International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 05 | May - 2023 Impact Factor: 8.176 ISSN: 2582-3930

IMPLEMENTATION OF LOAD SHARING OF TRANSFORMER WITH AUTOMATED COOLING USING IoT

HARSH VARDHAN[1] , HARSH KUMAR SINGH[2] , HARINANDAN CHAUHAN[3] , AMIT KUMAR[4]

[1]UG student of Department of Electrical Engineering, Shri Ramswaroop Memorial College of Engineering and Management Lucknow, Uttar Pradesh, India.
[2]UG student of Department of Electrical Engineering, Shri Ramswaroop Memorial College of Engineering and Management Lucknow, Uttar Pradesh, India.
[3]UG student of Department of Electrical Engineering, Shri Ramswaroop Memorial College of Engineering and Management Lucknow, Uttar Pradesh, India.
[4]Assistant Professor, Department of Electrical Engineering, Shri Ramswaroop Memorial College of Engineering and Management Lucknow, Uttar Pradesh, India

ABSTRACT

In the field of electrical engineering, there is a common belief that the transformer serves as the system's building block. Any damage to the transformer will, either directly or indirectly, have an unstable effect on the entire power system. The most obvious cause of these effects appears to be inadequate cooling and overloading. And last, with the growth and expansion of the nation's economy, reliability and safety concerns with the electricity system have taken on a significant amount of significance. Consequently, our strategy uses the Internet of Things to address this issue. With the use of HTTP protocols, the Internet of Things enables us to keep track of real-time metrics such as current, voltage, oil level, and temperature monitoring. Next, the fan automatically turns on as soon as the Transformer starts to heat up. Additionally, the Transformer shares the load with another one when the temperature approaches the bearing temperature.

Keywords : Power System, Transformer, Real time metrics, Load share, Internet of Things.

I. INTRODUCTION

Electricity is produced and distributed as part of the power system, and the transformer is a key component of this process. And data demonstrate unequivocally that means nearly 40% of Transformer failures are caused by mechanical problems.[1] These failures might cause a variety of problems, such as a full blackout of the area's electricity due to a minor fault at the power system's distributing end. These problems might also be highly dangerous since overloading the Transformers causes them to become hot, which increases the risk of component failure and, in some cases, fire and explosion owing to inadequate cooling.[2]

In order to track the functioning of all the key Transformer characteristics, the real-time monitoring system will be introduced as a solution to the problem.[4] These characteristics for the Transformer also include the Transformer's current, level, voltage, and temperature in real-time.[5]

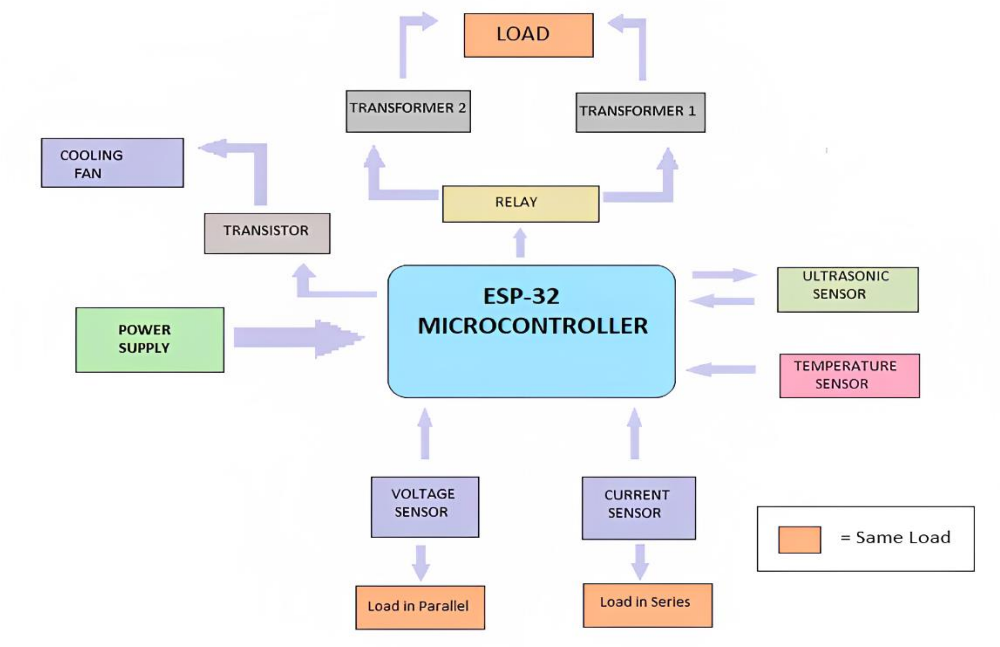
With the assistance of IoT technology, it is conceivable. IoT technology makes use of a broad variety of sensors to detect various physical inputs and offer various informational and statistical outputs.[6] With algorithms created to meet certain specifications, they are used to gather important data and communicate it over a large network of linked devices.[7]

