Design on IoT Based Real Time Transformer Performance Monitoring System for Enhancing the Safety Measures

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Abstract. The Internet of Things (IoT) is a continuing massive excitement for machine-to-machine communications to encourage individual devices to use the internet for data sharing. This work introduces the design and performance of continuous transformer monitoring and failure diagnostic and documents main distribution transformers indicators such as load current, transformer oil level, gas formation, and temperature. By using this project one must continuously take a look at it and it will reduce progress and maximize the stability, accuracy, and performance of this project. The sensors are used to track recurrent errors or voltage intake variations. The observed information is transmitted to the microcontroller and it tests parameter limitations that send it to the IoT web server using the IoT module. This data sharing means that the appropriate data are presented to the customer and before any significant errors occur according to the collected data the user will make useful choices.

Keywords: Internet of Things, Machine to Machine, Gas formation, Transformer oil level, Microcontroller.

1. Introduction
In our lives, energy plays a crucial role. Each second is electricity-dependent. Electricity has many devices and facilities that allow people to manage and move the supply through use. The power transformer is the most critical transmission and distribution equipment. The electrical transformer provides electricity directly to low voltage consumers in the control grid and its operative status is a prerequisite for all network operations. Almost all devices operate heavily and in diverse (electric, mechanical, environmental) conditions have been in operation for various years [1]. These include a significant part of capital expenditure. They are the main components. The activity of the transformer on a valued basis guarantees its longevity (as shown on their naming plate). However, their life is significantly shortened by overloading, low, and high-voltage ventilation, which ensures that countless clients are less likely to fail, and the supply failure is thereby making their machine efficient. The key issues that concern the delivery transformer include overload, oil temperature, load current, and inadequate cooling and insulation problems of the transformer.

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With multiple transformers in current electronic systems spread over a large area, the state of each transformer is very difficult to estimate manually. What one requires, then, is a distribution transformer system that tracks and sends the monitoring method promptly [2]. It provides the necessary data about the performance of the transformer. This will guide and help the utilities to fully make use of the transformer and keep the equipment in operation for a very long period. This newly proposed project presents the design and execution of an IoT embedded system to estimate load currents, transformer oil level, and temperature and gas leaks. For this to be implemented on-line measuring system using the Internet of Things (IoT), with PIC6F877A microcontroller and sensors are used. It is fixed at the distribution transformer site. The output values of sensors are processed and recorded in the system memory. The system is programmed with some predefined commands to check abnormal conditions. If there is any kind of abnormality in the system, all the details are automatically updated through the internet which is connected through serial communication [3]. This Internet of Things (IoT) will help the utilities to utilize transformers and identify problems before any cataclysmic failure occurs. Thus online measuring system is used to collect and analyze different kinds of data input by the sensors over time. So Transformer Performance measuring will help to distinguish or perceive unforeseen circumstances before any genuine disappointment which prompts more prominent dependability and critical cost savings [4].

Zhang et al., [5] performed an IoT surveillance framework and ensemble machine learning research on the process of converting fault diagnostics. A new approach for diagnosing faults using a monitoring system and an ensemble machine learning system (EML) based on the Internet of Things (IoT) is introduced in the paper. A data calculation subsystem and a data reception subsystem constitute the IoT-based control systems. The first thing to do is to calculate transformer vibration signals with the data measurement subsystem and transfer them through the data reception subsystem to the remote server. The EML is then suggested to provide a deep belief network (DBN) and stacked autoencoder denouncing (SDA) scheme with separate encoding functions and RVMs.

Eswar et al., [6] have carried out work on the IoT management system for wireless transformer parameters. The transformer is exposed to many problems, including overcurrent, temperature rise, oil volume, etc. Both of these flaws are constantly tracked all over the Arduino, which frequently transfers transformer health information to a Dedicated IP through the TCP/IP Wi-Fi module that presents data on a web-connected PC in real-time mode. All of them are tracked. Ganesh et al., [7] carried out real-time IoT control and transformer load sharing activities. The project’s goal is to secure the electric system by load sharing under the overload situation. The power declines and windings are heating and can be burned due to the overload on electric appliances. The electrical equipment is therefore shielded by sharing the load on an electrical system. It can be achieved by attaching a microcontroller to another electric system in parallel.

Khairnar et al., [8] have done an industrial process automation work using IoT analytics to track transformers. This paper focuses on the transformer control of faults in real-time and tracks various transformer operational parameters such as tensile mismatch, load present, oil temperatures, temperature, and vibration. The use of an artificial neural network algorithm based on these parameters predicts the loss and successful state of transformers. Lutimath et al., [9] provide a framework to spot distribution transformer errors and IoT protection for power manufacturers. The key objective of the proposed device is to track the delivery transformer in real-time and identify defects such as load current, temperature, oil level indicator with the aid of IoT. This machine also ensures protection for the power man during maintenance activities.

