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SMART ALERT SYSTEM TO PROTECT DISTRIBUTION TRANSFORMER FOR VARIOUS FAULTS

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ABSTRACT

A power system's most important component is the transformer. Transformer damage has a negative impact on the power system's balance. Overloading and poor cooling are the primary causes of damage. The primary goal of this project is to use GSM technology to monitor the health of the distribution transformer in real time. A transformer's temperature, oil level, and current are monitored, analyzed, and recorded in servers. Three sensors connected to an Arduino board are used for this. This makes it easier to recognize without relying on humans. This aids in identifying and resolving a problem before it becomes a failure, and it does it without the need for human intervention. As a result, we're building a system in which the system and the operator can communicate. Transformer, Arduino nano, and GSM (global system for mobile communication modem) are used in this project. By delivering messages to the system, this GSM modem aids in the monitoring of transformer health. As we all know, the transformer is an important part of the power system, and its proper operation is critical to the system's functionality.

Keywords*: Arduino Nano, Temperature sensor, current sensor, GSM*

1. INTRODUCTION

Electricity is very crucial in our lives. It is present in every aspect of our lives. It contains a number of components and equipment that assist humans in transferring and regulating distribution based on usage. The transformer is the most important piece of electric power transmission and distribution equipment. An electrical component transformer directly distributes electricity to low-voltage consumers in a power system, and the condition of its operation is a criterion for the entire network's functioning. The majority of the devices have been in use for many years in various environments (mechanical, electrical, and environmental). They are the essential components and account for significant capital investment. Distribution transformers operated in rated condition (as specified on their nameplate) have a long service life. However, suppose they are overloaded, heating high or low voltage current, resulting in unexpected loss and failure of supply to a large number of consumers. In that case, their life is dramatically shortened, compromising system reliability. The most common causes of distribution transformer failure include oil temperature, overloading, load current, and poor transformer cooling. Manually checking each transformer in today's electric systems is unfeasible due to the large number of transformers distributed across a large area. As a result, we'll require a distribution transformer system to monitor all essential parameters and send data to the monitoring system on a regular basis. It provides you with all of the information you require on the transformer's condition. This will assist and guide utilities in making the most use of the transformer and extending the equipment's life. Currently, distribution transformers are manually monitored, with a person visiting a transformer site on a regular basis for maintenance and recording important parameters. This sort of monitoring cannot detect occasional overloads or overheating of transformer fluid and windings. All of these variables can dramatically shorten the life of a transformer. Our system, which is based on online monitoring of key operational characteristics of distribution transformers, can provide helpful information about the health of transformers, allowing utilities to make better use of their transformers and maintain the asset in service for a more extended time. This paper describes the design and implementation of an autonomous real-time monitoring system consisting of sensors, an Arduino Nano, and a GSM modem.

2. LITERATURE REVIEW

It's difficult to manually inspect every single transformer in today's electric systems because there are so many of them spread out over such a huge region. As a result, we'll need a distribution transformer system to keep track of all critical parameters and communicate data to the monitoring system in real time. It gives you all the information you need regarding the transformer's health.