Following that, the fan will automatically turn ON to lower the temperature as the transformer heats up, resolving the problem of thermal overheating. Moreover, when the temperature exceeds its rating, the Transformer shares its load with the second Transformer. In addition, the load is switched back to the transformer when it cools down and resumes regular operation. Therefore, this system will help you identify the problems before an unfavorable failure results in the transformer being used for an extended period.[8]

Prior works have discussed topics like transformer load sharing and data monitoring. however, in our work, we also introduced the Internet of Things (IoT) while fusing these two features. Therefore, it might also be advantageous for us so that we can fix system errors more quickly and before any unforeseen issues that might arise in the power system.[9]

II. METHODOLOGY

BLOCK DIAGRAM



I. VOLTAGE SENSOR- ZMPTB101BAC

The ZMPTB101BAC voltage sensor module is the ideal choice when using Arduino as an open-source platform to detect AC voltage. A 250 V (50/60 Hz) AC voltage sensor module called ZMPTB101BAC is a compact 2 mA/2 mA voltage transformer-based device. Further adjusting the isolated analogue output is possible thanks to a built-in multiturn trimpot in its secondary circuitry, which is based on the LM358 dual-op-amp chip. The module's suggested operating voltage is 5 VDC. Through its analogue inputs, the Arduino Uno can measure voltages. With a precision of 4.9mV per unit (5.00V/1023 units), an analogue input pin by default maps analogue input voltages between 0V and 5V into integer values between 0 and 1023.[10]

II. CURRENT SENSOR- ACS712

The ACS712 Current Sensor uses an indirect sensing method to detect the current without compromising the system's performance. The current sensor is capable of monitoring and computing the amount of current applied to the conductor. To detect current, this IC uses a liner, low-offset Hall sensor circuit. The sensor is mounted on a copper conduction channel at the surface of the IC. As current flows through this copper conduction line, a magnetic field is created, which the Hall effect sensor can detect. As a result, the Hall sensor, which measures current, generates a voltage proportionate to the magnetic field that is being seen.[11]

III. TEMPERATURE SENSOR- DHT11

In the humidity sensor capacitor, a moisture-holding substrate serves as a dielectric between two electrodes. As the humidity levels change, so does the capacitance value. These changing resistance values are measured, processed, and converted into digital form by the integrated circuit.[12]

With a 2-degree accuracy, the DHT11 offers a temperature range of 0 to 50 degrees Celsius. This sensor offers a humidity range of 20 to 80% with a 5% accuracy. The sampling rate of this sensor is 1Hz. It offers one reading each second, in other words. The

DHT11 is a little gadget with an operating voltage range of 3 to 5. The highest current that may be utilized for measurement is 2.5 mA.[13]

IV. ULTRASONIC SENSOR- HC-SR04

The HC-SR04 ultrasonic sensor uses sonar to calculate how far away an item is. It provides a number of non-contact detection options with very accurate & trustworthy results. It consists of a receiver and an ultrasonic transmitter. The transmitter sends out a signal with a high pitch. When the signal finds an object, it reflects back to the echo pin on the transmitter. then utilizing the length of time needed for signal transmission and reception, one can calculate the distance to an object from that point. With a 15mA operational current, this sensor runs on a +5V DC power source.[14]

