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A System for Monitoring the Electricity Sub-Station using Internet of Things

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ABSTRACT

All-Pervading sensing enabled via Wireless Sensor Network (WSN) technologies has created a great impact on several areas of modern living stratum. It provides the facility to measure, conjecture and understand the environmental indicators starting from natural resources to metropolitan environment. The outburst of these devices in communicating-actuating network explores the Internet of Things (IoT), in which sensors and actuators binded together around us. Then the information is being shared among devices to develop a fully automated environment. Nowadays there are several applications supported by IoT, among that home automation, health care, social welfares are the major areas which attained more importance. In order to deal with emergency situations that arise in electricity supply station due to abnormal functioning of transformers, capacitors and reactors, its technological parameters must be monitored.The number of parameters to be measured and monitored is likely to error prone when it would be processed manually. This proposed system presents an IoT based real time online electric substation monitoring system and it can monitor as many transformers located at heterogeneous locations. By regular remote monitoring of transformers, capacitors, reactorshuge loss can be avoided and also can make accurate decisions using IoT.

KEYWORDS: GSM, GPS, Internet of Things (IoT), M2M, Smart Energy, SHEMS, Wireless Sensor Networks (WSN).

I. INTRODUCTION

IoT is a proficient paradigm of interconnected things which permits the physical items or objects to connect, act together and exchange data with other items or object. The main objective of IoT is not only to establish communication among items or objects but also to automate the tasks.The area of applications of IoT follows the broaden approach that includes home automation, health care, energy systems, smart cities, agriculture and industries.IoT is used for connecting the objects that are located at various detached locations from each other

[1]. The irrepressible, unswerving, seamless energy and electrical power flow systems are the crucial factors for enhancing the smart city features such as smart hospitals, smart factories, smart traffic and smart automation. These factors are running without any disruption with the help of smart energy and electrical management systems [2].

This proposed system is specially designed for monitoring the condition of sub-station transformers which are deployed at dispersed locations. There are many parameters to be quantified and monitored periodically. It is quite costly and difficult to monitor the parameters by appointing a person at all locations. It would also lead to error prone when the monitoring is manual and the greatest issue is to have all the transformers data at a single sink. In order to deal with these issues, this proposed system has many sensors connected to a microcontroller device, which senses the parameters. The sensed data's are transferred to a real time web application via wireless communication technology and through the web application the data can be monitored remotely.

II.LITERATURE REVIEW

The IoT changed the human life when compared to past decade. IoT has been foreshowed as one of the key development to be realized throughout the internet technologies [3]. IoT converged from the wireless technologies, micro-electromechanical systems, micro services and the internet. IoT is automation and embedded system which comprised of electronics, networks, software and sensors that enables objects to exchange data in order to control objects remotely.

WSN is a collection of specific transducers integrated with communication mechanism for remote monitoring and recording the data at distributed locations [4]. The common monitoring attributes are temperature, humidity, pressure, wind direction and speed, sound, voltage and so on [5]. WSN allow connecting the objects to the internet using a gateway which acts as interface for WSN and internet. To enable the integration of WNS in the IoT, there are two relevant protocols to be added such as the IPv6 over Low power Wireless Personal Area Networks (6LoWPAN) protocol and Machine to Machine communications (M2M) protocols [6].

Steven Lanziseral proposed an energy-efficient solution which uses a Communicating Power Supplies (CPS) for facilitating the energy information transfer and controls the information between the devices and building management system [7].QinranHu constructed a hardware system which has Smart Home Energy Management System (SHEMS) that includes applications like communication, sensing and a machine-learning algorithm. It reduces the total electricity bills for users without any human intervention [8].

Dae-Man Han initiated smart home interfaces and device that allows interoperability among Zigbee devices manufactured by various electrical equipment vendors. Zigbee is used for data transferring about the power and energy of home appliances [9]. Jinsoo Han offered a photovoltaic system management to improve home energy using PLC. It consists of PLC modem, Renewable Energy Gateway (REG) and smart devices. The amount of DC power generated by PV modules is transmitted to the grid-connected inverter through PLC modems with

REG. The received data is stored and processed by REG. The smart applications allow the user to view the status of the entire PV system and facilitate the clients to reduce the failures and fix them easily [10]. Overbyeet. al have presented a study on different visualization techniques for fair representation of the data. The techniques are contouring, animation, aggregation of data and virtual environments [11].

III. SYSTEM ARCHITECTURE

3.1 Objective of the Problem

In this fast emerging world approximately 2000 electricity sub-station were situated at various locations in and sound the every state. The monitoring and taking immediate remedial measures for the faults on each sub-station is the major challenge. There are as many factors to be measured and monitored to maintain a healthy sub-station. But it is more difficult work and also costlier to deploy a person at every sub-station. It would also lead to have error prone measurements when it is being manual. This proposed system provides a IoT based real time solution for the above problems. It uses sensors to measure the major factors of sub-station and the data can be monitored remotely via wireless technologies via web based applications.

