Real-Time Distribution Transformer Health Monitoring System, Based on IoT

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***Abstract*— Distribution transformers are a significant part of the electrical power grid. For the reliability of the power system, continuous monitoring is the key aspect of protection and tracking distribution transformer parameters. Since the transformer is distributed over a vast area of the power system, data collection and monitoring are major concerns. The principal purpose of the proposed system is to obtain the real-time health condition of the distribution transformer using IoT technology. Here the sensors are installed to detect parameters such as voltage, current, temperature, and transformer oil level. The sensors are interfaced with Arduino to record this data into servers. The recorded data can be sent using a Wi-Fi module and accessed remotely using the HTTP protocol of IoT technology. This proposed system helps in identifying and reviewing the problem before it causes severe damage to the power system. This paper presents a review of IoT (Internet of Things) based electrical parameters monitoring and controlling technology to avoid its future devastating failures.**

Keywords—Transformer, IoT, Arduino, Sensors, health tracking.

I.INTRODUCTION

Transformers are essential for the generation, transmission, and distribution of electricity. In the world we live in, it is hard to go an entire day without using energy. Every fundamental activity, whether domestic or for plants and industrial units, relies upon the power supply. A transformer that is used in distribution is a type of step-down transformer that guarantees energy for the clients, which can be applied in homes, industrial areas, etc. For long life, transformers must be operated in rated condition. This is impractical during whole working periods. Overloading and insufficient cooling of transformers can cause unpredicted failure in transformers, which can affect the continuity of power to consumers. The manual check-up of a rise in voltage, a rise in ambient temperature, a load current, etc. tends to be more complex as incidental parameters cannot be accessed. In IoT, the interchange between the physical and digital world is carried out with the help of sensors and actuators. A sensor or a network of sensors is used to sense the physical parameters or the respective environment. These sensor outputs are then sent to the main server or cloud with the help of Node MCU. The data can be accessed over the internet from anywhere in the world. Monitoring and control are the basic objectives of IoT technology. Hence, IoT-based monitoring is preferred over manual monitoring. The system gives real-time monitoring of distribution transformer parameters like voltage, current, and temperature. This will help to recognize the fault before a serious fault happens.

II.LITERATURE SURVEY

IoT-based distribution transformer monitoring systems have gained significant attention due to their ability to monitor transformer health, prevent equipment failures, and optimize maintenance. A literature survey on this topic reveals a plethora of research works that researchers have carried out worldwide.

"Design and implementation of real-time transformer health monitoring system using GSM technology" by Sajidur Rahman, Shimanta Kumar Dey, Bikash Kumar Bhawmick, and Nipu Kumar Das. This project presents the design and implementation of monitoring load currents, over-voltage, transformer oil level, and oil temperature [1].

“IOT Based Transformer Health Monitoring System: A Survey" by Kalpana Hazarika, Gauri Katiyar, Noorul Islam. This paper presents a review of IoT (Internet of Things) based electrical parameters monitoring and controlling technology to avoid its successive catastrophic failures [2].

"IOT Based Distribution Transformer Health Monitoring System" by SUBHASH YADAO, SANKET THAKRE, RISHABH DARWAI. The main purpose of this system is to monitor and control distribution transformers through IOT. It also sends SMS to the control room for further processing [3].

"IoT-Based Transformer Monitoring System" by Rajesh, K., Reddy, G. P., and Reddy, B. S. This paper provides an overview of different techniques used for transformer health monitoring, including traditional methods, and modern approaches such as IoT-based systems. The authors also discuss this field's challenges and future research directions [4].

"Health Condition Monitoring of Transformer: A Review " by Patel, N., Vora, D., & Basera, A. S. This paper is to convey the requirement for condition checking, the kinds of failure that can happen in transformers, and audit mitigation methods required to monitor distribution transformer health condition [5].

"Condition monitoring of power transformer: A review " by Dhingra, Arvind & Khushdeep, Singh & Deepak, Kumar. This paper introduces the various approaches adopted for the online monitoring of power transformers [6].

“A review on fault detection and condition monitoring of power transformer" by J Aslam M, Arbab MN, and Basit A et al. This paper audits constant methods utilized for condition-based observing of power transformers [7].

