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Transformer Oil and Coil Winding Temperature Monitoring System using IoT

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Abstract: The transformer is a vital component of an electrical system. A variety of factors, such as transformer temperature, must be monitored and examined to keep the transformer in good working order. However, doing it conventionally by deploying a person to monitor and examine could result in measurement errors due to human mistakes. This study presents a review of IoT (Internet of Things) based on the temperature of oil and coil winding monitoring. The purpose of the temperature monitoring system implement remotely is to do the process of monitoring by using Arduino and a temperature sensor. ThingSpeak is a platform used in this system in which the data collected will be stored in the cloud. The data collected is then validated and thus the purpose of the IoT system is to work satisfactorily.

Keywords: Transformer, Oil Temperature, Coil Winding Temperature, Iot, Thingspeak

1. Introduction

The transformer is a vital component of the electrical system's network. At least one transformer can be found in every area. We now live in a time where even a minute without electricity is unthinkable. Power is required for every primary activity, whether residential or for plants and enterprises. Without them, every firm will grind to a halt, with potentially disastrous financial implications [1].

The most critical parameter of transformer monitoring is the temperature that rapids rise while overcurrent condition causes rapid degradation of transformer insulation. Besides, the temperature is an essential factor influencing the transformer's dielectric strength. The temperature will rise or fall depending on the transformer's payload. Usually, a transformer has two temperature sensors and contacts to monitor the windings and oil temperature. Furthermore, the oil temperature is compared to the ambient temperature before the cooling unit is controlled [2].

Since the world is changing so quickly, the first and most crucial challenge for any transformer is monitoring it and taking immediate action if a failure arises. The IoT-based solution for monitoring and controlling distribution transformers is relatively easy and effective compared to the manual monitoring

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method [3]. Real-time data collection of these parameters may provide the transformer health information from time to time. In industrial growth, IoT is committed to providing the best possible solutions.

A person visits the transformer site regularly to record essential parameters that reflect transformer health. However, this approach to monitoring distribution transformers does not account for information concerning overloads that occur from time to time, as well as oil and winding temperatures. However, this approach to monitoring distribution transformers does not account for information concerning overloads that occur from time to time, as well as oil and winding temperatures.

Receiving information on essential parameters like oil temperatures and winding temperature continuously from the transformer can help in transformer maintenance planning and provide the operating engineers with knowledge about the transformer's health to maintain the grid's stability [4]. Therefore, real-time data collection of these parameters may provide the transformer health information from time to time.

This project is aimed to monitor transformer oil and coil winding temperature remotely and design an online data dashboard that can be assessed securely.

2. Materials and Methods.

2.1 Materials

i. NodeMCU

NodeMCU V3 module is mainly based on ESP8266, a low-cost WIFI microchip with both microcontroller capability and a full TCP/IP stack. It is an open-source firmware and development kit that plays a vital role in designing proper IoT products using a few script lines. This NodeMCU based on ESP8266 WIFI SoC version 3 and ESP-12E is an alternative to prototype IoT products within LUA scrip lines and can be programmed by Arduino IDE [4].

ii. DS18B20 Waterproof Temperature Sensor

This sensor is commonly used to calculate the temperature in stiff settings such as mines, chemical solutions, soil, etc. This sensor is often used to determine the temperature of liquids and can be utilised in a thermostat control system. It can be employed in industries as a temperature measurement device, and this sensor could be used as a thermometer or in thermally sensitive equipment [5]. The received data from the 1-wire can range from 9-bit to 12-bit. Based on the comparison of the temperature sensor, DS18B20 met the criteria of a waterproof sensor over oil and was used to measure oil medium [6]. This sensor is also for a user-friendly and relatively affordable price.

iii. Arduino IDE

The Arduino Software (IDE), often known as the Arduino Integrated Development Environment (IDE), has a text editor for writing code, a message area, a text console, a toolbar with buttons for essential functions, and several menus. It establishes a connection with the Arduino hardware to upload programs and communicate. The reason for choosing IDE is because of its speed, stability and universal availability

iv. Internet of Things (IoT)

