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A Study of Remote Monitoring of a Transformer using IoT

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ABSTRACT: The main aim of the paper is to acquire real-time data of transformer remotely over the internet falling under the category of Internet of Things (IOT). For this real-time aspect, we take one temperature sensor, one potential transformer and one current transformer for monitoring T, V, I data of the transformer and then send them to a remote location. These three analog values are taken in multiplexing mode and connected to a programmable microcontroller of 8051 families through an ADC 0808. They are then sent directly to a Wi-Fi module under TCP IP protocol to a dedicated IP that displays the data in real-time chart form in any web connected PC / Laptop for display in 3 different charts. So, This Transformer Health Measuring will help to identify or recognize unexpected situations before any serious failure which leads to a greater reliability and significant cost savings.

KEYWORDS: Step Down Transformer, IoT, Microcontroller, Transformer health monitoring, Sensors, Wi-Fi module, PC/Laptop.

I.INTRODUCTION

The remote monitoring of transformer health over internet system is a system that could be used for the real-time data monitoring of **transformer** or generator through internet of things (IoT). As we know, in our power system the transformer and generator are our expensive and important equipment's. If anyone from both is damage or trip due to any reason such as temperature, current or voltage then the whole supply would be switched off. Then the time and money both would be waste, so the real-time monitoring of transformer and generator is mandatory for supplying the smooth supply to the consumer. Different companies and peoples are working for the real-time monitoring and protection of these expensive equipment's but their system cost and size is so much high. Here we have designed a system that is called the remote monitoring of transformer /generator health over internet with the help of PIC microcontroller 18F 452, temperature sensor, current sensor, voltage sensor, WI-FI module and analogue to digital converter. By using this system, the user or supply company can easily check the instant status of their transformer or generator at their homes through the internet WI-FI service. PIC microcontroller is used in this embedded system project.

II.REVIEW OF LITERATURE

In this section, brief overviews on review of literatures regarding remote monitoring of a transformer using different techniques are presented.

According to Monika Agarwal, *et al.* This paper represents that they are designing a system where there exits communication between system and operator. For this we are using Transformer, microcontroller, logic level converter and GSM i.e. global system for mobile communication modem. This GSM modem helps to monitor transformer health by sending message to the system.

According to Hongyan Mao, *et al*. This paper represents a large number of power distribution transformer stations and they are far away from city, wireless GPRS transmission provides a good communication solution to supervise power distribution transformer stations. The scheme of remote wireless monitoring system for power distribution transformer station based on GPRS wireless network was designed in this paper. A control terminal system implement was mainly given, which adopted LPC2132 as main processor, GR47 as the date communication module. The monitor terminal software and flow chart were also designed. At last, the way of configuring the GPRS module to connect network is analyzed.

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According to Pathak A.K, *et al*. This paper represents a design and implementation of a mobile embedded system to monitor and record key parameters of a distribution transformer like load currents, oil level and ambient Modem, with a standalone single chip microcontroller and different sensors. It is installed at the distribution transformer site and the above parameters are recorded using the analog to digital converter (ADC) of the embedded system. The obtained parameters are processed and recorded in the system memory. If any abnormality or an emergency situation occurs the system sends SMS (short message service) messages to the mobile phones containing information about the abnormality according to some predefined instructions programmed in the microcontroller. This mobile system will help the transformers to operate smoothly and identify problems before any catastrophic failure.

III. DIFFERENT METHODS USED TO MONITOR THE WORKING OF A TRANSFORMER

Online Monitoring by using SCADA: The most commonly used online monitoring of power transformer is accomplished by supervisory control and data acquisition system (SCADA). It's a system of software and hardware elements that allows controlling industrial processes locally or in the remote locations and it's capable of monitor, gather, and process the real time data. But the main disadvantage of this system occurs when we extend SCADA for large electric network monitoring, which is very expensive.

