International Journal of Electrical Engineering & Emerging Technology, Vol. 05, No. 02, DEC 2022, pp 11-14

Transformer Oil Temperature Monitoring with Automatic Circuit Breaker Operation with SMS Alert

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[Received on: 13/09/2022 **Accepted on:** 05/10/2022 **Published on:** 11/12/22 **]**

Abstract: **Distribution transformer is most important component in power distribution system as it converts high voltages to low voltages for consumption. It can operate efficiently and for a long time if it operates on rated and good conditions. But, due to overload current and unwanted conditions, their life reduced significantly and unexpected failures will occur in the system. In distribution transformers, overloading and overheating are the main reasons for its failure. The aim of this research is to design a microcontroller-based device that can be used for the online monitoring and safety of distribution transformers. The system allows us to monitors the oil temperature, displays the fault status, and forwards the input to the automatic circuit breaker and GSM module, which sends the information to the control department through the SMS warning. It tracks the oil level at different time intervals. If it is above or below the normal operating level, it automatically isolates the distribution transformer from the distribution line. Before any disastrous failure, many operational problems can be recognized, thus, this will lead us to the long service life of the transformer. It has also advantaged of greater reliability and economical method.**

***Index Terms*— Automatic circuit breaker, Distribution transformer, GSM module, Oil temperature monitoring.**

I. INTRODUCTION

Distribution transformer can operate for long time if it operates on rated and good situation [1]. But, due to unwanted conditions and faults their life reduced significantly. When they are overloaded due to excessive load current, losses will increase, and unexpected failures will occur in the system. These losses and failures will affect the system and many consumers badly. These faults will also affect the system reliability. In distribution transformers, overloading and cooling of the transformer is the main reasons for its failure.

In present times, distribution transformers are operated manually by manpower. Where some persons monitored the transformer on daily basis by visiting the site for recording the parameters of the transformer and its maintenance. Manual monitoring of the distribution transformer cannot provide us instant and complete information about the transformer heating and overloading of the transformer oil temperature and its windings. Distribution transformer life can be affected badly by these factors. These factors play very important role in reducing the life of transformer.

This research is to design a system that based on online monitoring of the transformer oil temperature and levels occasionally. This system will be able to provide us information about various parameters of the transformer health, and its working condition through which we can assess the operating condition and parameters of the transformer for long time of period [2].

Before any disastrous failure in the transformer, many operational problems can be recognized, thus, this will lead us to the long service life of the transformer. It has also advantaged of greater reliability and economical method.

The preferred monitoring system will be based on GSM module for mobile or any communication device to monitor the system properly on regular basis, with ATmega32 microcontroller and sensors packages. Data of the operating transformer can be received on the device on suggested time interval and notify at some ranges of the temperature. This online method will help workers and engineers to make the system reliable and to keep the transformer service for long time.

II. WORKING OF THE PROTOTYPE

Regular monitoring of oil temperature will be done in short intervals of time through the level and temperature sensors, collected data will be transmitted to the microcontroller to conclude weather data is according to the safety standards or it indicates a faulty condition, if the faulty condition is occurred then microprocessor will send the command to the circuit breaker to isolate the transformer and also inform the operator about the fault. This GSM module will send notification for high oil temperature or level of oil. If temperature or level of oil increasing due to unavailability of any human being than after a commanded range, it will trip the automatic circuit breaker.

To program the microcontroller, Bascom-AVR will be used. The GSM module will be programmed in such a way that it shows the name code and location of the transformer.

III. WORKING OF GSM MODULE

If the temperature or oil level changes beyond the set point, the microcontroller sends a signal to the GSM modem. These signals include GSM modem AT commands and SMS of

authorized person. Microcontroller will collect all data from sensor and send input to LCD. Once oil temperature increases above the limit value it will send signal to automatic circuit breaker which will trip shortly [3].

IV. WORKING OF OTHER MAJOR COMPONENTS

A. *Arduino Nano*

Due to its versatility, this device uses an AVR ATmega328 (Arduino Nano 3) [4]. It is a high performance low-power computer with RISC architecture. It is faster than PIC and 8051. The microcontroller device interfaces with temperature sensors 10k thermistor, LCD, oil level sensors, GSM modules, reed switches, and voltage sensors [5].

B. *Micro-switches*

When the transformer runs beyond its maximum rating, the oil temperature starts to rise, which will expand the oil volume. Expansion will cause the oil to reach its maximum limit. The proposed monitoring system will send an SMS to WAPDA engineers on first limit to warn them. When second limit exceeds which is maximum value it will send SMS to concern and open the switch to cut the transformer from load.

