Design and Development of Transformer Health Monitoring System Using IOT

[1]Prabu M, [2]Manoj A, [3]Mohan Chandru R, [4]Shiva G, [5]Tamilselvan V
[1]Associate Professor, [2,3,4,5]Students, Department of Electrical and Electronics Engineering,
Nandha Engineering College (Autonomous), Erode, India

Abstract: Transformers are essential parts of power networks that provide effective electrical energy distribution and transmission. Sustaining their well-being and operational dependability is essential for a continuous supply of power. Transformer Health Monitoring Systems (THMS) have been developed as a result of the revolution in transformer monitoring and maintenance brought about by the incorporation of Internet of Things (IoT) technologies in recent years. This study provides a comprehensive analysis of THMS driven by IoT. Among the main parts of the system are several sensors that are thoughtfully positioned inside transformers. These sensors include electrical parameter monitors, humidity detectors, temperature gauges, and oil quality analyzers. Operators can keep an eye on transformers remotely from a central location, which makes it possible to react quickly to new problems. There are numerous advantages to implementing such a system. Early defect identification improves system reliability by reducing the possibility of unplanned downtime. Early detection of possible risks strengthens safety precautions and helps to avert potentially disastrous failures. Predictive analytics-driven maintenance schedule optimization also results in lower costs and improved operational effectiveness. Nevertheless, there are difficulties in utilizing IoT technology to deploy THMS. Access control and strong encryption are still essential for maintaining data security. Careful evaluation and solutions are needed for the following difficulties: interoperability between various sensors and devices; scalability issues with maintaining a multiplicity of transformers; and seamless integration inside the current infrastructure.

Keywords -- Internet of Things, Current sensor, Temperature sensor, Voltage sensor, A-D converter, Level sensor, Control circuit, PIC controller.

I. INTRODUCTION

This system is designed for online monitoring of distribution transformers parameter can provide useful Information about the transformers health which will help the utilities to optimally use their transformers and keep the asset in operation for a long time. Transformer is used for providing electricity to the consumers. It provides the required voltage to the consumers by stepping down the voltage in distribution side. So, monitoring the distribution transformer is the unapproachable task for the electricity department to monitor those transformers regularly. This paper provides a solution for reducing the man power in monitoring of the transformer in online by analyzing various parameters like voltage, current, temperature. The power system any unbalance cortication informed IOT.AB switch open without permission informed officer using IOT Line voltage stress & power transformer winding stress for premier & sectary controlling & monitoring using IOT. The on-line monitoring system integrates a Global Service Mobile (GSM) Modem, withstand alone single chip microcontroller and sensor packages. It is installed at the distribution transformer site and the above-mentioned parameters are recorded using the built-in 8-channel analog to digital converter (ADC) of the embedded system. Customers by measuring those parameters voltage, current, temperature of a windings, oil Level of a transformer by using various sensors and in the future trends various updates may be come across towards the innovative ideal system. Its installation on Wireless technology.

II. LITERATURE SURVEY

The IoT-based solution for monitoring and controlling of distribution transformers is quite easy and effective compared to manual monitoring method. The paper focuses on transmitting real time data from each transformer to IoT platform using LoRa (Long Range) modules. Selected advantages of this method are like, continuous monitoring of DTs, timely alerts to rectify the abnormality if any, there by extending the lifetime of distribution transformers, simplifying. In this paper distribution transformers are monitored and controlled using LoRa modules and LoRa WAN (LoRa wide area network) which are referred under Internet of Things (IoT) technology. IoT is a network of smart devices that are embedded with sensors, actuators and network connectivity that enables them to collect and exchange data. A mobile monitoring system for distribution transformer was designed, implemented and tested.

The designed system is connected to a distribution transformer and is able to record and send abnormal operating parameters information to a mobile device using a GSM network. The time to receive the SMS messages varies from 2-10 seconds and this is due to the public GSM network traffic. The system hardware was constructed from off-the-shelf components. The experimental results came out as expected. A server module can be added to this system to periodically receive and store transformer parameters information about all the distribution transformers of a particular utility in a database application. Embedded system, GSM modem, mobile-users and GSM networks and PC-based server. The embedded module is located at the transformer site.

