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IoT Based Solar Roof Top Management System

[1] Malini K.V HOD (EEE), [2] Saiprasad K.V, [3] Mubarak.S, [4] Hitesh Kumar Chodhary, [5] Firoz Khan
[12345], Electrical and Electronics Engineering, Bangalore

Abstract: **- Solar energy generation requires an efficient monitoring and management in moving towards technologies for net-zero energy buildings. This paper presents a dependable control system based on the Internet of Things (IoT) to control and manage the energy flow of renewable energy collected by solar panels within a micro grid. Data for optimal control include not only measurements from local sensors, but also metero-logical information retrieved in real-time from online sources. For system fault tolerance across the whole distributed control system featuring multiple controllers, dependable controllers is developed to control and optimize the tracking performance of photovoltaic arrays to maximally capture solar radiation and maintain system resilience and reliability in real-time despite failures of one or more redundant controllers due to a problem with communication, hardware or cybersecurity. Experimental results have been obtained to evaluate the validity of the proposed approach.**

Index Terms **— Solar tracking, solar energy, dependable control, Internet of Things.**

I. INTRODUCTION

technologies, internet-connected mobile devices such as smart phones and tablets are now in widespread use. Thus resulting in a new concept, Internet of Things (IoT) [1-2], was introduced and has received attention over the past few years. In general, IoT is actually an information sharing environment where objects in every-day life are connected to wired and wireless networks. Recently, it is used not only for the field of consumer electronics and appliances but also in other various fields such as a smart city, healthcare, smart home, smart car, energy system, and industrial security At present, the solar photovoltaic (PV) energy is one of the pivotal renewable energy sources. The solar energy is becoming a potential solution towards sustainable energy supply in future. As more and more Rooftop Solar Photovoltaic systems are getting integrated into the existing grid, there is a growing need for monitoring [3] of real time generation data obtained from solar photovoltaic plants so as to optimize the overall performance of the solar power plant and to maintain the grid stability. As local monitoring is not possible for the installer therefore monitoring remotely is essential for every solar power plant. At this juncture harnessing the power of IoT for monitoring solar power plants by using digital technologies and more advanced computational facilities is promising. Power generation from Solar Photovoltaic plants is variable in nature due to changes in solar irradiance, temperature and other factors. Thus remote monitoring is essential. For developing remote monitoring system for solar photovoltaic power plant, IoT (Internet of Things) approach is taken in this work which actually envisions a near future where everyday objects will be armed with microcontrollers and transceivers for digital communication. The remote monitoring eliminate the hazards associated[4] with the traditional wiring systems and make data measurement and monitoring process much easier and cost effective and IoT based systems take a giant leap towards monitoring by intelligent decision making from web. The decentralized architecture of the remote monitoring systems and its flexibility of deployment make it most suitable for industrial purposes In general remote monitoring systems have to fetch, analyze, transmit, manage and feedback the remote information [5], by utilizing the most advanced science and technology field of communication technology and other areas. It also merges comprehensive usage of instrumentation, electronic technology and computer software. Prevalent monitoring PV system approaches present poses some problems like low automaticity and poor real-time. These problems can be averted with an efficient remote environment information monitoring and controlling system. The discussion in this paper is 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 This system should include automatic diagnosis techniques the PV station. system is very important. In what follows,

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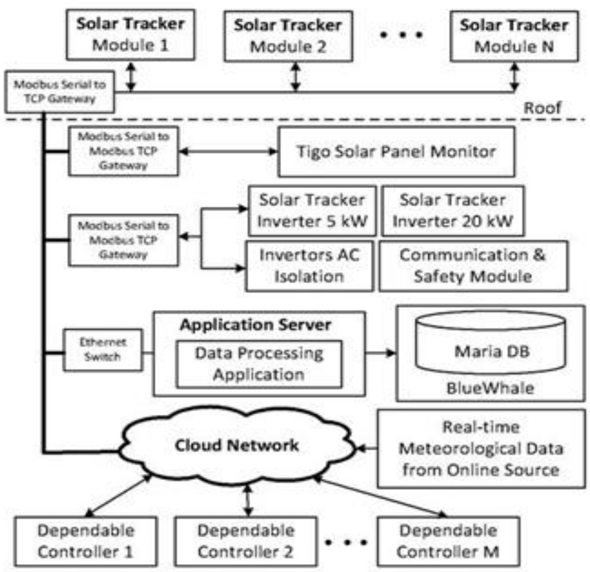


Fig. 1: Overview of the solar energy management in micro-grids.