C. *Bascom*

Bascom-AVR is the original Windows Basic compiler for the AVR microcontroller series [7]. It is a compiler built by Atmel, powerful and easy to use. Bascom-AVR has four programs in one toolkit, called Integrated Development Environment (IDE). They all include program editors, compilers, programmers and simulators. Such a development environment facilitates the entire process from coding and testing programs to programming the microcontroller used. This article writes and burns Bascom commands into the microcontroller flash memory so that the built-in circuit can complete its tasks and achieve goals

V. METHODLOGY

A. *Block Diagram*

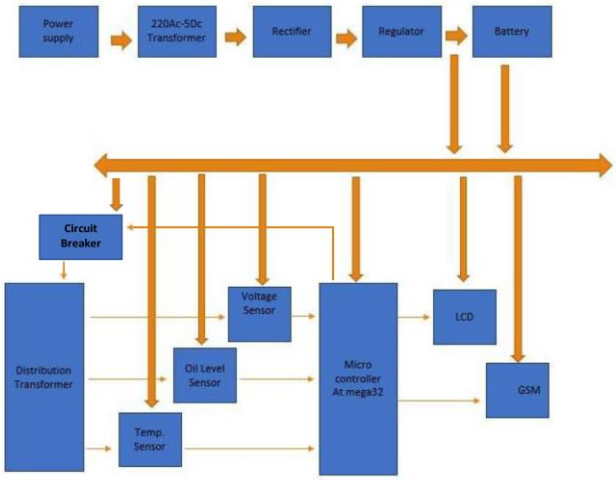

Fig.1. Block Diagram

Detailed methodology for our project is to gain our objectives of research under as:

It consists of power transformer, thermistor, oil sensor, microcontroller ATmega328 (Arduino Nano)' converter, LCD monitor, GSM modem and Automatic Circuit breaker. Generally, transformers will fail due to voltage and current fluctuations, overheating, oil level changes, etc. In this task, we use microcontroller, temperature sensors, oil level sensors, etc. to sense these faults.

Both sensors are connected to the converter, and the microcontroller ATmega328 (Arduino Nano) receives the digital output from the converter. Microcontroller ATmega328 (Arduino Nano) has four ports: viz. We will connect to P1, P2, P3 and P0 of the address block, GSM model and LCD, respectively. If a malfunction occurs due to the above reasons, the change in the rated value will be displayed on the LCD screen, and via the GSM modem, a fast SMS will enter the control room or to the specific person [6]. If temperature increase continuously due to unavailability of person, it will send signal to circuit breaker to cut the transformer from load to avoid the severe loss.

B. *Flow Chart of working of the circuit*

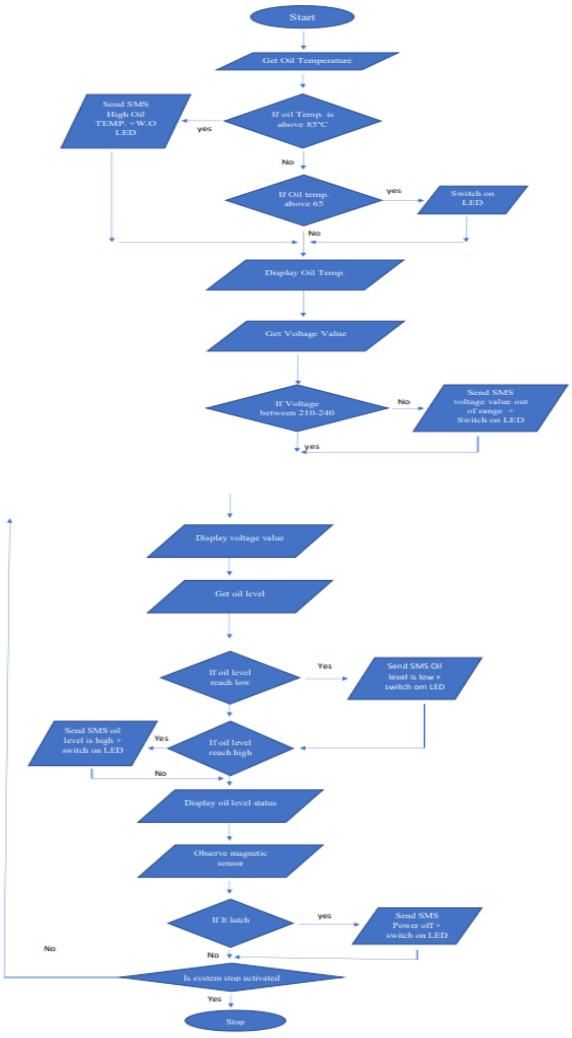

Fig.2. Flow Chart of Project

C. Components of Project

The components used in this project are following given below:

