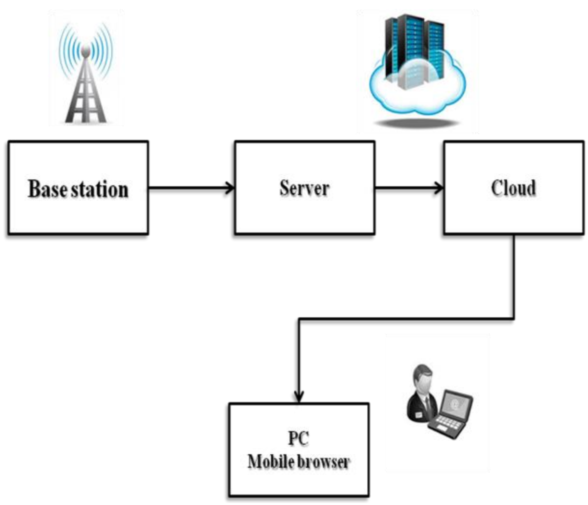

Fig. 3. Receiver block diagram

Mobile station

The mobile station (MS) consists of the physical equipment, such as the radio transceiver, display and digital signal processors, and a smart card called the Subscriber Identity Module (SIM). The SIM provides personal mobility, so that the user can have access to all subscribed services irrespective of both the location of the terminal and the use of a specific terminal. By inserting the SIM card into another GSM cellular phone, the user is able to receive calls at that phone, make calls from that phone, or receive other subscribed services. The mobile equipment is uniquely identified by the International Mobile Equipment Identity (IMEI). The SIM card contains the International Mobile Subscriber Identity (IMSI), identifying the subscriber, a secret key for authentication, and other user information. The IMEI and the IMSI are independent, thereby providing personal mobility. The SIM card may be protected against unauthorized use by a password or personal identity number.

Base station subsystem

The Base Station Subsystem is composed of two parts, the Base Transceiver Station (BTS) and the Base Station Controller (BSC). These communicate across the specified bus interface, allowing (as in the rest of the system) operation between components made by different suppliers. The Base Transceiver Station houses the radio transceivers that define a cell and handles the radio protocols with the Mobile Station. In a large urban area, there will potentially be a large number of BTSs deployed. The requirements for a BTS are ruggedness, reliability, portability, and minimum cost. The Base Station Controller manages the radio resources for one or more BTSs. It handles radio channel setup, frequency hopping, and handovers, as described below. The BSC is the connection between the mobile and the Mobile service Switching Centre (MSC). The BSC also translates the 13 kbps voice channel used over the radio link to the standard 64 kbps channel used by the Public Switched Telephone Network or ISDN.

GSM modem

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone. GSM networks enjoy wide international coverage. The use of a SIM (Subscriber Identity Module) card makes it easy to switch between different handsets and allows for the quick and easy import of data such as contacts and text-messages. The amount of battery-supported 'talk-time' is generally higher on GSM phones.

Results and Discussion

For PCB design electronic circuits we can use Proteus software .The ISIS Intelligent Schematic Input System (Intelligent Switching Input system), is the environment for the design and simulation of electronic circuits. The component library includes claims more than 10,000 circuit components with 6000 Prospect Simulations models. Own components can be created and added to the library.

ISIS includes a base VSM engine with support for the following functions: DC / AC voltmeter and ammeter, oscilloscopes, logic analyzers; Analog signal generators, digital pattern generator; Timer functions, protocol analyzers (including RS232, I2C, SPI). In the proposed system, prototype for 6 watts PV panel was designed. The hardware setup is shown in figure 4.