V. System on Chip(SoC) Microcontroller -ESP32

The System on Chip (SoC) microcontroller ESP32 includes built-in RF parts such as a power amplifier, low-noise receiver amplifier, antenna switch, filters, and RF balun. The ESP32's Xtensa® Dual-Core 32-bit LX6 microprocessors, which have a maximum performance of 600 DMIPS, enable it to run at frequencies between 160 MHz and 240 MHz. That rate is excellent for anything requiring a microcontroller with networking capabilities. The CPUs have 448 KB of on-chip ROM for booting and core operations in addition to 520 KB of on-chip SRAM for data and instructions.

Additionally, the ESP32 supports Wi-Fi Direct. Wi-Fi-Direct is a wonderful choice for peer-to-peer connections without an access point. Infrastructure BSS Station mode, P2P mode, softAP mode support, WPA/WPA2-Enterprise, and WPS driver are all included in the ESP-IDF Wi-Fi implementation.[15]

III. PROCESS OF WORK

Two 12 o 12 transformers and several sensors, including the ACS712, DHT11, HC-SR04, ZMPTB101BAC, and NODEMCU, are included with this model. These sensors monitor the real-time characteristics of the transformer and transmit that data to the user via IoT. Both the user's smartphone screen and the led display provide current, voltage, and temperature readings in real-time. In order to assist the transformer in cooling down and resolving the problem of thermal overheating, the buzzer broadcasts a warning and turns on the fan. Additionally, the Transformer switches its load to the second Transformer when the temperature exceeds its rating.

- The transformer delivers 4.25 Amps of current, 11.1 volts of voltage, and a temperature reading of 19.82 degrees Celsius when everything is working properly. For this parameter monitoring, you can utilize a 16x2 LCD or a web dashboard/phone app. This program offers features for tracking the temperature graph of the transformer over time.

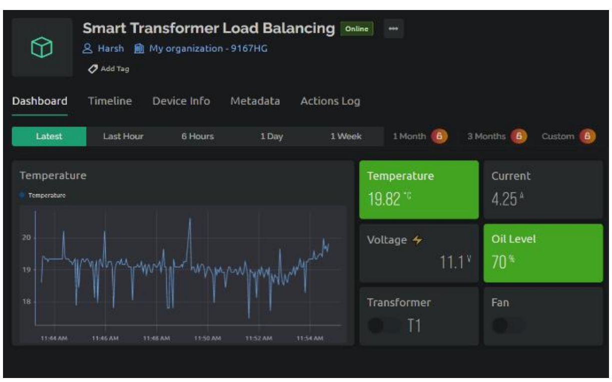


FIGURE 1 – All the parameters are displayed on the web interface.

FIGURE 2 – The 16x2 LCD display showing parameters.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 05 | May - 2023 Impact Factor: 8.176 ISSN: 2582-3930

- The oil indicator shows the amount of oil in the transformer's tank as a percentage. The tab shows the percentage of oil level and is normally green. The tab flashes red to show that the oil level is low if it drops to 40% or less in the tank.

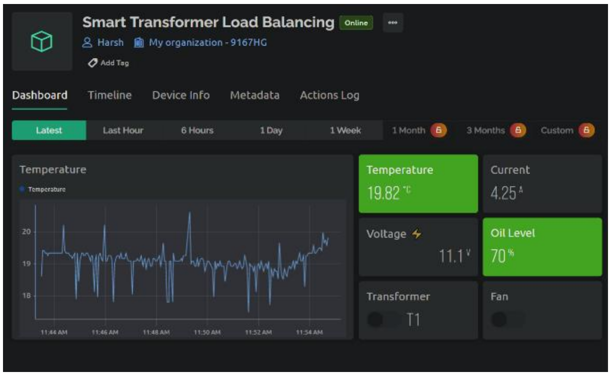


FIGURE 3 – 70% of an oil tank is full (Green indication).