1. AURDUINO NANO (ATmega328)
2. Global System for Mobile Communications (GSM)
3. LCD (Liquid Crystal Display)
4. ZMPT101B AC Voltage Sensor
5. Magnetic oil level indicator
6. NTC Thermistor 10k
7. Bascom
8. Buck Converter
9. Relay Module
10. 220AC to 5DC Inverter
11. Battery
12. Connecting wires
13. Wires connector

D. Prototype Model

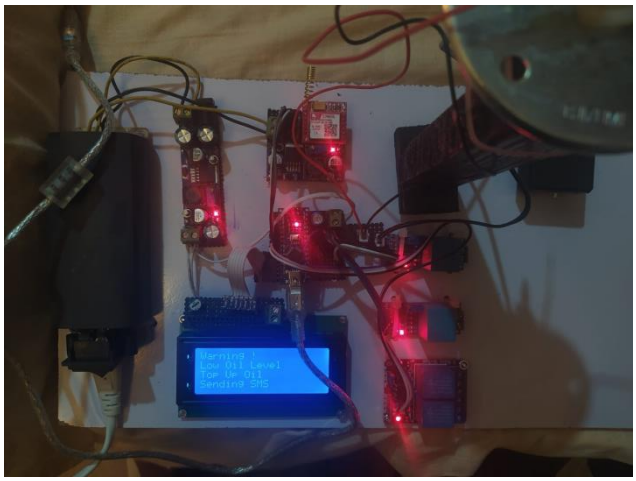

Fig.3. Prototype Model

VI. DISCUSSION AND RESULTS

The microcontroller will receive the input analog signal in the circuit diagram and convert it into a digital signal in the microcontroller, and the result of the transformer status will be displayed on the display. Initially the value of the transformer will be set, and if it reaches any value above this value, the LED will be triggered and the SMS will be sent to the mobile user who is feeding the GSM modem number at the same time [6, 8].

There are different cases depending on different conditions. Here are some situations of different faults and protype results, given as below.

A. Case 01: Low Oil Level

If the oil level of the transformer is low, it will be sensed by a low-level sensor, which is represented in the circuit by a low-level button. Then text will be sent to the assigned person in such a way it will show as “Oil Level is Low in Tran” and LCD will show the “O: Low” and LED will also indicate it. As shown in fig 4.

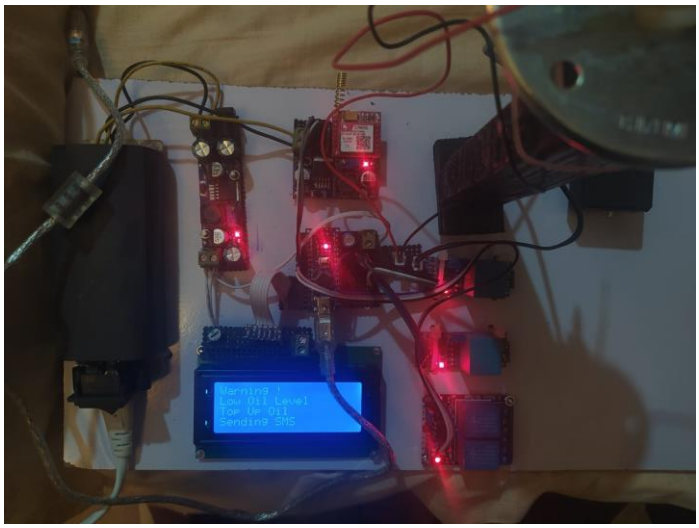

Fig.4. Fig of low oil level

B. Case 02: High Oil Level

If the oil level of the transformer is high, the high-level sensor represented by the high-level button in the circuit will feel it. The text message is " Oil Level is High in Tran ", and "O: High" and reduce the load is displayed on the LCD screen as shown in figure 5.