U.V. Patil et al. have analyzed a low-cost system for monitoring the health of remotely situated distribution transformers using GSM technology in order to prevent premature distribution transformer breakdowns and improve customer service reliability[1]. The reliability of power transformers is necessary for the operation of the energy system since they are a complicated and critical component of the power transmission and distribution system. As a result, there is growing interest in using monitoring systems and on-line diagnosis methods to diagnose transformers, which are one of the most expensive and crucial components of a power system. Mehdi Nafar et al. have investigated the comparative approach of transformer status estimate based on continuous transformer vibration monitoring[2]. One of the most significant pieces of electrical equipment is the distribution transformer. The duty of keeping track of the transformer's condition had become a fiery one. Because any damage to the transformer's internal properties will result in significant downsides. As a result, it is necessary to keep a check on the transformer on a frequent basis. S S. Tamilselvi et al. have proposed to collect real-time data on transformer health over the internet using Internet of Things (IOT) technology, and to monitor transformer parameters such as temperature, current, and voltage, as well as oil level[3]. The most common reasons of distribution transformer failure are overloading and poor cooling. R.V. PATIL, et al. have examined the key parameters of a distribution transformer, such as load currents, oil level, and ambient temperature, are monitored and recorded by a mobile embedded system[4]. Transformers are the most fundamental type of electrical device that transmits power by converting induced current from one circuit to another. Manually measuring and monitoring electrical properties is difficult for them. P.M. Sneha Angeline et al. have analyzed features of the transformer and communicate the information to the controller on a regular basis; the controller, in turn, will transmit the information to the client through RF. As a result, this architecture enables real-time parameter control and monitoring[5]. For many years, maintaining the health and reliability of the distribution power substation has been a challenge. Only one transformer characteristic, such as current, power, voltage, or phase, is detected by conventional transformer measurement equipment. While some approaches can detect several factors, the operation parameters and acquisition time are excessively long, and the testing speed is inadequate. Tosin P. Ojo et al. have examined a monitoring system that continuously monitors the transformer's temperature and predicts issues such as overcurrent and overheating, with the fault diagnosis transmitted to the base station through a GSM modem [6].

Transformers can be monitored for problems before they occur, preventing costly repairs and service interruptions. Current systems can offer information about a transformer's condition, but they are either offline or extremely expensive to implement. Transformers, which are an important part of the power transmission system, are costly, as are power outages. Due to the high cost of scheduled and unscheduled maintenance, particularly at remote locations. Sajidur Rahman et al. have analyzed data from an electrical sensing system, an embedded-based hardware. GSM networking is designed to communicate data from one network to another in order to take corrective action as soon as possible[7]. Distribution transformers, on the whole, have a long life if they are mainly used in a safe manner. The life of a transformer, on the other hand, is significantly reduced if it is overloaded. Due to this, an unexpected failure happens, as well as a significant loss of supply to a large number of consumers. V. Sanjeeya et al. examined that for all intents and purposes, the Internet of Things allows for billions of machine-to-machine connections. The process element takes advantage of the relationship between data objects and humans in order to give the correct information[8].

Embedded system automation is vital in a variety of applications. Automation decreases the impact on humans and saves a significant amount of time. Although a transformer cannot work with a direct current, it often produces a transient output pulse when connected to a DC source as the current rises. A transformer is an electrical device that uses electromagnetic induction to transmit energy between two circuits. Vishwanath R et al. identified various failures on three-phase transmission lines and used a GSM modem to send messages to monitor temperature, voltage, and current [9]. Substation distribution transformers are some of the most significant pieces of equipment in the power system. Because power systems have numerous components and a high number of transformers spread out across a substantial region, condition monitoring, data collecting, and automatic control are critical challenges. Satya Kumar Behera et al. have analyzed the design and implementation of automated control circuits for PLC automation to monitor and diagnose transformer conditions such as transformer temperatures, load currents, and voltages [10]. A high-quality power transformer that has been correctly constructed and outfitted with protection relays and monitors is exceptionally dependable. When a transformer in an electrical substation fails, the damage is usually significant due to the high-power rating. The ultimate goal is to reduce the response time after a failure occurs. V. Thiyagarajan et al. provide a novel idea for creating a system based on an AVR microcontroller that monitors the current, temperature, and voltage of a distribution transformer in a base and protects the system from increases in the supplied parameters [11].

When power transformers are overloaded above their nameplate rating, the transformer oil and windings temperature might rise. Overloading is an overcurrent fault that happens on the distribution transformer's secondary side. The insulation will degrade and fail prematurely if the winding temperature increases over the transformer limitations. External power system problems can result in low and high voltage levels on the transformer. It causes overvoltage and undervoltage problems.

