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Design of an IoT Based System for Monitoring and Controlling the Substation Equipment

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ABSTRACT

In the era of modern digitalization world it is a simple to monitor and control the substation equipment remotely using expensive PLC and SCADA system but it is desirable to design a system which is cost effective, smart and reliable. So that IoT is an effective solution as the real-time capability of IoT is considered as a key feature for monitoring and control applications of power systems. The IoT is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human to human or human to computer interaction. These devices capable of interacting with one another directly or indirectly and also data collection are performed locally or remotely via centralized servers or cloud based applications. This paper aims to design a low cost energy monitoring and controlling system using IoT devices. This paper shows result of effective use of IoT devices in power system to obtain better efficiency with less time. The use of IoT devices improves the power system performance remotely without any human intervention. In this project the prototype of the system using Raspberry pi has been designed. The use of Raspberry pi reduces manpower and maintenance cost. It performed mainly two functions such as oil quality and oil level sensing and transformer differential protection. Keywords-Internet of things, power system monitoring and controlling, oil quality and quantity sensing, Iot based differential protection.

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I. INTRODUCTION

The past 50years have been dominated by the so-called communication revolution. The upcoming years are expected to contemplate what we might call the electric power and energy systems revolution. Concepts such as smart grid, intelligent energy networks, and the "internet of energy" are already in our lexicon.

Remote monitoring and controlling of the sub-station equipment is an important issue for the power/energy management department which is normally done manually, or using an expensive PLC and SCADA system. With the emergence of the internet and computational era, a smart monitoring and reliable controlling system over the entire sub-station equipment is highly desirable that can be achieved by introducing the Internet of Things (IoT) technology.

IoT is the network of physical devices embedded with electronics, software, sensors, actuators and network connectivity which have the ability to identify, collect and exchange the data. Each thing is uniquely identifiable through its embedded computing system and able to interoperate within the existing internet infrastructure. An IoT based network strategy for monitoring and controlling the sub-station equipment provide efficient time and resource management.

This project mainly focused on to indicate the quality and present amount of oil in the transformer & oil circuit breaker (OCB) at remote location without being physically present so that proper corrective actions must be taken by the operator. This system represents an alternative way to provide differential protection where the distance between two sides of the equipment has no effect on system performance.

II. PRINCIPLE OF IOT BASED SUBSTATION MONITORING SYSTEM

Figure shows the design model of the system. It uses the different sensors to sense the transformer oil quality and

quantity as well as current sensor has been used and the data is sent to the cloud server through Wi-Fi network. The advantage of this system is that the data can be saved and the real-time data can be obtained at any time. Once the data is received it analyses and checks for the respective action and signal are sent to the actuator.