Using GSM: The large data about the transformer condition can be processed by using the devices like GSM modem, programmable logical controller and PC as a monitor device and sensors like current transformer and potential transformer. This technology is used by many of the monitoring system. Abdul Rahman Al-Ali this paper deals with the recording of transformer load currents, transformer oil and ambient temperature by implementing a mobile embedded system. In this type of monitoring, the system is connected to a distribution transformer and is able to record and send the abnormal values of the transformer parameters to a mobile device using a GSM network.

Using GPRS: The reliable operation of distribution network can be improved by implementing a centralized monitoring. It's usually accomplished or feasible by implementing GPRS to achieve wireless transmission. This type of monitoring system is capable to communicate in both directions. The parameters that will be monitored include voltage, current and temperature. The hard ware of such a system includes: GPRS, PIC microcontroller, and the monitored output is displayed on a PC through a wireless communication network. The monitored outputs are compared with the rated values of the transformer, accordingly microcontroller programmed to control the transformer parameters.

Using SFRA: There are technologies developed for the condition monitoring of the distribution transformer which measures the mechanical movements in transformer especially of the transformer's core and winding. Sweep Frequency response analysis (SFRA) of transformer provides mechanical information of core and winding. Sweep frequency response analysis is a proven technique to assess the mechanical integrity inside transformer core and coil before the incidence of a major or catastrophic failure. This type of measurement is based on the transfer function concept which is the ratio of voltage/current output to voltage/current input. The generated signal is a sinusoidal voltage with sweeping frequency between 20Hz and 20MHz.
The communication based on GSM or GPRS, which does not take the data continuously which is a drawback. Another model proposed where different parameters like temperature and oil level that directly acts as a health monitor are incorporated. This type of model is explained using the functional diagram of the SFRA. It consists of data acquisition, power supply for different components, processing, communication and Human Machine Interface (HMI). Monitoring is established by sensing the parameters and send to the processing unit .The processing unit is a single board computer. Then it's communicated to the remote end where we control and protection maintenance of the transformer is done by taking suitable decisions. The functional block diagram of such a system is shown below in Fig.3 where we are monitoring the parameters like temperature, oil level, loading and humming noise of the transformer.

NET CBM Based Monitoring: An important technology used for the effective management of distribution network based on the network condition based monitoring (Net CBM). The use of Net CBM in smart grid is capable of monitoring distribution transformer by detecting the partial discharge, electrical arcs and hot spots which helps to identify the deteriorating condition of transformers. Magnetic radio frequency capacitive coupling based partial discharge detection sensors are used in the Net CBM. Infrared thermal sensors are used to detect thermal hotspots in critical elements of the transformer.

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IV. METHODOLOGY

This remote monitoring of transformer health over internet system worked on the principle of hardware components and programmed PIC microcontroller. Suppose we want to monitor the data such as temperature, current or voltage of a transformer, then this system is directly connected with these components or equipment's. Then we just switch on this system directly from 220V ac. After that, the current sensor, voltage sensor and temperature sensor sense their corresponding data but this data is in analogue from it converted into digital form through the ADC 0808, which is interfaced with current, voltage and temperature sensors. Then this data is received by the microcontroller through the ADC 0808, then microcontroller display this data at LCD display and too send this data to the Wi-Fi module. Then the Wi-Fi module (ESP8266) which is interfaced with wireless network and by using wireless network we can see this data at our computer or laptop through any dedicated IP (internet protocol) address. This data is displayed at dedicated website (Thingspeak.com) in three different charts such as current, voltage and temperature charts.