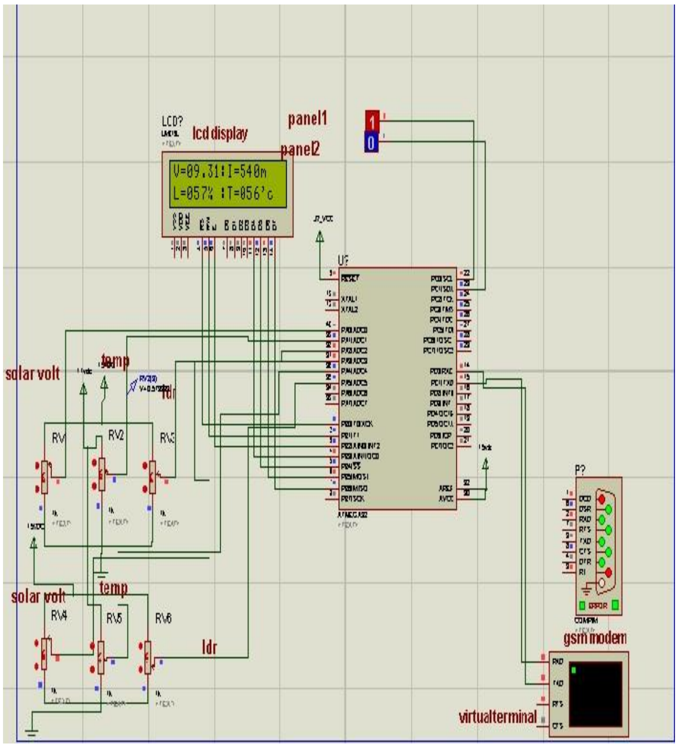

Fig. 4. Hardware implementation

The output from the panel is as shown in figure 5. This output is obtained from the router with the help of mobile phone or internet. In the past studies the problems are in the PV panels are to discover immediate faults occurring in solar panels, concerns measuring degradation over time and differentiate solar panel faults from partial shading [11-13]. The above problems are solved in using the proposed system and thus the control the PV panel anywhere in the world with the help of GSM and IoT.

Panel Monitoring

Voltage	Current	Temperature	Irradiance	Leakagecurrent	Date / Time
					2017-04-11 11:48:45
Solar+Volt=06.77V	Current=393ma	Temp=058c	Irradiance=023%	leakage=00.05ma	2017-04-11 08:59:23
Solar+Volt=06.77V	Current=393ma	Temp=058c	Irradiance=023%	leakage=00.05ma	2017-04-11 08:58:19
Solar+Volt=06.81V	Current=395ma	Temp=058c	Irradiance=023%	leakage=00.05ma	2017-04-11 08:56:18
Solar+Volt=06.81V	Current=395ma	Temp=058c	Irradiance=022%	leakage=00.05ma	2017-04-11 08:54:35
Solar+Volt=07.13V	Current=414ma	Temp=053c	Irradiance=013%	leakage=00.07ma	2017-04-11 08:53:00
Solar+Volt=06.97V	Current=404ma	Temp=060c	Irradiance=021%	leakage=00.05ma	2017-04-11 08:52:51
Solar+Volt=07.13V	Current=414ma	Temp=054c	Irradiance=014%	leakage=00.07ma	2017-04-11 08:51:59
Solar+Volt=07.01V	Current=407ma	Temp=060c	Irradiance=016%	leakage=00.05ma	2017-04-11 08:51:36
Solar+Volt=05.82V	Current=338ma	Temp=041c	Irradiance=015%	leakage=00.05ma	2017-04-11 08:19:32
Solar+Volt=06.10V	Current=354ma	Temp=053c	Irradiance=019%	leakage=00.05ma	2017-04-11 08:19:21
Solar+Volt=06.10V	Current=354ma	Temp=054c	Irradiance=019%	leakage=00.05ma	2017-04-11 08:18:44
Solar+Volt=00.00V	Current=000ma	Temp=031c	Irradiance=015%	leakage=00.00ma	2017-04-11 08:17:16
Solar+Volt=00.00V	Current=000ma	Temp=031c	Irradiance=019%	leakage=00.04ma	2017-04-11 08:17:06
Solar+Volt=04.04V	Current=234ma	Temp=029c	Irradiance=026%	leakage=00.04ma	2017-04-11 03:51:25
Solar+Volt=04.63V	Current=269ma	Temp=035c	Irradiance=029%	leakage=00.05ma	2017-04-11 03:51:15

Fig. 5. Simulation results

Conclusions

The PV panel output can be continuously monitored and controlled by wireless communication using internet. PV panel fault identification using wireless sensor node method was identified and implemented. we developed a real-time expert system based on a central microcomputer used as a micro server and can be easily consulted from different automatic stations. The developed system is able to ensure the monitoring, supervision, and control of PV systems installed over a wide area, on one hand, and to create a general PV systems database, on the other. This system presents a design of a universal data acquisition system with available components and which is easily accessible through a server. This system presents a novel procedure for fault diagnosis in PV systems with. This work described the development of a system designed for renewable power generation integration. It continuously acquires solar and temperature, current, voltage, irradiance which is automatically correlated with energy parameters, obtained from renewable energy systems will be implemented

Conflict of interest

Authors declare there are no conflicts of interest.

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