The fault currents are relatively high due to the low fault impedance of the power line. When a fault occurs, the power flow is redirected to the fault, the supply to the neighboring zone is disrupted, and voltages rise [12]. Internet of Things (IoT) is a smart communication strategy that generates an enthusiastic impression in the future of the vehicle sector in today's world. The advancement of IoT innovation in every industry can be linked to the escalating events that have triggered a desire for a better human way of life. Its applications are numerous and varied. Keshav Kumar Jha et al. have examined a real-time Engine Oil Monitoring (EOM) System based on IoT technology for engine lubricant troubleshooting [13].

Transformers are the most crucial component of every substation or grid. In India, transformer failure occurs at a rate of 12 to 15%, which is higher than the global average. Failure of the transformer is common in industry, resulting in financial loss and reducing the transformer's lifetime to three years (usually, transformers have a lifetime of 25 to 30 years). Tejas patil et al. designed a distribution transformer protective circuit with a programmable controller to monitor the ambient temperature, voltage, current, and oil level of the transformer using various sensors[14]. In response to a growing demand for lower-cost and more efficient diagnostic tools, the electrical distribution power substation has used online monitoring and artificial intelligence analysis techniques. Mohammad Riyaz et al. proposed a flexible inserted framework for monitoring and recording critical transformer characteristics such as load currents, voltage level, and ambient temperature[15]. Currently, distribution transformers are manually monitored, with a person visiting the transformer site on a regular basis for maintenance and recording important parameters. This sort of monitoring is unable to detect overloads and overheating of transformer oil and windings on a regular basis. D.Sarathkumar et al. analyzed that a data from a transformer can be monitored in real time through the internet, which is part of the Internet of Things (IOT)[16]. Transformer is a high-efficiency static electrical device that is used to convert electricity from one voltage level to another. It is an important part of the electrical transmission and distribution system. Different stresses, such as electrical, mechanical, chemical, and environmental elements, have been affecting the transformer's state since its inception. Monika Agarwal et al. have proposed a design where overvoltage, overcurrent, temperatures, and oil level decrease are all critical operations of a distribution transformer that are being monitored and recorded using a mobile embedded system[17].

A transformer is the most preferred electrical equipment in a power system network for transferring power from a generating station to consumers via transmission lines. When operated under the specified parameters, it benefits humanity by providing long-term service. It is critical to monitor real-time transformer health in order to preserve grid resilience. Debanga Jyoti Baruah et al. have proposed that compared to the manual procedure, the transformer monitoring process employing the IOT mechanism is far more efficient. It automatically checks the oil level, temperature rise, ambient temperature, and load current, and sends an alarm to the authority if there is a problem with the system[18]. The low voltage users are supplied directly by the distribution transformer. As a result, the transformer's operational condition is critical in the distribution network. For a long life, transformers must be operated in rated condition. This is not feasible for the duration of the working day. Biju Rajan B et al. have analyzed that using IOT technology, real-time monitoring of the distribution transformer's health is possible. Temperature, voltage, and current of a transformer are all monitored, processed, and recorded on servers[19]. The inspected information about the distribution transformer should be conveyed properly by considering the coverage to the electrical network, which is an important issue to consider. As a result, for modern distribution transformer monitoring, it is vital to use an energy-efficient, dependable, and low-cost technology. Pustaraj Kore et al. examined that in the event of an emergency at the distribution transformer, the collected parameters detect the signal and send an alarm to the Android app with information about the parameter signals at the distribution transformer based on the microcontroller's data[20].

3. PROPOSED SYSTEM

The goal of the proposed project is to obtain real-time information on transformer health metrics. Transformer temperature, voltage, and current are all monitored and sent over the SMS. These metrics may be tracked in real time with technology from anywhere in the world. In nature, this is cost-effective. As a result, the competent authority has access to data on any power outage or repair. As illustrated in fig 1, it consists of an Arduino Nano, a temperature sensor, a current sensor, an oil level sensor, and a power supply. The sensors collect data and send it to the Arduino Nano. It decodes it and sends it to the GSM module and then the SMS is sent to a authorized person.