3.2 Proposed System Architecture

The proposed system architecture is depicted in the Fig. 3.1

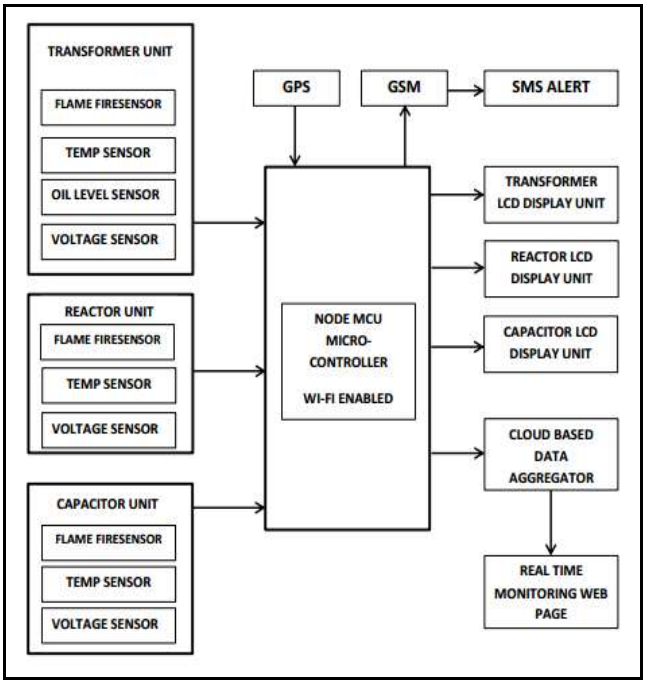

Fig. 3.1 Proposed System Architecture

3.3 Hardware and SoftwareRequirements

The proposed system requirements are listed in the table 3.1

Component	Description	
Node-MCU [11]	Type Operating System CPU Memory Storage	Single-Board Microcontroller XTOS ESP8266 128 KBs 4 MBs
GPS (Global Positioning System) Module [12]	It is used for detecting the Latitude and Longitude sub-station and exact UTC time (Universal Time Coordinated).	
GSM (Global System for Mobile Communications) [12]	It is used for sending and receiving the sub-station status information via SMS (Short Message Service).	
LCD (Liquid Crystal Display)	It is used for displaying the parameter values at every sub-station node.	
Flame Fire Sensor	It is interfaced with the microcontroller to detect the fire.	
Temperature Sensor	LM35 temperature sensor used to measure the current temperature reading of transformers, capacitors and reactors in the sub-station.	
Voltage Sensor [13]	It is used to detect the voltage supply of transformers, capacitors and reactors in the sub-station.	
Oil Level Sensor	It is used to detect the oil level in the transformers.	
Arduino IDE	It is used for programming the Node MCU micro-controller.	

Table 3.1 Hardware and Software Requirements

3.4 Working Principle

An electricity substation may have transformers to convert voltages between two end points and voltage correction devices like capacitors, reactors [14]. These three elements are to be carefully monitored for avoiding faults to maintain uninterrupted transmission of power. Flame fire sensor, oil level sensor, voltage sensor and temperature sensor are integrated with transformer for sensing the various parameters like oil level, voltage, temperature and fire. Flame fire sensor, voltage sensor and temperature sensor are integrated with capacitor and

reactor for sensing the parameters like voltage, temperature and fire. All the sensors integrated to three units (transformer unit, capacitor unit, reactor unit) are interfaced with Node MCU to receive and process the substation parameters. From the micro-controller the data is forwarded to the cluster-based [15] data aggregation sink which is cloud storage as scenario shown in Fig. 3.2. Then the values are transferred to the predefined web application via wireless communication and it would be accessible remotely from any location. In addition to this, the concerned authority can be notifiedby the status of each substationvia SMSusing GSM. The location status of each substation is extracted via GPS and it is also notified along with parameter values.The values of the parameters are displayed in the LCD's at the each substation.

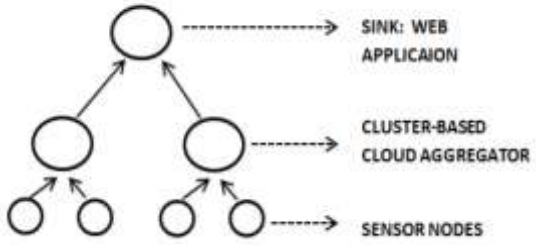

Fig. 3.2 Cluster-Based CloudData Aggregation

3.5 Process Flowchart

The process progress of the proposed system is depicted as flowchart in Fig. 3.3

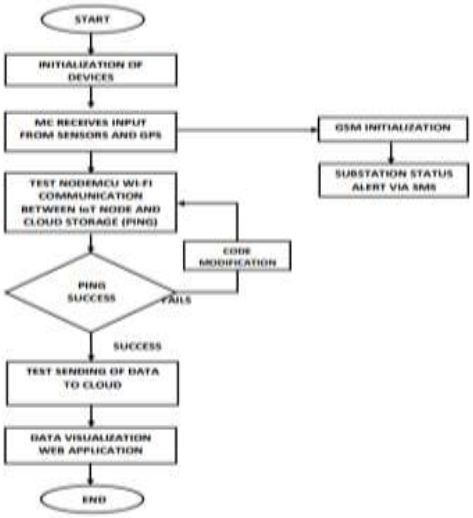

Fig. 3.3 Process Flowchart

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IV. RESULTS AND DISCUSSIONS:

In this section, the reactor unitprototype of the proposed system is shown in Fig. 4.1, the status of the substation is intimated via SMS are shown in Fig. 4.2 and the data displayed on web application is shown in Fig. 4.3.

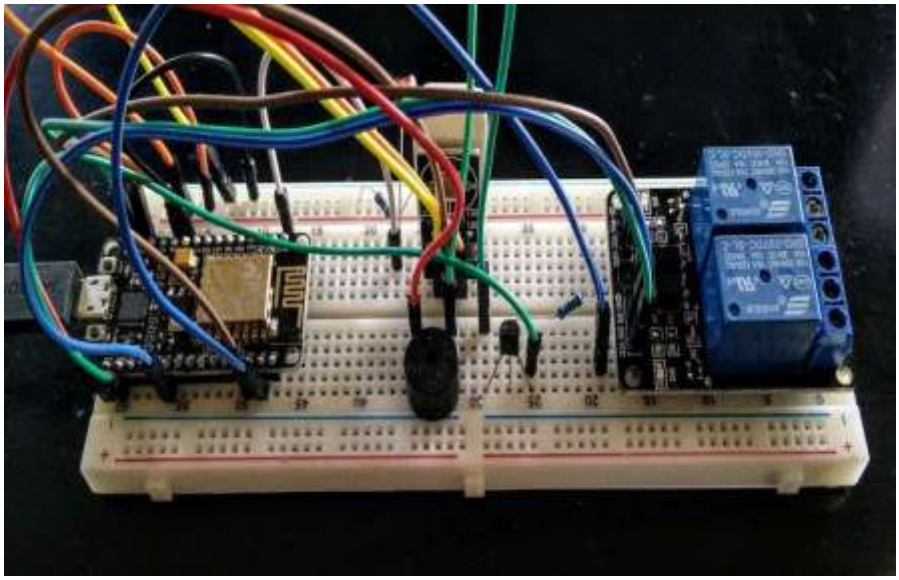

Fig. 4.1 Proposed System Prototype Model(Reactor Unit)

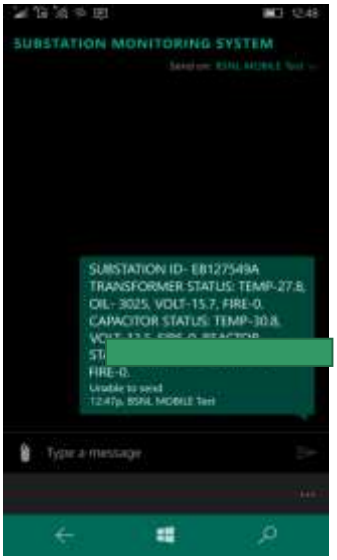

Fig. 4.2 Substation Status SMS Alert

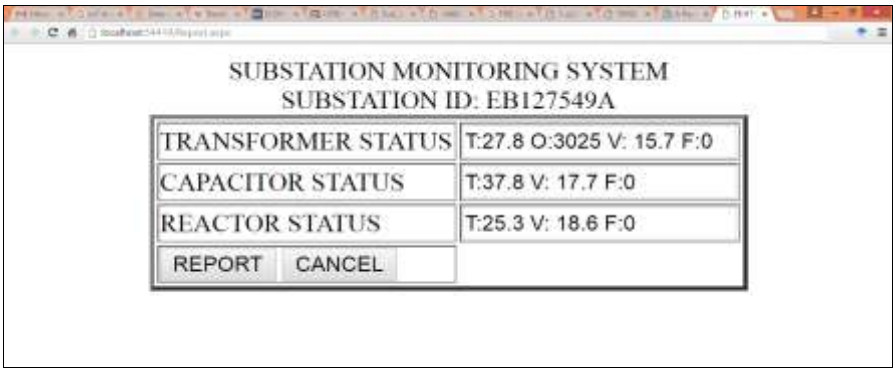

Fig. 4.3 Substation Status displaying on Web Application

V. CONCLUSION

The proposed system is very cost effective and replaced the error prone that would occur by manual substation monitoring scenario. The system provides a cloud-based storage and web application through which the sensor data can be accessed from remote location at a glance. It has SMS alert mechanism for notifying substation status. Also, it created a new pathway to take necessary measures priory in case of any emergencies that may occur in substations. In future, the system can be enhanced with additional features for automation of the tasks at substations.

VI. ACKNOWLEDGMENT

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