III. PROPOSED SYSTEM

This system is designed for online monitoring of distribution transformers parameter can provide useful Information about the transformers health which will help the utilities to optimally use their transformers and keep the asset in operation for a long time. In this system, we used three sensors for monitoring that is voltage sensor, a current sensor, and temperature sensor. An 8-bit microcontroller that has 8-channel analog to digital converter (ADC) and several digital input/output ports. The ADC is used

to read the parameters, the embedded software algorithm that takes care of the parameters acquisition, processing, displaying, transmitting and receiving.

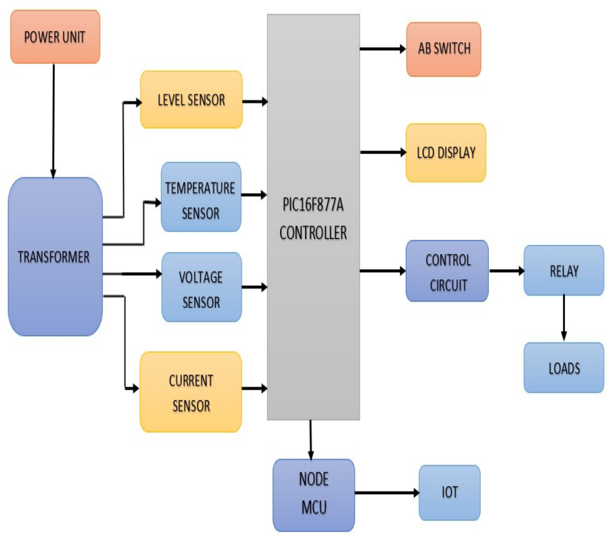

Figure 1. Proposed work

And same time an electric switch in which the opening and closing of contacts and extinguishing of the electric arc are accomplished by means of compressed air an air-break Switch consists of three basic structural elements: a reservoir with a supply of compressed air, an arc extinguisher, and an electro pneumatic actuator also used in this system. Smart distribution transformer is needed in the future trends electric power system since is going to be digitalized transmission of electricity in future.

This work presents design and execution of real time monitoring and fault detection of transformer and record key operation indictors of a dispersion transformer like load current, voltage, transformer oil and encompassing temperatures and humidity. The user can track the entire database of the Air Quality Monitoring system with the help of cloud technology. This system is an automated system, and it does not require any human interference because of the implementation of AI technology. It automatically sense the data from the atmosphere, sends it to the PIC controller, operates the blower motor, and shares the real-time data with user. Here, AI works based on a machine learning algorithm, and this helps the system avoid unexpected working issues due to its higher level of intelligence. A user does not need to worry about the workings of the system.

IV. HARDWARE IMPLEMENTATION

1. PIC Microcontroller:

PIC stands for “Peripheral Interface Controller”. This system uses the “PIC16F877A” microcontroller, an integrated chip consisting of RAM, ROM, CPU, timers, counter, ADC and DAC. It is an 8-bit microcontroller that