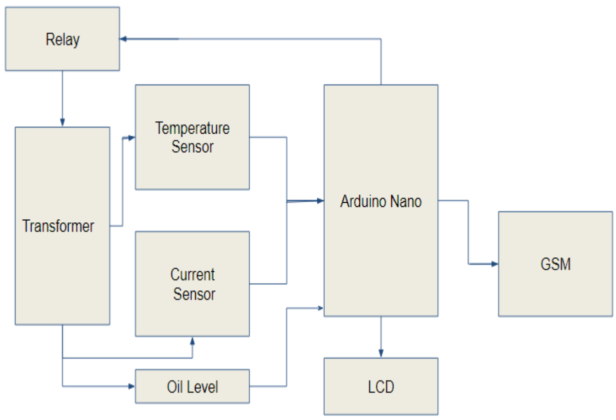

Fig 1. Block Diagram

4. COMPONENTS OF HARDWARE

4.1 Arduino Nano

The Arduino Nano circuit board with Arduino IDE can read analogue or digital input data from various sensors, activate the motor, turn on/off LEDs, and perform a variety of other tasks. The ATtmega328 primary microcontroller on the board is controlled by the Arduino IDE, which sends a set of instructions to it.

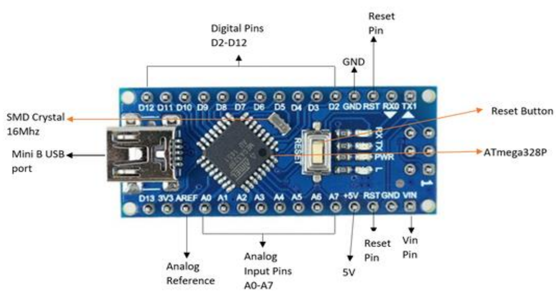

Fig. 2 Arduino Nano

4.2 GSM SIM 800L

The Mini GSM breakout board is centered on the SIM800L component, which facilitates a quad-band GSM/GPRS connectivity and can transfer SMS and GPRS message data remotely. The board is tiny and uses little power. Because of power saving technology, the consumption levels in sleep mode is as minimal as 1mA.

Fig. 3 GSM SIM 800L

4.3 Negative Temperature Coefficient Thermistor

NTC thermistors, or negative temperature coefficient of resistance thermistors, lower or decrease their resistive value when the operating temperature around them rises. NTC thermistors are the most prevalent sort of temperature sensor since they may be utilised in almost any type of equipment that has to do with temperature.

Fig. 4 Negative Temperature Coefficient Thermistor

4.5 ACS172 Current Sensor

In the commercial, industrial, and communications systems, the Allegro® ACS712 provides cost-effective and precise AC or DC sensing solutions. The device package makes it simple for the client to use. Load detection, Motor control and management, switched-mode power supplies, and overcurrent fault protection are common uses.

Fig. 5 ACS172 Current Sensor

5. RESULT

The results of proposed transformer fault detection system for various faults are presented below

Fault No 1: When the gadget detects a low oil level, it sends the information to the controller, the transformer shuts off, and an SMS is sent to the user via GSM.

Fault No 2: When current rises, the current sensor ACS172 detects it, the transformer shuts down, and an SMS is delivered to the user via GSM.

Fault No 3: If the temperature of the transformer rises, the sensor DS1820 (temperature sensor) detects this and shuts down the transformer, sending an SMS to the user via GSM.