“Detection of internal winding faults in power transformers based on graphical characteristics of voltage and current,” by Chenguo Yao and Zhongyong Zhao and Yu Chen and Xiaohan Chen and Chengxiang Li and Wei Li and Jian Wang. This paper attempts to propose a recently evolved winding disfigurement internet observing strategy given the Lissajous graphical examination of voltage and current [8].

“IoT-based Distribution Transformer Health Monitoring System using Arduino, NodeMCU and Thingspeak,” by Biju Rajan B, Amanraj S, Akhil S, Nayana S . This paper proposed an IoT-based transformer monitoring system that can monitor the transformer’s temperature, oil level, and vibration. The system uses wireless sensor networks and cloud computing technology to collect and analyze data [9].

From a worldwide perspective, the studies reviewed showcase the potential benefits of implementing IoT-based distribution transformer monitoring systems, including improved transformer health and equipment failure prevention through the provision of real-time data and analytics to operators. Despite these advantages, challenges still exist in this field, such as ensuring data transmission and storage security and reliability, which require further research to overcome.

III.PROPOSED SYSTEM

The proposed model of an IoT-based transformer monitoring system involves the use of sensors to measure parameters such as voltage, current, temperature, and transformer oil level. These sensors are connected to an Arduino board, which collects and records the data from the sensors. The recorded data is then transmitted using a Wi-Fi module to a server or cloud-based platform using the HTTP protocol of IoT technology [10].

Operators can remotely access this data from anywhere in the world using a computer or mobile device. The collected data is analyzed using various machine learning algorithms and analytics tools to provide insights into the health of the transformer. This real-time monitoring helps identify any anomalies or potential issues with the transformer before they cause serious damage to the power system [11].

The proposed model provides an efficient and reliable way of monitoring transformers, which can help improve their lifespan, reduce downtime, and optimize maintenance. It can also help in the prevention of equipment failures and ensure a consistent and reliable power supply to consumers.

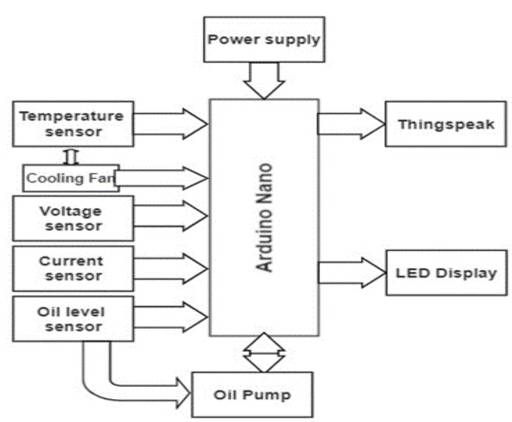

Fig.1 Block Diagram

IV.METHODOLOGY

The system is built around Arduino Nano. Arduino Nano is used as the main controller board. In the proposed concept, the system measures the four parameters of the distribution transformer namely temperature, load current, voltage, and oil level [12]. When there is a minimum of one parameter value that contradicts the predetermined value, after that the microcontroller takes movement to deliver this information to the unit of controller [13]. Once the data are sensed they can be read from the LED display and at the same time these values are transmitted to the IOT module and the IOT module sends the data to the

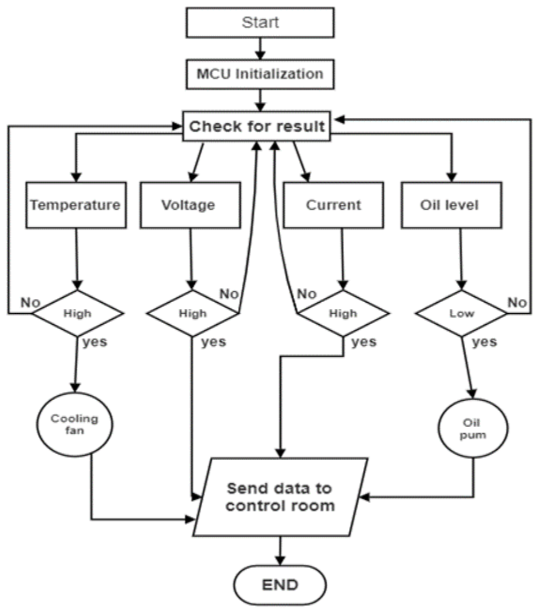

Fig2-Flow Chart

The user is on the given IP address as per the program. This information sufficiently supports the transformer to avoid its sudden failure. For any abnormal conditions on the load side we can control by switching off the relay and if the temperature level is above the threshold value, the cooling system automatically will be ON until the temperature value return to the threshold value [14].

