# A Smart Monitoring Systems for the Electric Grid in the remote territory

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## Abstract

Industrial automation and smart energy monitoring are just a few of the many uses for the Internet of Things (IoT). For the Electric Grid (EG) to be reliable and efficient, IoT devices are employed at many stages of the EG, including monitoring and controlling grid data. Despite the various advantages of IoT integration in the EG sector, the grid must overcome obstacles in IoT-EG integration in order to function properly. Based on the findings of Electric grids in outlying regions may be kept under control with the use of sophisticated devices that check voltage and current, then communicate the results to a master system, which subsequently transmits the information to control room. In an ad hoc network, devices connect and interact with one other without the intervention of a central authority. Wireless local area networks (WLANs) account for the vast majority of ad hoc networks (LANs). The distance between devices is predetermined by us (Ex. after 6-10 towers). Rather of using a base station or access points to coordinate data transfer, the devices interact directly with each other. In this system, we will use Atmega2560, Relay Module, Wireless Fidelity (Wi-Fi), Hyper Text Markup Language (HTML), Cascading Style Sheet (CSS), Java Script, Python, and Oracle Relational Data Base Management Data System for developing applications and checking Output data from monitoring systems to the Pre-Defined Data Base Management System and for storing data.

**Keywords:** Internet of Things, Smart Systems, Electric Grid (EG), Smart Grid (SG), Atmega2560, Current Sensors, Voltage Sensors, Oracle RDBMS.

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## 1. Introduction:

Integration of information and communication technologies (ICTs) and the Internet of Things (IoT) in Smart Grids provides reliability, cost-effectiveness, and intelligent features while requiring minimum human participation. The ability for smart devices and components to communicate with one another is crucial in the Internet of Things paradigm [1].

In light of the above-mentioned advancements in the Internet of Things and their implementation in power grids, we have presented an Internet of Things-assisted power monitoring system for the Electric Grid. When devices connect to one another and interact with one another on their own, they constitute an ad hoc network. Wireless local area networks (WLANs) account for the vast majority of ad hoc networks (LANs). When compared to wireless LANs, which depend on a base station or access points to coordinate data transfer, mesh networks rely on the devices themselves to interact with one another. In distant and hard terrains, it is difficult to monitor the health and condition of cables and poles in real time in order to prevent failures and outages from occurring. In the case of deploying devices at a certain distance (for example, after 6-10 towers) (as seen in Figures 1 and 2), the future generation of electric grids will depend largely on sensors, actuators, and transducers [1, 2]. The Internet of Things has developed into a technology that allows for the development of innovative solutions to challenges in the electric grid system. In distant and hard terrains, it is difficult to monitor the health and condition of cables and poles in real time in order to prevent failures and outages from occurring. In the electric grid system, Internet of Things (IoT)-enabled sensors are commonly used to transmit useful data over the internet and via web-based applications, allowing for improved grid management[3].

We will have a workable solution if we direct them to check voltage and current, and then utilize an ad hoc network to transport the data to the closest master system illustrate in figure 4, which will subsequently transmit the data to control room, as described above. Using this information, we construct a model that checks for healthy and faulty wires and warns the operator if any poor wire sectors are detected. A distinction between major and small difficulties will also be presented to the model during training. It gives advantages to businesses in terms of analyzing and managing their resources.

A power monitoring system based on the Internet of Things that utilizes Oracle RDBMS to detect and analyze electrical properties such as voltage, current, active power, and load energy Transferable is discussed in this paper. SGs, the Internet of Things, and IoT-assisted SGs are all discussed in detail in a review of the present research in these fields.

## 2. Literature Review

The Internet of Things is used in a variety of applications, including smart energy monitoring, industrial automation, and a variety of other uses (IoT). Devices connected to the Internet of Things (IoT) are being installed at different stages of the Smart Grid (SG) to monitor and regulate grid statistics in order to ensure reliable and efficient electricity distribution. Despite the fact that IoT integration in the SG sector offers various benefits, the challenges of IoT-SG integration must be solved in order for the grid to function properly and efficiently. In order to get real-time electrical data from System the Internet of Things-based software package 'Think Speak' is employed by the authors in this work [4].


Fig. 1: Smart System Connected to Towers.

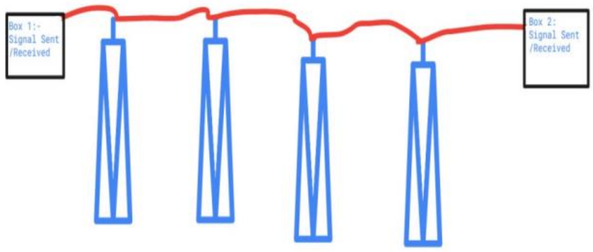


Fig. 2: An Overview of Data Transfer.