Wi-fi technology is also used for remote monitoring and control of PV system for domestic applications. Wi-Fi (IEEE 802.11g) is chosen as it operates at 2.4GHz and offer high data rate of about 54Mbps in contrast to ZigBee (250Kbps). But this solution is suitable for microgrid network architecture. At present, a number of PV monitoring system have been put into operation .These systems often use wireless public networks such as GSM or other wireless communication networks for data transmission. But there are problems of high operation and maintenance cost which restrict the development of monitoring system and ultimately hinder the process of efficient generation monitoring in real time. This has influenced us to investigate a novel remote monitoring and control of PV system based on IoT[7]. The experimental set up includes solar panels, temperature sensor LM35, voltage transducers, current transducers, SIM900A GPRS module, PIC18F46K22 microcontroller, RS232 interfaces and converters. Programming Codes developed in house are run in MikroC software and hex code is loaded using MPLAB software. The visualization of the collected data in the control station has been done using website designed.

from the sensors is transmitted via the mobile radio network. A GPRS module is employed to send data to the remote server. IoT application schematic for the Solar Power Plant is shown in figure 1. The schematic diagram is three layered starting with the sensing layer at bottom which comprises of current sensors, voltage sensors, pyranometer for irradiance measurement and other sensors, this layer also includes microcontroller based data processing of data acquired from the sensors. The microcontroller communicates with wireless module to initiate and transmit data to server. Layer 2 as envisaged is the network layer where data logging from the plant for real time processing is done which includes database for storage. Then after the network layer, this processed and stored data is used in the application layer. In this layer sophisticated web based services are designed based on the data collected, processed and stored. Graphical user interfaces will help to monitor the performance of the plant,

PROPOSED CONCEPTUAL IOT BASED SYSTEM FOR PHOTOVOLTAIC MONITORING

The proposed conceptual system in this work is to monitor the state of a photovoltaic system through an IoT based network in order to control it remotely. The information advice the administrator with decision based on historical data that will significantly reduce the decision making time.

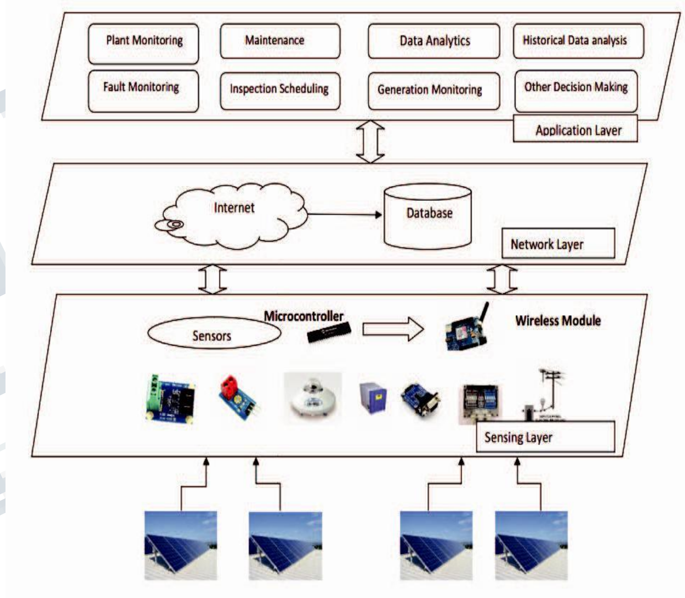
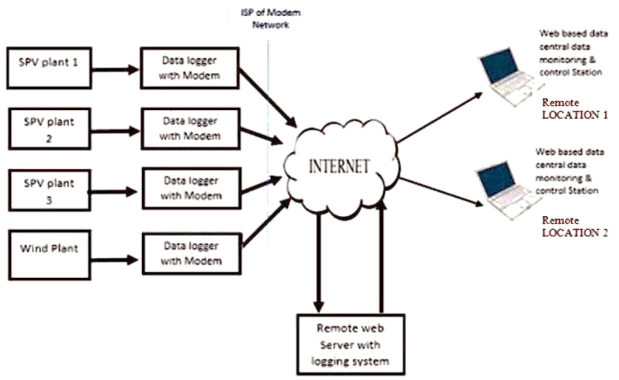


Figure 1 : Proposed IoT Application for Solar Power Plant

By using the IoT based remote monitoring system it will be easier to supervise the overall performance of a solar power plant The heart of the data logging unit is a PIC18F46K22 microcontroller, it is an extremely low power advanced RISC microcontroller. The data-logger has a Secure Digital Memory card of 2Gb for storing logged data. Using I2C protocol of the PIC18F46K22 microcontroller the monitored data is being written to MicroSD card for local storage. The sampling rate is 1 scan per second, there are 8 analog inputs, and the channel function and range selection can be done by programming



A smart data acquisition system as shown in figure 2 for solar power plant is described in this paper. The data acquisition system is capable of acquiring the values for Battery voltage, Battery current, PV voltage, PV current, Grid Voltage, Grid current, Solar insolation and temperature. The PV voltage is sensed by voltage divider circuit, PV current is sensed by using shunt with differential amplifier, Grid Voltage is sensed by potential transformer with precision rectifier, Grid Current is sensed by current transformer with precision rectifier, Battery Voltage is sensed using voltage divider circuit, and Battery Current is sensed by using shunt with differential amplifier.