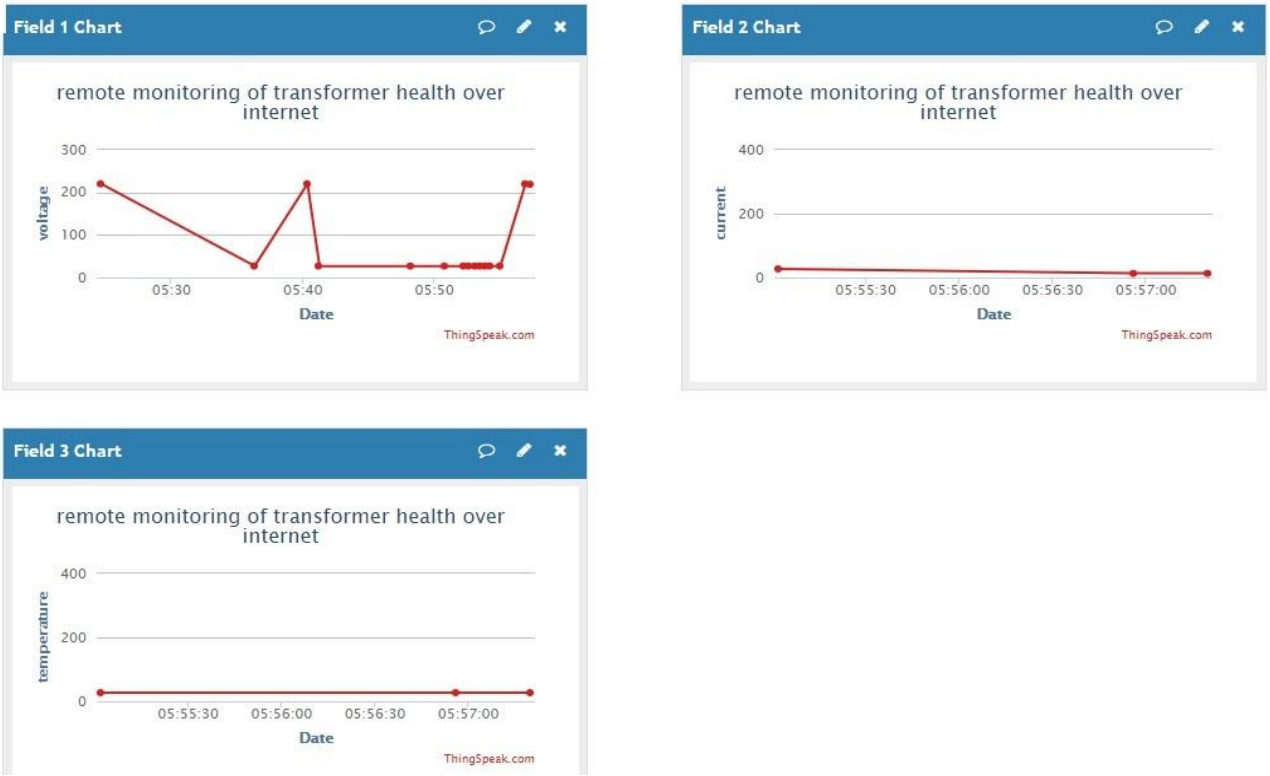

Fig 1: Different shapes of charts could be used for displaying this data such as line type and pie type.

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BLOCK DIAGRAM:

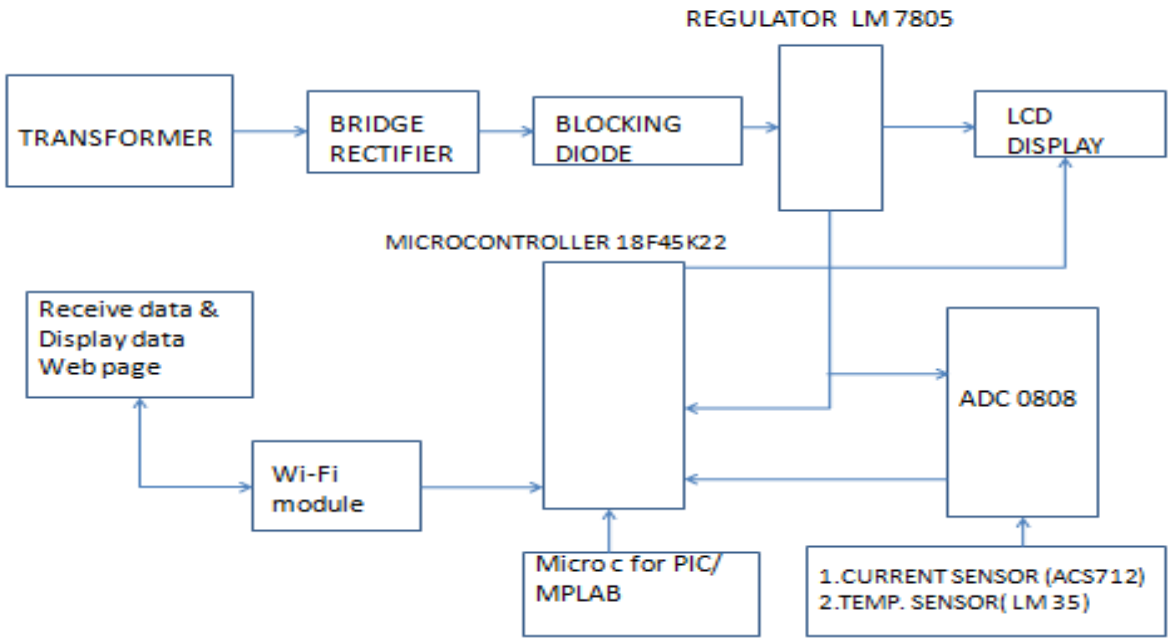

Fig2: Block diagram of remote monitoring of transformer health over internet system

COMPONENTS USED

Transformer: In this remote monitoring of transformer health over internet system, the transformer used for step down the 230V ac into 12V ac.

Bridge Rectifier: The bridge rectifier is used for converting the ac voltages into dc and is connected at the output of transformer.

Blocking Diode: The blocking diode is used for blocking the reverse polarity current.

Voltage Regulator: The voltage regulator (LM7805) is used for regulating the 12V dc into 5V dc and is connected at the output of blocking diode.

LCD Display: The LCD display(16*2) is used for displaying the monitoring data such as temperature and current of the connected transformer.

Microcontroller PIC 18F45K22: The microcontroller is used for the intelligent control of this system. It is 40 pin micro controller and is programmed in "C" language with the help of mikro/c software. It is powered up with 5V dc and is interfaced with Wi-Fi module and LCD display.

Wi-Fi Module: The Wi-Fi module is used connecting this system to the Wi-Fi network for the remote monitoring of data of transformer. It is interfaced with microcontroller for receiving the logic data.

Temperature Sensor: The temperature sensor is used for sensing the temperature of corresponding transformer. For this purpose, the LM35 temperature sensor have been used.

Current Sensor: The current sensor is used for sensing the current of corresponding transformer. It senses the current in amps and gives output in milli-amps.

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APPLICATIONS AND ADVANTAGES

- This remote monitoring of transformer health over internet system could be used for the real-time data monitoring of transformer or generator.
- This system could be used for real time data monitoring of industrial loads.
- This system could be used for real time data monitoring of domestic load.
- By using this system, the user or supply company can easily check the instant temperature, current or voltage of transformer if they increased their rated parameters then the user can shift the load to another supply source before something occurred.
- This system is more reliable, cheap and compact as compared to the other systems.

V. INTERNET OF THINGS (IoT)

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an Internet Protocol (IP) address and is able to transfer data over a network. Increasingly, organizations in a variety of industries are using IoT to operate more efficiently, better understand customers to deliver enhanced customer service, improve decision-making and increase the value of the business.

Working of IoT

An IoT ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data. The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed. IoT can also make use of artificial intelligence (AI) and machine learning to aid in making data collecting processes easier and more dynamic.

VI. CONCLUSION

The proposed technique that is Transformer Health Monitoring will help to identify or recognize unexpected situations before any serious failure which leads to greater reliability and significant cost savings. If transformer is in abnormal conditions we can know from anywhere. Details about the transformer are automatically updated in webpage when the transformer is in abnormal conditions.

FUTURE ENHANCEMENT

In future work we can develop database of all parameters of distribution transformer which are placed at different places. We can get all information by placing the proposed system modules at every transformer. We can send the data through Wi-Fi module and also through Ethernet shield. With Ethernet shield we can make remote terminal unit as a server and store data on webpage or website. A Wi-Fi module connects to nearby network and sends information to monitoring node.

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