V.COMPONENTS

Arduino Nano

It is based on an ATMEGA328P microcontroller. It works with a mini-USB cable. It is a small-sized one [9].

- Microcontroller ATMEGA328P
- Operating voltage 5V
- Input voltage 7-12V
- Digital i/o ins 14
- PWM 6 out of 14 digital pins
- Max. current rating 40mA
- USB mini
- Analog pins 8
- Flash memory 16KB or 32KB
- SRAM 1KB OR 2KB
- Crystal oscillator 16MHz
- EEPROM 512 bytes or 1KB
- USART Yes

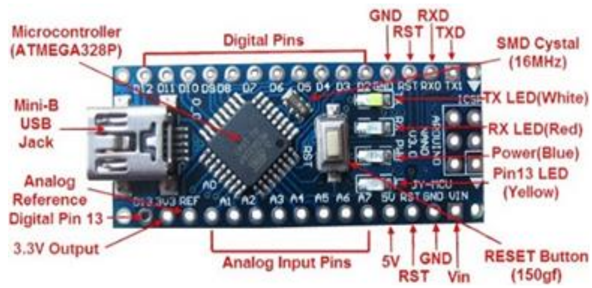

Fig.3 Arduino NanoNode MCU

Node MCU is an open-source IoT platform. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP -12 module [15]. The Arduino nano and Node MCU exchange data through serial communication. The Node MCU will be treated as the master and Arduino Nano act as a slave during this communication. Arduino acts according to the instructions given by Node MCU.

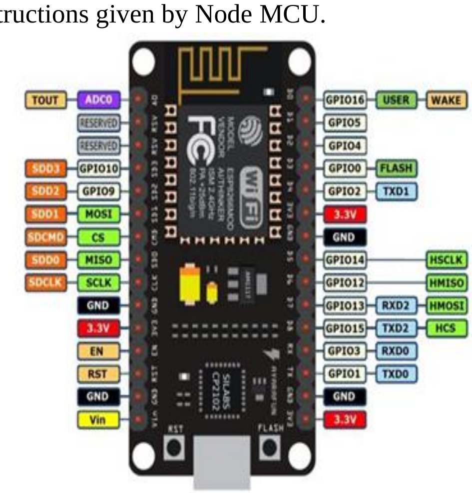

Fig.4 Node MCU

Oil level sensor

Ultrasonic ranging module HC - SR04 provides a 2cm - 400cm non-contact measurement function, and the ranging accuracy can reach 3mm. The modules include ultrasonic transmitters, a receiver, and a control circuit.

Fig.5 Ultrasonic sensor

Temperature sensor

LM35 sensors are used for sensing the temperature and an IC ADC0808 is used to convert the data into the digital form [16]. The equation to measure temperature in Celsius,

Temp = output_voltage/0.01

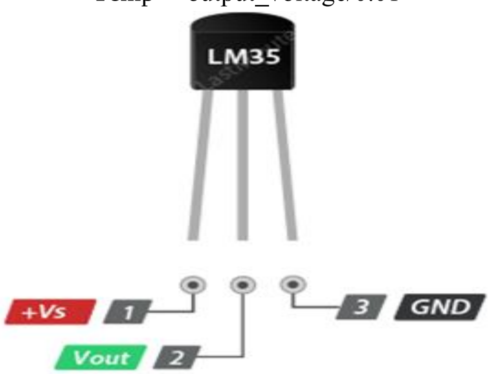

Fig.6 Temperature sensor

VI.CONCLUSION

Transformers are a crucial component of power distribution systems, and ensuring their proper functioning is of utmost importance. This proposed system presents an enhanced approach to monitoring and protecting transformers using IoT technology. The system includes sensors that gather essential transformer health parameters such as voltage, temperature, and current. The collected data is then transmitted to an IoT platform, thing speak, using the HTTP protocol, enabling real-time monitoring and storage of the data. With this system, continuous monitoring of the transformer health parameters becomes possible, leading to more efficient maintenance and protection of the transformer [17].

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