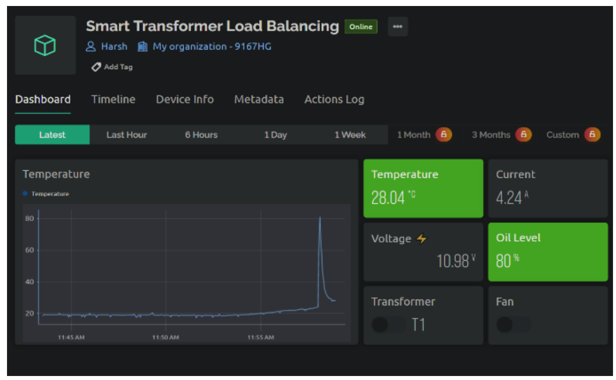


FIGURE 5 – 80% of an oil tank is refilled(Green indication

FIGURE 4 – 30% of an oil is left in the tank (Red indication).

- In addition, when the temperature rises beyond 40 degrees Celsius, the fan will automatically switch on and display a pop-up message.

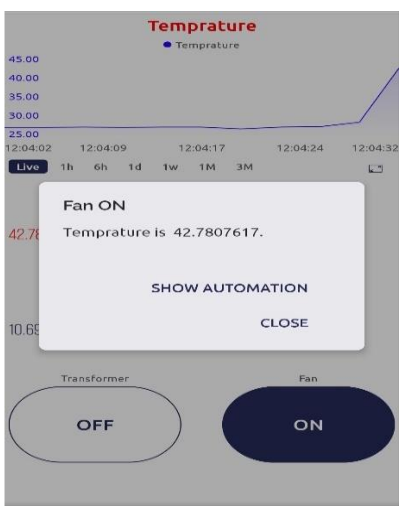


FIGURE 6 – Notification of the fan's activation on smartphone application.

- To help the transformer cool down more rapidly when the temperature rises over 80 degrees Celsius, the load on Transformer1 is moved to Transformer2 and the fan speed is raised. In addition to that, the user may watch the graph in addition to seeing a notification indicating "Transformer 2 is working" on the LCD screen and in the application.

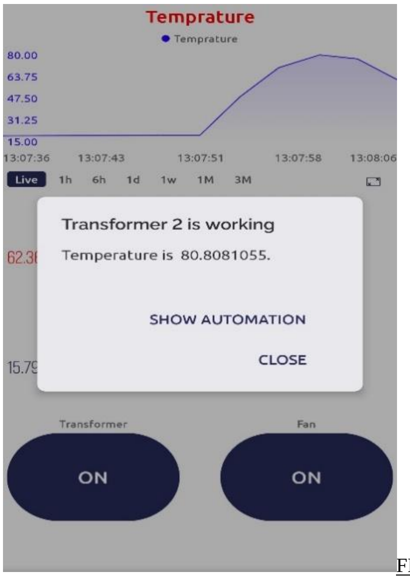


FIGURE 7 – Notification showing that load is shifted to Transformer2 from Transformer1.

FIGURE 8 – Notification showing Transformer2 started working.

- Once again, after 30 seconds, Transformer2 will automatically switch the load back to Transformer1 when it has cooled down to normal (below 80 degrees Celsius) with a pop-up notice stating "Transformer 1 is working" on both the user's screen and the LCD.

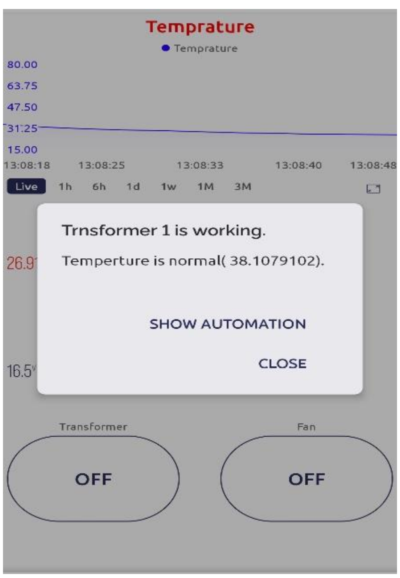


FIGURE 9 – Notification showing that load is shifted Transformer1 from Transformer2.