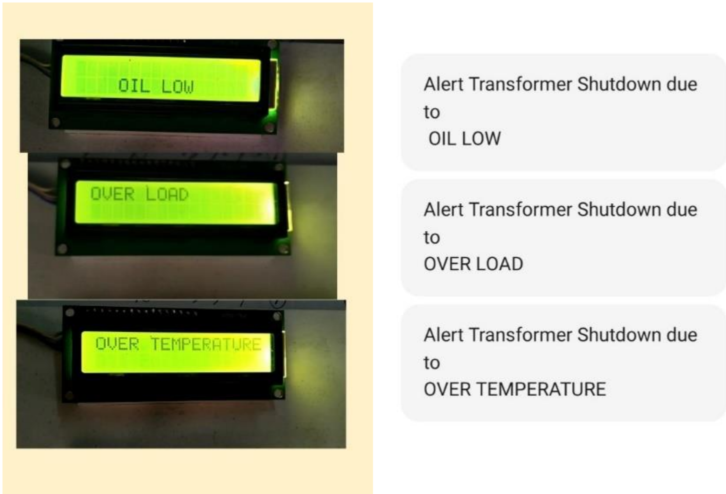

Fig. 6 Alert SMS sent to the user

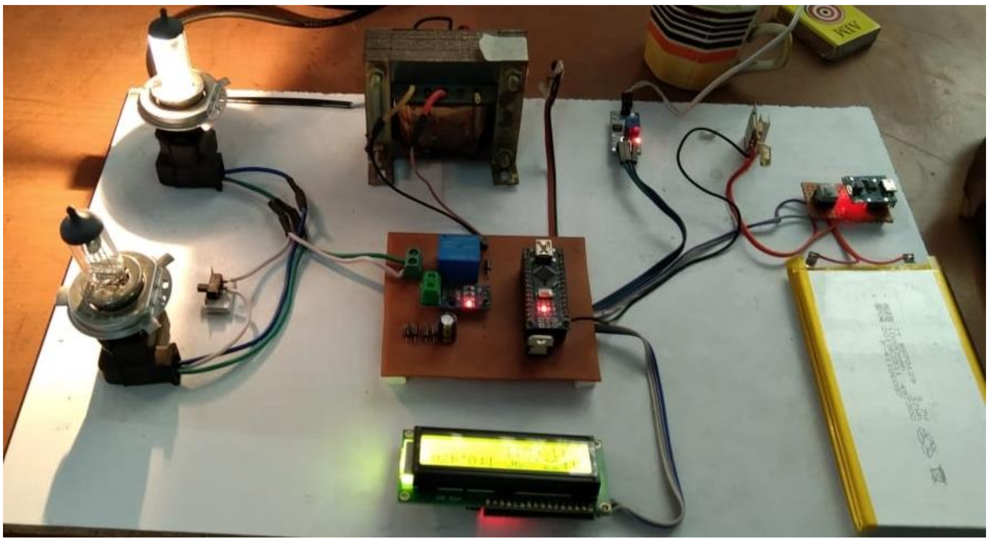

Fig. 7 implementation of the proposed system in hardware

6. CONCLUSION

The gsm-based distribution transformer monitoring is more reliable and valuable than manual monitoring since it is impossible to manually monitor the oil temperature rise, ambient oil level, temperature rise, and load current. After getting a message of any abnormality, we can take immediate action to prevent catastrophic distribution transformer breakdowns. There are many distribution transformers in a distribution network. By identifying each transformer with a particular system, we can quickly identify which transformer is experiencing a problem based on the message given to mobile phones.

REFERENCES

[1] U. V Patil, K. Mohan, H. Saurabh, and W. Nilesh, "Transformer Health Condition Monitoring Using GSM Technology," *Vol-2 Issue-2*, vol. 3, no. 12, pp. 1–5, 2016.

[2] M. Nafar, B. Bahmanifirouzi, and M. Jabbari, "Transformer monitoring by using vibration analysis," *Aust. J. Basic Appl. Sci.*, vol. 5, no. 11, pp. 984–990, 2011.

[3] S. Tamilselvi, B. Bharathiraja, S. Gowthami, C. Princy, and A. Subashini, "Advanced Distribution Transformer Load Monitoring and Controlling," vol. 07, no. 03, pp. 489–494, 2019.

[4] D. Kalantre, N. Hirugade, and A. More, "Transformer Health Monitoring and Control Through Arduino 1 R.V. Patil, 2 Dhiraj Kalantre, 3 Niranjan Hirugade, 4 Arun More, 5 Ashwinee Kakade," *Int. J. Electr.*, no. 51, pp. 2320–2084, 2017, [Online]. Available: http://iraj.in

[5] P. M. S. Angeline, "Performance Monitoring of Transformer Parameters," *Ijireeice*, vol. 3, no. 8, pp. 49–51, 2015, doi: 10.17148/ijireeice.2015.3811.