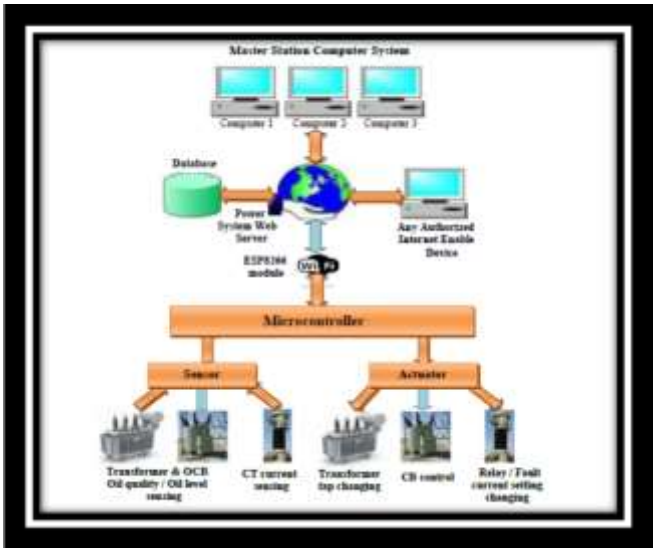

Fig. 1: Black Diagram of the System

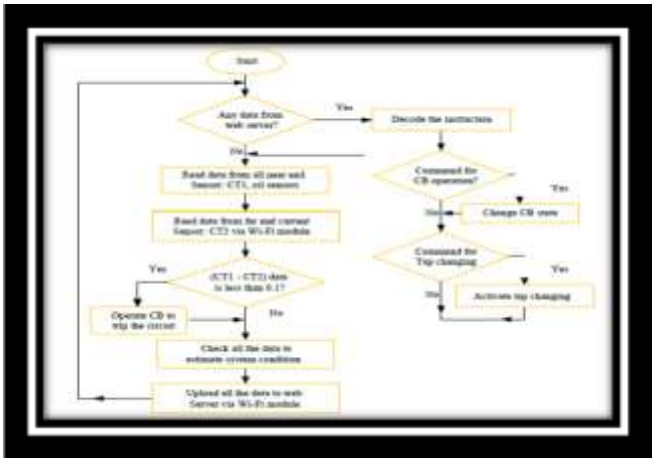

Fig. 2: System Architecture

The algorithm of the proposed model is simplified to a flowchart as shown in Fig. 2. After the successful connection of communication devices with the internet the process actives by searching the instructions from a web server and ends by uploading the data to the server via Wi-Fi

III. MAJOR PART OF THE SYSTEM

1. Sensor- sensors are used to sensors the transformer oil quality and oil amount it can also senses current of the current transformer and the data is sent to the server. A current sensor is a device which is used to detect electric current in the system and generates a signal proportional to it. The generated signal can be analog or current or even digital form. Then utilized it to display the measured current in an ammeter. The current sensed by sensor the output signal can be Direct current input.

1.1 Transformer or OCB oil level sensor- Oil level sensor is a device is used to check the oil height in the transformer. Due to Overheating of windings the oil will start to evaporate. Due to evaporate the oil level become decreases. Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:

1. Using IO trigger for at least 10us high level signal,

2. The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.

3. IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning. Test distance]= (high level time×velocity of sound (340M/S) / 2,

Wire connecting direct as following:

- 5V Supply
- Trigger Pulse Input
- Echo Pulse Output
- 0V Ground

1.2 Transformer or OCB oil quality sensor-For measuring the transformer/OCB oil quality IR sensor is a popular one. IR Sensors are basically electronic devices which are used to sense the changes that occur in their surroundings. The change may be in color, temperature, moisture, sound, heat, etc. They sense the change and work accordingly. In the IR sensor, there is emitter and detector. The emitter emits the infrared rays and detector/receiver detects it.

1.3 Actuator-Actuators have inverse functions. Digital output from the control computers and their software are delivered through an interface to drivers that take the signals and convert them to whatever inputs the transducer in the actuator requires

IV. IoT BASED DIFFERENTIAL PROTECTION

The differential protection is one of the best protection schemes for electrical equipment, this protection scheme can't be applied for every system due to the fact that cost of pilot wire, the effect of pilot wire's capacitance on system performance increase with the increase of pilot wire length. IoT based differential protection is a smart solution where two modules send the secondary current data to the web server. When the data coming from two different terminals of the protected zone differs from each other beyond permissible limit, the web server sends a command to an internet module,

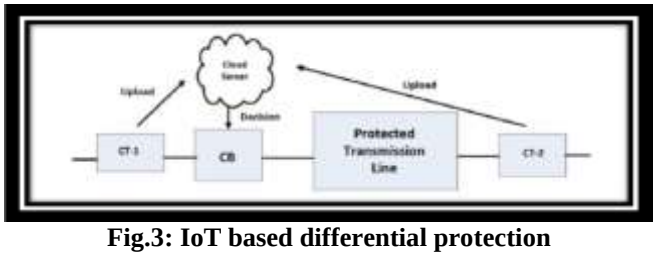

Fig.3: IoT based differential protection

V. CONCLUSION

In this paper, IoT based smart system has been developed for remote monitoring and controlling the entire sub-station equipment which is very reliable, user-friendly and low cost as compared to the conventional system. The proposed system is an absolutely automatic system that includes self-checking of oil level and oil quality from the transformer/oil circuit breaker, continuous sensing of two CTs secondary current, sending data to the web server, storing and displaying data in web page, and sending a comment to an internet module for performing the specific task such as initiating the CB operation, tap changing the transformer, and so on.

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