Kevin Ashton first created the phrase "Internet of Things" (IoT) in a presentation about Procter and Gamble's implementation of radio-frequency identification (RFID) for supply chain management. IoT is a cutting-edge technology connecting all intelligent things in a network without requiring human input [7]. Simply put, an IoT device is anything that can be connected to the internet for monitoring or sending data [8]. Because each device is connected, it can exchange and collect data. Each device must be distinct for its embedded system to recognise and connect it to the current internet infrastructure [9]. ThingSpeak is a cloud computing platform designed for IoT and suitable for big data applications. Users can view their data in cloud storage anytime and from any location by logging into their ThingSpeak account. The ThingSpeak IoT platform has a well-designed user interface that allows users to analyse data and visualise it [10].

2.2 Methods

The input data came from the temperature of the oil and coil winding of the transformer. The transformer oil sample Diala S4 SX-1 is collected in the oil bath, and the coil winding sample is taken from Dry Type step down transformer 240V to 110V. DS18B20 sensor manages the temperature data and is connected to the microcontroller's digital input. NodeMCU V3 module is used as the microcontroller unit (MCU) in this system as shown in Figure 1. The programming of this system is uploaded to the NodeMCU module performed as coding designed, and data is uploaded to the ThingSpeak platform.

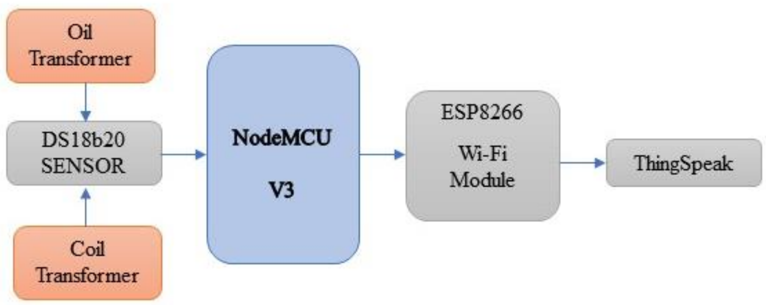

Figure 1: Block Diagram of the monitoring system

The hardware prototype is designed as shown in Figure 2 for oil temperature monitoring and coil winding temperature monitoring. Two units of DS18B20 Waterproof sensors were used to monitor the temperature of the oil transformer and coil winding transformer sample in the oil bath. Figure 2 shows the sensors positioned in the oil bath which place in the centre area oil bath to measure the temperature of the oil transformer. Figure 3 shows the position of the sensor that is placed on the coil winding sample in the oil bath it places in the middle of the oil bath and must not touch the inner surface of the beaker. The DS18B20 waterproof sensor is connected to NodeMCU V3, which acts as the system's main controller of the system, and the raw data received will be sent to the cloud server for storage and display on the ThingSpeak side.

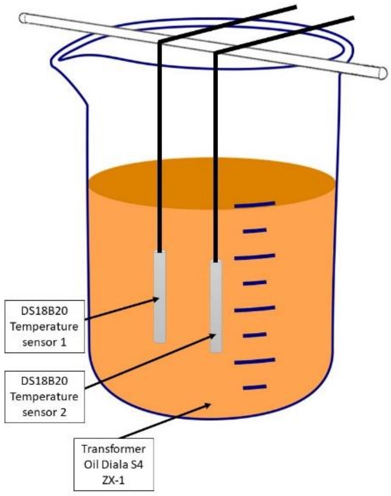

Figure 2: Hardware design for oil transformer monitoring

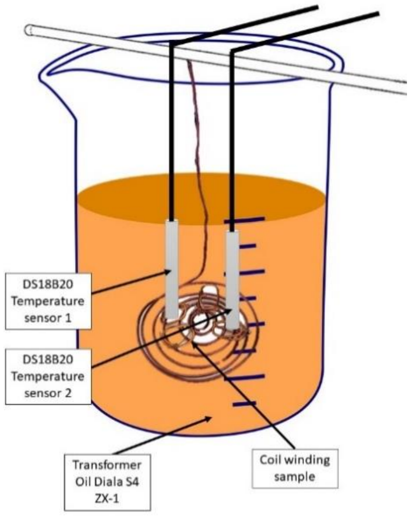

Figure 3: Hardware design for coil winding transformer monitoring

3. Results and Discussion

The temperature oil and coil winding data measured by two units of DS18B20 are uploaded to the ThingSpeak website and displayed in the graph. The oil and coil winding temperature data are taken individually in the assigned channel. Data in Figure 4 and Figure 5 used two units of DS18B20 sensors for the temperature measuring and collection in ThingSpeak. The sensor was used to measure two different points in the oil bath of oil and the coil winding temperature and every temperature data is taken for 15 seconds, respectively.