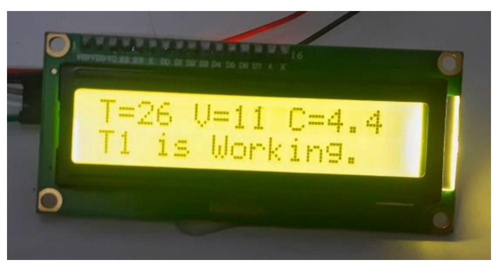


FIGURE 10 – Notification showing Transformer1 working.

IV. RESULT

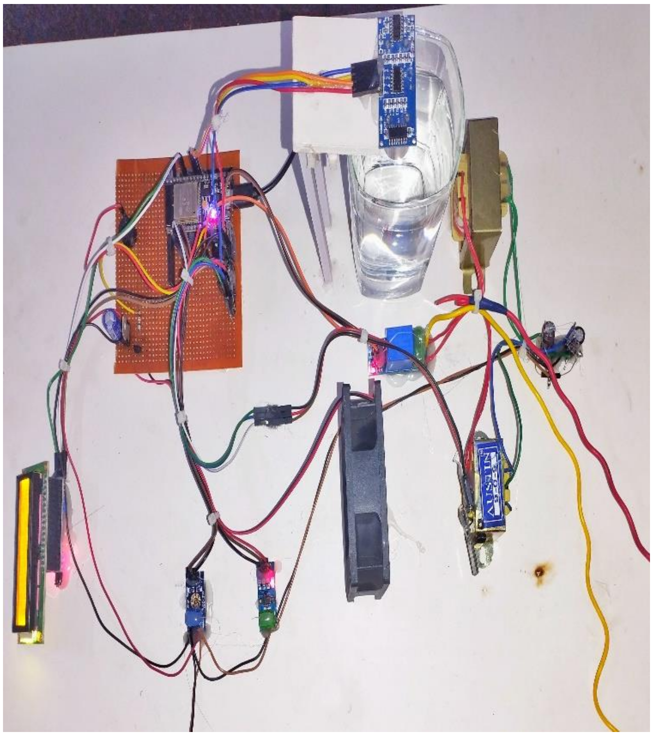


FIGURE 11 – Proposed Hardware System.

VOLTAGE	CURRENT	TEMPERATURE	WORKING TRANSFORMER	FAN ON/OFF
11.11v	4.25A	19.82°C	TRANSFORMER 1	OFF
10.69v	4.36A	42.78°C	TRANSFORMER 1	ON (Medium Speed)
15.79v	3.72A	80.81°C	TRANSFORMER 2	ON (High Speed)
11.56v	4.41A	26.18°C	TRANSFORMER 1	OFF

TABLE 1 – Experimental results of the System.

The protection system's accuracy and correct operation have been shown by the results of the recommended approach.

V. CONCLUSION

By utilizing contemporary technologies, the suggested solution safeguards and increases the transformer's lifespan. This technology transmits precise, reliable real-time data from the transformer that is being watched over by Wi-Fi to the user. When a transformer's temperature increases significantly, the technology also introduces the concept of load shifting.

As a result, the proposed technique reduces the likelihood of a transformer breakdown in the power system. Additionally, the time it takes for the power system to recover will be shorter if another problem arises.

IV. REFRENCES

[1] Abu-Siada, A. & Hashemnia, N. & Masoum, Mohammad. (2013). Understanding Power Transformer Frequency Response Analysis Signatures. Electrical Insulation Magazine, IEEE. 29. 48-56. 10.1109/MEI.2013.6507414.