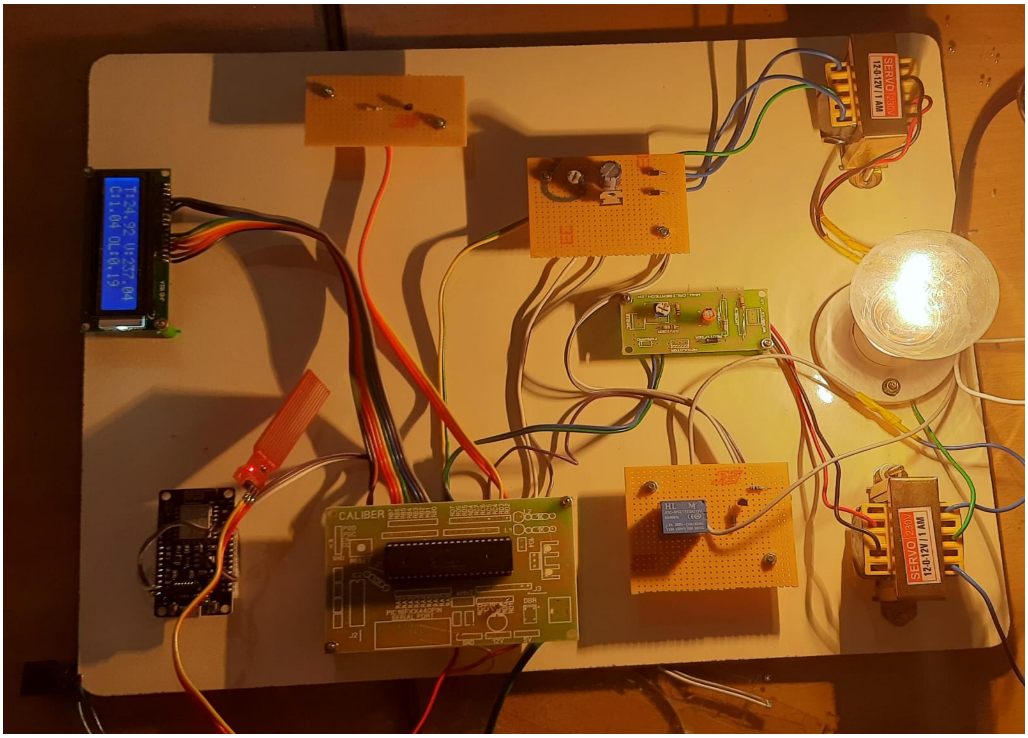

Figure 2. Design and development of Transformer health monitoring hardware kit

was developed by “Microchip Technology”. PIC is designed based on “Harvard Architecture” and “Reduced Instruction Set Computer (RISC)” architecture. It consists of 40 pins with 256 bytes of EEPROM memory. A PIC is a self-programming controller, and it requires a minimum operating voltage of 2V and a maximum operating voltage of 5.5V. It contains comparators and ADC channels. The memory capacity of RAM is 368 bytes. Compared to other microcontrollers like the 8051, this controller consumes less power, has larger programming memory, and is easier to program. It easily allows users to interface with other external devices. PIC 16F877A supports “Inter-integrated Circuit (I^2C) Communication”. This controller also supports Controller Area Network (CAN), Serial Peripheral Interface (SPI), and Universal Asynchronous Receiver Transmitter (UART) protocols.

2. Transformer:

A transformer is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. It consists of two or more coils of insulated wire wound around a core, typically made of ferromagnetic materials such as iron or ferrite.

The primary function of a transformer is to change the voltage level of an alternating current (AC) electrical signal while keeping the frequency constant. Transformers can step up (increase) or step down (decrease) voltage levels depending on the configuration of the winding turns.

3. Voltage Regulator:

Voltage regulation involves maintaining a constant output voltage despite changes in load or input voltage. This is essential for providing stable power to electrical and electronic devices, ensuring their

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proper operation and protection from voltage fluctuations. Voltage regulation is achieved using voltage regulation circuits or devices such as voltage regulators or transformers. These devices adjust the output voltage to compensate for variations in input voltage or load, thereby providing a stable voltage to the load. In electrical power systems, voltage regulation is critical for maintaining the quality of power delivered to consumers. Voltage fluctuations can lead to equipment malfunction, reduced efficiency, or even damage to sensitive electronic devices. Voltage regulators are used in power distribution networks to ensure that the voltage supplied to consumers remains within acceptable limits

4. Current Regulator:

Current regulation involves maintaining a steady output current despite changes in load or input voltage. This is particularly important in power supplies and electronic circuits where the load may vary. Current regulation ensures that the required amount of current is delivered to the load regardless of external factors. In power supplies, current regulation is achieved using feedback control mechanisms such as feedback loops or sensing circuits. These circuits monitor the output current and adjust the output voltage or other parameters to maintain a constant current level. Current regulation is crucial in applications such as battery charging, where overcharging or undercharging can damage the battery or reduce its lifespan. By regulating the charging current, the battery can be charged safely and efficiently.

5. Temperature Sensor:

A temperature sensor is a type of device that measures the temperature level in the surrounding environment and converts the sensed data into electronic signals for recording and monitoring the temperature changes.

6. LCD:

LCD stands for “Liquid Crystal Display”. It is a combo of both solid and liquid phases. These displays have two layers. which consist of polarized filters and electrodes. There are two types of pixel grids used in LCDs, namely “active-matrix grid” and “passive matrix grid”. Every LCD has pixels and sub-pixels. The working principle of LCD is the “Liquid Crystal Color Emission principle”. This device is an electronically modulated optical device. Twisted Nematic Display, in-plane switching display, vertical alignment panel, advanced fringe field switching (AFFS), and passive and active-matrix display are the different types of LCD.