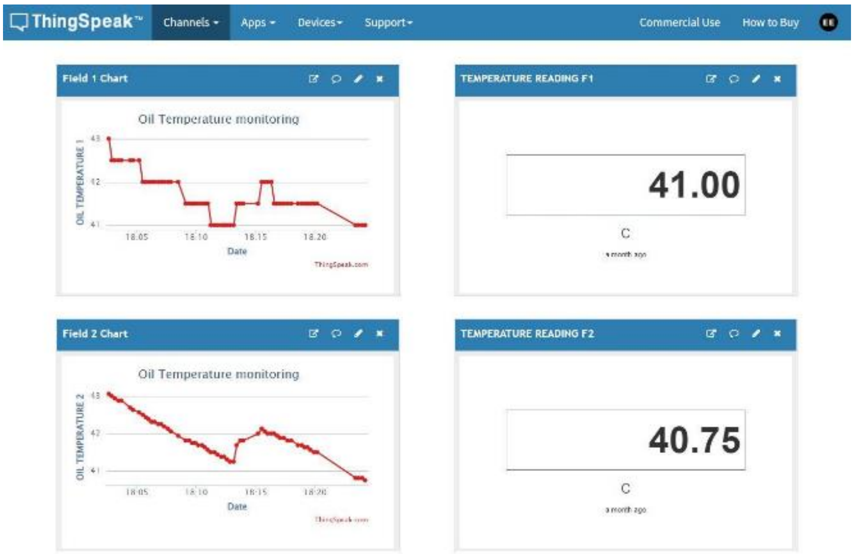

Figure 4: Oil Transformer Temperature Data in ThingSpeak

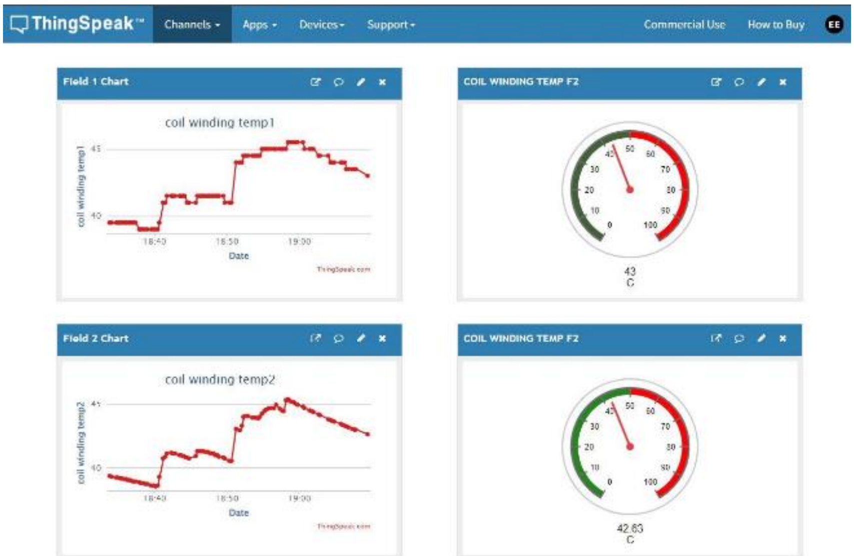

Figure 5: Coil Winding Temperature Transformer Data in ThingSpeak

The data collection temperature of oil and coil winding result has verified that the hardware and software implementing cloud-based monitoring using ThingSpeak is feasible. The data collected is uploaded to the ThingSpeak website to visualise. Real-time data streaming of the oil and coil winding temperature was displayed in the ThingSpeak dashboard. The visualisation of data in the ThingSpeak report was impactful as it records the temperature data, is stored in the cloud and is user-friendly. In addition, the future of ThingSpeak in data visualisation help in the analysis of the data trends over time which is shown in graphical visual. Thus, a sudden increase in the oil and coil winding temperature rising was easily observed as the graph form communicated the data finding patterns and trends to gain insight and make better decisions faster. Besides, the oil and coil winding temperature monitoring by using ThingSpeak help reduce the regularity of manpower to visit the site as the oil and coil winding temperature are easily and more frequent to be tracked by real-time monitoring using the help of Thingspeak.