[6] T. P. Ojo, A. O. Akinwumi, F. O. Ehiagwina, J. M. Ambali, and I. S. Olatinwo, "Design and Implementation of a GSM-based Monitoring System for a Distribution Transformer," *Eur. J. Eng. Technol. Res.*, vol. 7, no. 2, pp. 22–28, 2022, doi: 10.24018/ejeng.2022.7.2.2733.

[7] S. Rahman, S. K. Dey, B. K. Bhawmick, and N. K. Das, "Design and implementation of real time transformer health monitoring system using GSM technology," *ECCE 2017 - Int. Conf. Electr. Comput. Commun. Eng.*, no. February, pp. 258–261, 2017, doi: 10.1109/ECACE.2017.7912915.

[8] R. S. Lini, R. K. Thana, R. A. Ana, and K. P. Ja, "Real Time Transformer Health Measuring System using IOT Technology," *Int. J. Eng. Trends Technol.*, vol. 56, no. 2, pp. 77–83, 2018, doi: 10.14445/22315381/ijett-v56p213.

[9] R. Vishwanath, A. V Shetty, and M. Thanuja, "A New Approach to monitor Condition of Transformers incipient fault diagnosis based on GSM," vol. 3, no. 2, pp. 875–882, 2015.

[10] S. K. Behera, R. Masand, and S. P. Shukla, "A Review of Transformer Protection by Using PLC System," *Int. J. Digit. Appl. Contemp. Res.*, vol. 8, no. 47, pp. 82344–82351, 2014, doi: 10.13140/RG.2.2.26174.59200.

[11] V. Thiyagarajan and T. G. Palanivel, "an Efficient Monitoring of Substations Using," vol. 4, no. July, pp. 63–68, 2010.

[12] I. Journal, "Technical Research Paper " Microcontroller based Fault Detector," *Int. J. Adv. Res. Technol.*, vol. 1, no. 5, pp. 1–8, 2012.

[13] K. Kumar* and D. B. S. Pabla, "A Real Time Engine Oil Monitoring System for Diagnosis of Lubricant using IoT Network," *Int. J. Innov. Technol. Explor. Eng.*, vol. 9, no. 8, pp. 497–505, 2020, doi: 10.35940/ijitee.h6524.069820.

[14] O. Tupe and S. Tiwari, "Transformers monitoring using Arduino," pp. 3414–3416, 2020.

[15] R. A. M. Riyaz and S. Kumar, "Analysis of Distribution Transformer Health Monitoring and Protection using Arduino," *Int. J. Innov. Res. Sci. Eng. Technol.*, vol. 7, no. 6, pp. 7371–7377, 2018, doi: 10.15680/IJIRSET.2018.0706106.

[16] D. Sarathkumar, M. Uvaraj, K. K. C. V, and A. Kalaiselvi, "System Using IOT," pp. 696–703, 2019, doi: 10.15662/IJAREEIE.2019.0803025.

[17] M. Agarwal, B. V. M. E. College, and V. V Nagar, "GSM Based Condition Monitoring of Transformer," vol. 1, no. 12, pp. 2818–2821, 2014.

[18] D. J. Baruah, "Design and Develop Transformer Monitoring System using NODE-MCU and Real Time IOT Platform Connected using NODE-RED," *Int. J. Res. Appl. Sci. Eng. Technol.*, vol. 9, no. 1, pp. 562–568, 2021, doi: 10.22214/ijraset.2021.32886.

[19] B. R. B, S. Amanraj, S. Akhil, and S. Nayana, "IoT based Distribution Transformer Health Monitoring System using Arduino , Nodemcu and Thingspeak," vol. 8, no. 04, pp. 673–676, 2019.

[20] P. Kore, V. Ambare, A. Dalne, G. Amane, and S. Kapse, "Iot Based Distribution Transformer Monitoring and Controlling System," no. 2, pp. 122–126, 2019.