Traditional power systems are being changed into SG systems, which are intelligent, secure, efficient, and trustworthy, among other attributes[5]. In contrast to the existing electric system, which is built on a one-way flow of energy and information from sources to end users, the future Smart Grid will enable various channels for the movement of power, and especially information about that flow, across the system. The smart infrastructure system, the smart management system, and the smart protection system are the three key systems that are investigated in this work[6]. Future directions are also suggested in each system, as are possible future possibilities. Authors especially investigated the smart energy subsystem, the smart information subsystem, and the smart communication subsystem as they pertain to the smart infrastructure system in general. Different management objectives, such as increasing energy efficiency, profiling demand, increasing utility, decreasing cost, and controlling emissions, are investigated for the smart management system and for the smart protection system. Additionally, different failure protection mechanisms that improve the reliability of the smart grid, as well as security and privacy issues in the smart grid are investigated [7]. Authors investigated the smart energy subsystem, the smart information subsystem, and the smart communication subsystem in the context of the smart infrastructure system [8].

It is not feasible to have SG without the use of IoT technologies. It is possible to participate in several forums addressing SG and IoT integration, with specific concerns focusing on Smart Grid Internet of Things(SGIoT) [9]. Several efforts have been made to cover the SGs that are facilitated by the Internet of Things. [7] Authors Provides a high-level overview of the SG concept in this work[10]. Al-Ali and Aburukba [11]proposed a vision of SG in the context of the Internet of Things, with a particular emphasis on the SG communication layer. A full assessment on advanced metering infrastructure (AMI) and smart metering was presented in [12] to solve the challenges of electricity quality and reliability in the traditional grid[12]. The authors, on the other hand, did not discuss other important aspects of IoT-assisted SGs, such as designs and applications. When it comes to smart grid technology, the smart energy meter (SEM) is one of the most important components. [13] Discussed how the billing function of SEM is one of the most significant services for its operators and end-users, and how it may be improved. [14]presented an overview of SG technologies such as the Internet of Things, smart meters, and the Energy Management System is provided (EMS). The SG's primary responsibilities are data monitoring, control, and analysis. Hundreds of thousands of monitoring devices are installed at power plants, distribution hubs, transmission towers, and consumer sites [15][12]. To convey data on load consumption to the utility on a regular basis, the authors used power sensing and communication devices, which they developed themselves. We also discuss the development of an algorithm for identifying power theft, which may be used by utility companies to better protect their customers. However, the technology that has been developed is prohibitively costly and impractical for large-scale adoption[16]. The Electric Grid system makes use of a range of equipment for monitoring, analyzing, and controlling its operations. The next section shows how to configure an Internet of Things-assisted monitoring smart system in Electric Grid.

## 3. Material and Methods

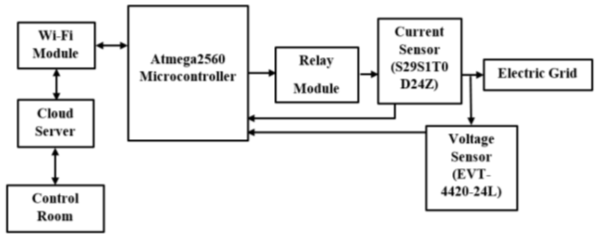


Fig. 3: Block diagram of an IoT based Electric monitoring system.



### 3.1. System Overview

The monitoring, communication, and analysis units that are envisioned are organized as follows: Monitoring equipment consists of (S29S1T0D24Z) current sensors and a voltage sensing circuit that are linked to towers at a certain distance (for example, after 6-10 towers) from each other (ass shown in Fig. 2). The communication unit is made up of an Atmega2560 and a Wi-Fi module, respectively. Voltage and current measurements, load profiles, energy usage, and other data may be obtained from the analysis unit using a remote application.

### 3.2. System Design

The block diagram of an Internet of Things-based power monitoring system is shown in Figure 3. In order to test the node, an Atmega2560 with a Wi-Fi (ESP-8266) communication module was connected to an electric grid, voltage and current sensors, a relay, and an Atmega2560. In this case, sensors are linked to the Atmega2560, which gathers the resulting load data and stores it in internal memory. Through the use of a UART interface, Wi Fi module communicates with the server by obtaining load data from the Atmega2560. Wi-Fi module modulates act as a gateway between the monitoring side and the website on the other end.

### 3.3. Atmega2560

The Atmega2560 is a high performance low power 8-bit microcontroller board. It has 8 KB of static random access memory (SRAM), 256 KB In-system programming (ISP) flash memory, 86 number of general purpose Input/Optut (I/O) lines, Real time counter, 32 general purpose working registers, pulse width modulation

(PWM), four Universal Synchronous Asynchronous Receiver Transmitter (USARTs), 16-channel 10-bit A/D converter, and a Joint Test Access Group (JTAG) interface for on-chip debugging [17, 18].

The board also has an oscillator with a frequency of 16MHz, a USB connection, an input power connector, an In Circuit Serial Programming (ICSP) header, and a reset button. It has everything required to support the microcontroller; to get started, it connects to a computer through a USB connection or is powered by an AC-to-DC converter or a battery. Atmega2560 is used in this project because it regulates the system, such as when voltage, current, power, and loads are received from the wire and processed by the system [19].