Real-time data streaming of the oil and coil winding temperature was displayed in the ThingSpeak dashboard and collected data can be exported in a comma-separated values (CSV) file and performed in the Excel platform. The time details of the data collection from the oil and coil winding temperature from the two units of the sensors represent in column A, while Field 1 in column C is data from DS18B20 Sensor 1, and Field 2 in column D represents data from DS18B20 Sensor 2 as shown in Figure 6 for oil temperature and Figure 7 for coil winding temperature. This exported data by the ThingSpeak cloud to the CSV file is another way to monitor and analyse the transformer temperature data history. Therefore, the changes in the oil and coil winding temperature also can be accessed in Excel and analysed for future review and reference for the operator in analysing the data history for maintenance works.

	A	B	C	D
1	TIME	Entry_ID	Field 1	Field2
2	2022-05-22T23:34	1	31.5	31.50
3	2022-05-22T23:34	2	31.5	31.50
4	2022-05-22T23:35	3	32	31.56
5	2022-05-22T23:35	4	32	31.56
6	2022-05-22T23:35	5	32	31.56
7	2022-05-22T23:35	6	31.5	31.50
8	2022-05-22T23:36	7	32	31.50
9	2022-05-22T23:36	8	31.5	31.50
10	2022-05-22T23:36	9	32	31.56
11	2022-05-22T23:37	10	32	31.56
12	2022-05-22T23:37	11	31.5	31.56
13	2022-05-22T23:37	12	31.5	31.63
14	2022-05-22T23:37	13	32	31.56
15	2022-05-22T23:38	14	32	31.50
16	2022-05-22T23:38	15	32	31.50
17	2022-05-22T23:38	16	31.5	31.50
18	2022-05-22T23:38	17	31.5	31.44
19	2022-05-22T23:39	18	31.5	31.44
20	2022-05-22T23:39	19	31.5	31.38

Figure 6: Oil temperature in Excel sheet.

	A	B	C	D
1	TIME	Entry ID	Field 1	Field 2
2	2021-12-19T22:05	1	41.5	41.50
3	2021-12-19T22:05	2	41.5	41.50
4	2021-12-19T22:05	3	41.5	41.50
5	2021-12-19T22:05	4	41.5	41.50
6	2021-12-19T22:06	5	41.5	41.50
7	2021-12-19T22:06	6	41	41.00
8	2021-12-19T22:06	7	41.5	41.50
9	2021-12-19T22:06	8	41	41.00
10	2021-12-19T22:07	9	41	41.00
11	2021-12-19T22:07	10	41	41.00
12	2021-12-19T22:07	11	41	41.00
13	2021-12-19T22:08	12	41	41.00
14	2021-12-19T22:08	13	41	41.00
15	2021-12-19T22:08	14	41	41.00
16	2021-12-19T22:09	15	41	41.00
17	2021-12-19T22:09	16	41	41.00
18	2021-12-19T22:10	17	41	41.00
19	2021-12-19T22:10	18	41	41.00
20	2021-12-19T22:10	19	41	41.00

Figure 7: Coil winding temperature in Excel sheet.

4. Conclusion

The oil and coil winding temperatures and the input data from the sensor node were uploaded to the ThingSpeak IoT platform for future data analysis and visualisation. The display of real-time oil and coil temperature streaming allowed the user to monitor the temperature. The information gathered is submitted to an internet database. Users with numerous devices can access data storage and the web dashboard on the condition the users have the password to access the web dashboard. The private channel only allowed the data to be viewed by the owner channel and resisted by the public.

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