[2] Jaspreet Singh, Sanjeev Singh," Transformer Failure Analysis:Reasons and Methods," International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Published by, www.ijert.org ACMEE - 2016 Conference Proceedings.

[3] D. Srivastava and M. M. Tripathi, "Transformer Health Monitoring System Using Internet of Things," 2018 2nd IEEE International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES), Delhi, India, 2018, pp. 903-908, doi: 10.1109/ICPEICES.2018.8897325.

[4] Biju Rajan B , Amanraj S , Akhil S , Nayana S "IoT based Distribution Transformer Health Monitoring System using Arduino, Nodemcu and Thingspeak," INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY

(IJERT), Volume 08, Issue 04 (April – 2019).

[5] K. Hazarika, G. Katiyar and N. Islam, "IOT Based Transformer Health Monitoring System: A Survey," 2021 International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE), Greater Noida, India, 2021, pp. 1065-1067, doi: 10.1109/ICACITE51222.2021.9404657.

[6] M. Lian, D. Yang, Z. Yin, J. Liu, M. Li and A. Chai, "Research and Design of Semantic Model of IoT Entity Based on Ontology," 2020 IEEE 6th International Conference on Computer and Communications (ICCC), Chengdu, China, 2020, pp. 897-901, doi: 10.1109/ICCC51575.2020.9345168.

[7] H. Zhang, X. Zhang, Z. Guo, H. Wang, D. Cui and Q. Wen, "Secure and Efficiently Searchable IoT Communication Data Management Model: Using Blockchain as a new tool," in IEEE Internet of Things Journal, doi: 10.1109/JIOT.2021.3121482.

[8] Aziz S, Wang Hz, Peng JC, Ruan JQ. Power sharing of transformer. In: 2018 international conference on power system technology (POWERCON). New York: IEEE; 2018. p. 4438–42.

[9] S. Aziz, H. -z. Wang, J. -C. Peng and J. -Q. Ruan, "Power Sharing of Transformer," 2018 International Conference on Power System Technology (POWERCON), Guangzhou, China, 2018, pp. 4438-4442, doi: 10.1109/POWERCON.2018.8601790.

[10] Abubakar1, S. N Khalid1, M. W. Mustafa1, Hussain Shareef and M. Mustapha," CALIBRATION OF ZMPT101B VOLTAGE SENSOR MODULE USING POLYNOMIAL REGRESSION FOR ACCURATE LOAD MONITORING," ARPN Journal of Engineering and Applied Sciences, VOL. 12, NO. 4, FEBRUARY 2017 ISSN 1819-6608.

[11] Berlian Sari, Mona & Yuliantini, Lia & Prihtiadi, Hafizh & Djamal, Mitra. (2021). Easy monitoring and data record system of electric current detected by ACS712 affordable non-destructive electrical current sensor. 10.24036/10741171074.

[12] Ms.Sujeetha. R/AP, K Reddy Deeraj, B Bhaskar Yeseswi, Lenin Sade," Humidity and Temperature Monitoring System using IoT", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249-8958 (Online), Volume-9 Issue-2, December, 2019.

[13] N. Aji, Nazuwatussya'diyah and E. Joelianto, "IoT-Based Temperature and Relative Humidity Monitoring System Using Simple Network Management Protocol," 2021 International Conference on Instrumentation, Control, and Automation (ICA), Bandung, Indonesia, 2021, pp. 174-179, doi: 10.1109/ICA52848.2021.9625689.

[14] Mutinda, Mutava & Kamweru, Paul. (2020). Arduino Uno, Ultrasonic Sensor HC-SR04 Motion Detector with Display of Distance in the LCD. International Journal of Engineering Research and. V9. 10.17577/IJERTV9IS050677.

[15] Maier, Alexander & Sharp, Andrew & Vagapov, Yuriy. (2017). Comparative Analysis and Practical Implementation of the ESP32 Microcontroller Module for the Internet of Things. 10.1109/ITECHA.2017.8101926.