WIRELESS TRANSFER MODULE

'SIM900' is a GSM/GPRS module used for communication between the data logger and the server. This modem as shown in figure 5 is a quad-band GSM/GPRS module with a powerful single-chip processor integrating AMR926EJ-S core manufactured by 'SIMCom Wireless Solutions Ltd'. It delivers GSM/GPRS850/900/1800/1900 MHz performance for voice, SMS and data. It is a low-power consumption module with current consumption as low as 1.0 mA in sleep mode thus it is highly energy efficient. The module is 24 mm x 24 mm x 3 mm and is ideally designed to meet any requirements for Machine2Machine [8] applications .It is interfaced by COM port by using RS232 protocol. It has a GPRS multi-slot class 10/8 and a B-type GPRS mobile station class. Microcontroller is programmed to provide AT[9] commands to control the GSM/GPRS module.

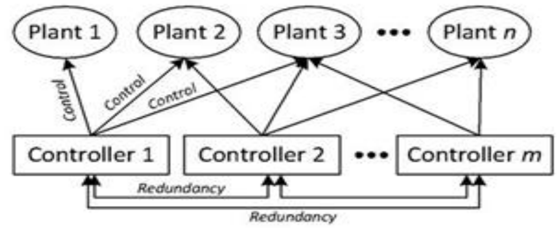
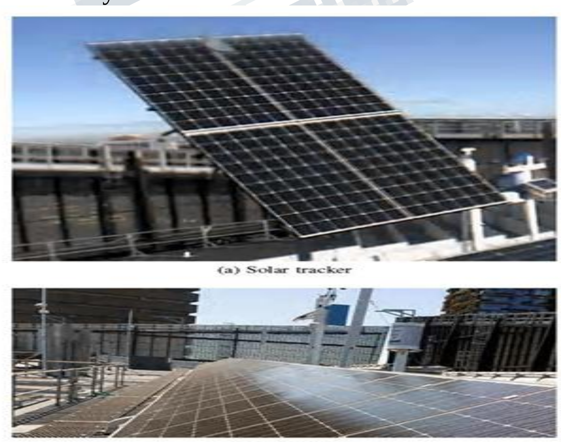


Fig. 3: Resource efficiency: one controller controls multiple plants while acting as redundancy for other controllers.

Resource efficiency in dependable control and Internet of Things With IoT, every device is connected to each other and through the cloud infrastructure, the abstraction between them are established. Consequently, no controller is dedicated to a certain device. Instead, one controller can be allocated to simultaneously control multiple plants while, at the same time, act as a backup controller for others as shown in Fig.3. The number of plants that each controller can control depend on the computation complexity of the control algorithm and the processing capability of the control processor. With rapid ad- vancements in very-large-scale integration (VLSI) design and hardware manufacturing, the embedded computer boards are becoming more powerful with better multi-tasking capability As a result, a small number of controllers can be deployed to control multiple plants while still maintain the redundancy for reliability and self-recovery.



(a) Solar tracker

(b) PV array

Fig. 4: Solar energy harvesters.

II. CONCLUSION

In this work, we have introduced a system to manage the re-newable energy harvested by the solar tracker. A hardware and network framework have been successfully implemented with real solar energy fed to the microgrid to power local facilities such as laboratory lighting system and battery charging station. The IoT technology has been utilised to provide ubiquitous computing and control within the microgrid. On top of it, the dependable control technique has been employed to enhance not only the optimal tracking but also the reliability and self- recovery of the system. During the implementation, related concepts including the stability of dependable control systems, transport protocols for real-time data communication,

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BIOGRAPHY

	**Mrs. MALINI K V** M.Tech, MBA, MIE, LMISTE, Prof & Head of the department (EEE) Sri Sairam College Of Engineering Bangalore, having 18years of experience in industries and 9 years of teaching.
	**Saiprasad K.V** Studying 7th Sem Electrical and Electronics Engineering in SSCE Bangalore
	**Firoz Khan** Studying 7th Sem Electrical and Electronics Engineering in SSCE Bangalore
	**Hithesh kumar choudhary** Studying 5th Sem Electrical and Electronics Engineering in SSCE Bangalore
	**Mubarak.S** Studying 5th Sem Electrical and Electronics Engineering in SSCE Bangalore