7. Node MCU:

Node Micro Controller Unit (MCU) is an open source IoT technology platform that is a combo of both hardware and firmware. The firmware is based on an “ESP8266 Wi-Fi SoC” and the hardware is based on the “ESP-12 module”. Node MCU is similar to an Arduino electronic board. The main difference between Arduino and Node is that Arduino uses the “Atmega328p controller” and Node MCU uses the “ESP266 controller”. The programming of Node is done using the “Lua Scripting Language”. This scripting language is similar to JavaScript and easy to learn and understand. Node MCU is an economical controller board that also support Arduino IDE.

8. Relay:

A relay is an electrical switch that opens and closes circuits based on receiving electrical signals from other components. It works based on the principle of “Electromagnetic Induction”. It depending on the poles and throws, relays are classified into single pole single throw (SPST), single pole double throw (SPDT), double pole single throw (DPST), and double pole double throw (DPDT). Relays are not only used as switches but also as protective device.

V. RESULT AND DISCUSSION

From this paper, we can conclude that Transformers are critical components in power systems, and any failure can lead to significant disruptions and costly downtime. Monitoring allows for the early detection of issues such as insulation degradation, winding faults, overheating, and oil leaks. Identifying these problems early enables proactive maintenance and repair, preventing catastrophic failures and minimizing downtime. Monitoring transformer parameters such as temperature, load, and voltage can help optimize their performance and efficiency. By analyzing data collected from monitoring systems, operators can make informed decisions about load management, cooling, and maintenance scheduling to ensure that transformers operate at their peak efficiency. Regular monitoring provides valuable data about the condition of transformers, allowing for preventive maintenance activities to be performed proactively. This includes tasks such as oil testing, insulation resistance testing, and thermal imaging inspections. Preventive maintenance helps extend the lifespan of transformers, reduce the risk of unexpected failures, and optimize maintenance costs.

Faulty transformers can pose safety hazards, including the risk of fire, explosions, and electrical shocks. Monitoring allows for the early detection of potential safety issues, enabling corrective action to be taken before accidents occur. Additionally, monitoring systems can provide alarms and alerts to operators in the event of abnormal conditions, allowing for prompt response and mitigation of safety risks. Many regulatory standards and industry guidelines require the monitoring of transformers to ensure compliance with safety and performance requirements.

Figure 3. l CO2, O2 and Temperature Sensed Value

Monitoring systems provide documentation and reporting capabilities, allowing operators to demonstrate compliance with regulatory requirements and internal standards. Transformers are significant assets with a long service life and high replacement costs. Monitoring helps asset managers track the condition, performance, and lifespan of transformers, allowing for informed decisions about repair, replacement, or refurbishment. Effective asset management ensures that resources are allocated efficiently and that transformers continue to meet the needs of the power system. Blynk IoT is an Android application used to control IoT devices using Internet of Things technology. This app supports home automation by connecting all the home appliances and controlling the working of devices. This app also monitors the real-time sensed data and sends alerts and notifications to the user. We connected our proposed system to this application for easier monitoring and controlling of the air filtration process and to transfer the real-time data to the user. This app shows the sensed CO_2, O_2 and temperature levels and helps to track the entire process and progress.

III. CONCLUSION AND FUTURE SCOPE

In conclusion, the monitoring of transformers is indispensable for ensuring the reliability, efficiency, and safety of electrical power systems. By continuously monitoring key parameters such as temperature, load, voltage, and insulation condition, operators can detect early signs of potential issues, optimize performance, and implement preventive maintenance measures. This proactive approach helps to minimize downtime, reduce the risk of catastrophic failures, and extend the lifespan of transformers.

Looking ahead, the future scope of transformer monitoring holds significant promise for further advancements in power system reliability and efficiency. Here are some potential future directions as Advanced Sensing Technologies, Integration with Smart Grids, Data Analytics and Artificial Intelligence, Condition-based Maintenance, Cybersecurity and Data Privacy.

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