### 3.4. Voltage Sensor

A voltage sensor is a sensor that is used to compute and monitor the amount of voltage present in a system or in a device. Voltage sensors may be used to detect the level of an alternating current or direct current voltage. It is a wireless tool that may be connected to a wide range of assets, machinery, and other pieces of machinery and equipment[20]. 24/7 monitoring is provided, with staff members continuously on the lookout for voltage data that might suggest an issue. Having low voltage may indicate a possible problem, while having too much voltage may put other assets at risk of damage. It senses the voltage from the wires/cables for checking voltage in the wire/cables is comes in the normal range or not. It is connected to a Smart system for sharing data to a cloud server.

### 3.5. Current Sensor

A current sensor is an electronic device that measures the amount of current flowing through an item and calculates and monitors it Current sensors may be used to identify whether an alternating current or a direct current is present. In electrical engineering, it is defined as a device that detects and transforms current to a readily quantifiable output voltage that is proportionate to the current flowing through the measured route. Sensors are available in a broad number of configurations, each of which is optimized for a given current range and ambient condition. It senses the current from the wires/cables for checking current in the wire/cables is comes in the normal range or not. It is connected to a Smart system for sharing data to a cloud server[20].

### 3.6. Wireless Fidelity

Computers, mobile devices (smart phones and wearable’s), and other equipment (printers and video cameras) may all communicate with the Internet via the use of Wi-Fi, which is a wireless networking technology. It enables these devices, as well as many others, to communicate with one another, resulting in the establishment of a network. We use Wi-Fi because of it can share the data from Smart systems to Data base management system.



### 3.7. Relay Module

An electromechanical device that establishes or breaks electrical connections is known as a relay. It has a moveable mechanical part that may be controlled electrically through an electromagnet. A relay is comparable to a mechanical switch in that it may be switched on and off electrically instead of manually.

### 3.8. Software Application

Oracle RDBMS is an open-source IoT platform that is used to store, analyze, and retrieve data from loads. It is available for free download here. Data base management systems (DBMS) make it possible to interpret the information that has been saved. The recorded information offers information on load patterns, faults in electric networks, and how to better balance demand and supply of power between generation and consumption, among other benefits.

## 4. Proposed Methodology

Each of the offered solutions is built on the Atmega2560 (microcontroller), which communicates with a network of voltage and current sensors as well as Wi-Fi module, load appliances, and other components (as shown in Fig.3). Atmega2560 is a programmable electronic board. Atmega2560 can read current and voltage from sensors if they are programmed properly. This Smart System is present at towers that are a specified distance apart, usually between 6 and 10 towers. The Wi-Fi module will upload data to a cloud server and then send it to an Oracle RDBMS application on the same server. This information should be consistent with our previously specified Data Set. Providing that the data is correct in accordance with the pre-defined data set, there is no issue with the electric wires; their health and conditions are in good shape. A server will get a warning if the data is incorrect, indicating that there is an issue with the electric lines at that particular Tower number. Figure 4 illustrates this working concept.

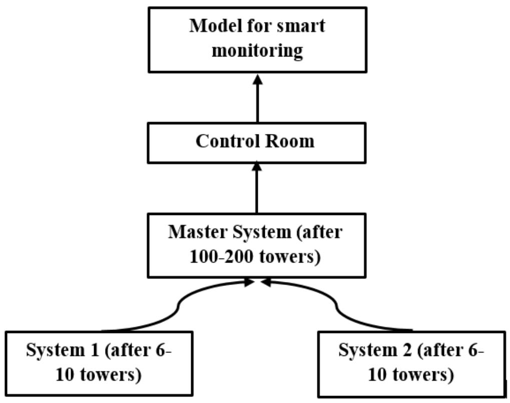


Fig. 4: An overview of working of Smart Systems

## 5. Hardware Prototype and Results

The hardware design of an Internet of Things-based power monitoring system is being developed (as shown in Fig. 3). This hardware combination will be linked to the Electric Towers in order to evaluate its functionality (as shown in Fig. 1). Real-time display of load results is achieved via the use of computer systems, and data transmission to the Oracle RDBMS application is accomplished through the use of the Wi-Fi module. Tests will be carried out on the hardware using a variety of different current, voltage, power, and energy loads. Wi-Fi delivers real-time data to the Oracle RDBMS (Relational Data Base Management Systems) for storage, and Computer Systems outputs data on a Software application, according to the manufacturer. After running a simulation program, our gadget gets data from the cloud using the MQTT messaging protocol. An example of a protocol is MQTT, which gathers data from devices and transmits it to a server. The gadget is controlled by the usage of the Oracle RDBMS Application.

## 6. Conclusion

Modern grid systems need the implementation of intelligent operations in the power system architecture. The electric grid is a new and improved grid that addresses the numerous issues of efficiency, health, and the state of the wires and cables that have plagued the old grid in the last several decades. The implementation of an Internet of Things (IoT)-based Electric Grid monitoring prototype is described in this study. The Oracle RDBMS is used as a software tool to access the data from the Smart System load. The large-scale application of the proposed design needs the development of a low-cost power sensing and monitoring device to be used in conjunction with it. A cloud-based smart monitoring system for the Obscure Terrain Region is being developed by the authors with the goal of deploying it in the near future.

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