The construction of the IoT-based dry-type Temperature Controller was performed by Leng et al., [10]. The typical dry transformer temperature sensor links to the cloud in this configuration, representing the internet of things as well as growing the cloud service. In this article, an STC89C52 dependent temperature sensor on hardware structure, software architecture, and the cloud is presented. It consists
primarily of the temp module PT100, the digital-analog conversion module, the warning module, the relay module, a digital tube monitor module, a communication module, and a module for storage.

2. Product Perspective
This framework is intended for Real-Time online monitoring of distribution transformers parameter can give valuable information about the performance of the transformer which will help the utilities to ideally utilize their transformers and keep the machine in good condition for a long time. In this framework, one utilized three sensors for checking that is the voltage sensor, a current sensor, Gas sensor, and a temperature sensor [11]. One utilized a power supply unit to power the microcontroller PIC16F877A and IoT Module. Sensors sense the information and show it on LCD show in the meantime the IOT module sends the information to the client on a given IP address as given in the program. As one gets Real-Time data one can avoid failure. This proposed model is grouped into four sections Power supply (230v) step down transformer, a bridge rectifier (converter and controller), controlling, data processing, and data uploading [12]. The hardware interface required for designing the system are, PIC16F877A assembled PCB+UART+LCD, current sensor (CT1270), temperature sensor (LM35), gas sensor, level sensor, two-channel relay, USB to RS232 converter, IoT module, and DC fan.

3. Proposed System Design
The main types of faults which occur in Distribution Transformers are because of over current, insulation, Gas formation, or low level of oil which is used for insulation purposes. In this project, the authors have used a temperature sensor, level sensor, Gas sensor, and Current sensor to monitor the level or degree of these physical quantities. A power supply unit consists of Step down transformer, Rectifier Unit, Input Filter, Regulator Unit, and Output Filter. These are connected directly to the PIC6F877A Microcontroller+ PCB+ LCD+ UART Kit. The sensed value from different sensors is fed into the Analog to Digital Converter and the analog signal gets converted to a Digital signal there and this signal is fed into the PIC Microcontroller kit. The values from different sensors are displayed on the LCD kept on the kit instantly.

Figure 1. Design of Proposed System
4. Result and Discussion
The microcontroller is connected to the Control Unit which is used to manage voltage and the relay connected to the control unit is used for switching operations. The relay can cut off and restore the current flow. The DC Brushless fan is used for cooling purposes. The PIC microcontroller which consists of a UART converter is connected to the IoT module with a Sim tray. The IoT module is used to send all the information to the specified API address which is already specified in the predefined program fed into the microcontroller [13]. There is an IoT webpage used to monitor all these values. If the value from the sensors goes above or below the specified threshold value, the relay will automatically cut off the power supply thus saving the transformer from the even bigger danger of explosion. Figure 1 shows the design of the Proposed System.

The data which PIC Microcontroller receives is sent to the IoT webpage whose API has already been mentioned in the program which has fed into the PIC Microcontroller. The IoT Webpage has two sections namely the ‘Data Section’ and the ‘Control Section’. In the data section, the values from different physical quantities are monitored constantly and if any value exceeds or falls below the threshold value given in the program, the current will be cut off automatically from the Control section which has an ‘ON and ‘OFF’ button [14]. The current flow can be cut off or reinstated manually and automatically using the Control section. When the off button is activated a signal will be sent to the relay which switches off the current supply preventing the Transformer from having serious damages. The previous values are stored in the IoT Cloud server for reference later. Figure 2 shows the IoT interface of the proposed system [15].

5. Conclusion
This newly-developed method and subsequent techniques have demonstrated that the safety project transformer operates correctly in an unnatural and unsafe situation with a high degree of precision, flexibility and performance. Transformers may help discern or interpret events that are unpredictable before the major accidents, which lead to increased performance, consistency and considerable cost savings. You can say anywhere you are if the transformer's not in regular order. No human force has to constantly control the transformer. The transformer specifics are changed automatically on the website if the transformer is not usually present. In forthcoming, a much more advanced database will be generated for all distribution transformer parameters using a set of sensors, which can be stored in and without the distribution transformer in several different locations. The data can be transmitted via the proposed modules via the Wi-Fi card, as well as the Ethernet shield. Remote terminal computer can be built as a server using the Ethernet Shield and data can be stored on servers or browsers. A Wi-Fi module links to the surrounding network and transmits information about node surveillance.
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