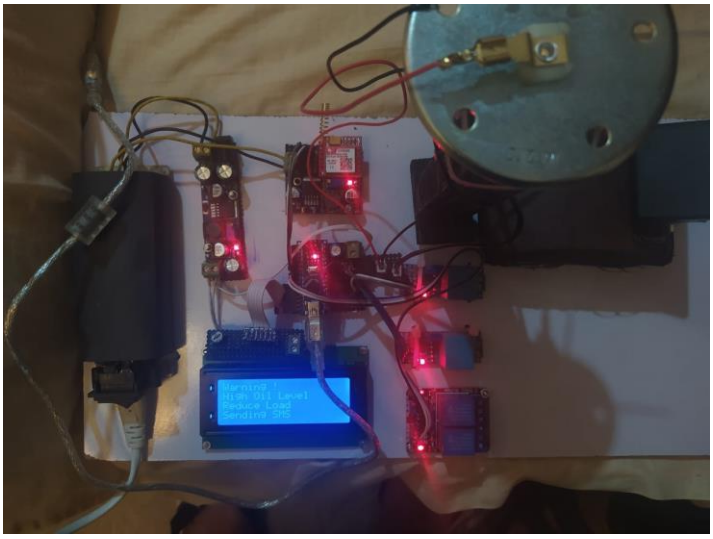

Fig.5. High Oil Level

C. Case 03: Oil Temperature Higher than 85°C

If the oil temperature in the transformer is higher than 85°C, the Thermistor 10k will feel it, and the temperature is expressed by temperature. Online sensor. As shown in fig 4.4 LCD will displayed the warning. The text message is "Tran: High oil temperature and supply is cutting off.

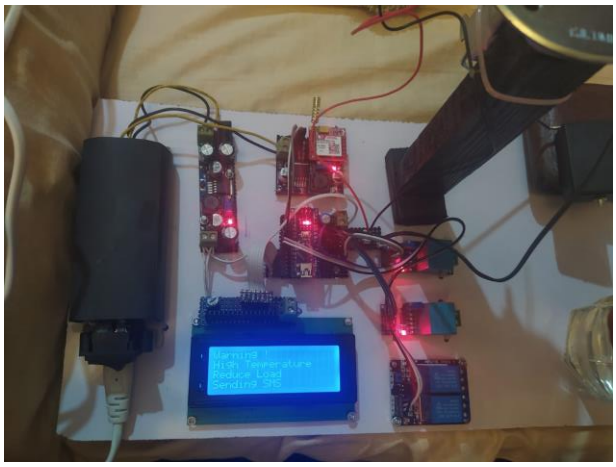

Fig.6. High Oil Temperature

If the oil temperature in the transformer is higher than 65°C, the Thermistor 10k will feel it, and the temperature is expressed by temperature, Online sensor. As shown in fig 6 LCD will displayed the warning. The text message is "Tran: High oil temperature reduced the load".

When the value of any parameter will be above the given range than automatic circuit breaker will trip in the absence of any person to make the system reliable and to provide more control.

VII. CONCLUSION

Monitoring the health of the transformer every day is not only economical, but also improves efficiency. In the past, [1]transformer maintenance was performed according to a predetermined schedule. Now a day, when everything is going to be more advanced, with implement of new technologies it is possible for us to operate the transformer online through GSM technology in the remote as well as in develop areas before converting the small faults into dangerous one. This design is particularly designed for 500KVA distribution transformer and this method is not only to avoid from damage of equipment but provide us more reliability and control on the system.

By comparing with manual monitoring, GSM-based monitoring is very useful and highly accurate because oil level, oil temperature, load changes and transformer tripping are not always manually controlled. Engineers can take necessary steps to prevent equipment damage by understanding the value of the infringing parameter. We can able to save the cost of replacing the new transformer and equipment repairing cost also.

Such monitoring can lead to effective and consistent operation,

i. Protect the distribution transformer and isolate from the system.
ii. Reduce Human effort.
iii. Improve transformer life.
iv. Reduce failures and increase reliability.
v. Provide more effective monitoring quickly and easily.
vi. Improve system performance.
vii. Digitalization and automation of the system.

VIII. RECOMMENDATIONS

A very critical engineering concept is transformer protection. Obviously, with population growth and economic growth, electricity demand is increasing rapidly. This requires the use of more advanced transformer safety methods in the future to ensure the reliable power supply needed for economic growth. Based on the work carried out in this project, some adjustments will be required in the future.

i. A current sensor can be added to further extend the design to calculate the current of the transformer and then measure its overload value.
ii. In any ab normal situation that requires quick response from the controller, this design can be enhanced by incorporating control behaviors.
iii. Linking all transformers to the SCADA system may be an acceptable option in order to display its parameters in the human machine interface (HMI).

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