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Distribution Transformer Health Monitoring and Protection System

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Abstract - In our project, we have to create a centralized distribution transformer and protection system. All distribution transformers here are controlled by the control room. We can turn on and off the distribution transformer in the control room. Temperature sensors are used to limit distribution transformers to avoid uncertainties created by distribution transformer insulation and windings. Current and voltage transformers are used to measure the current and voltage of distribution transformers and display the readings through the controller in the control room. We use two relays or magnetic switches in a distribution transformer to isolate the main line connection of the station from the network to protect the transformer in hazardous situations. A distribution transformer or service transformer is a transformer that steps down the voltage used on a distribution line to provide the final voltage conversion in the distribution lines.

1.INTRODUCTION

Transformers play an important and decisive role in the network of electrical systems. In each area we can see at least one transformer. We are in a time where we cannot live for even a minute without electricity. All nuclear activity, whether it is a house or a factory, depends on the supply of electricity. Without them, every business comes to a halt and could face huge financial consequences .There are several implicit and explicit reasons why transformer performance may deteriorate. The most frequently observed incidents are partial discharges, insulation degradation, moisture, humidity, overheating, winding resonance, loss of winding, solid insulating oil contamination , lightning, system failure, system overload, switching operations, etc. .

2. LITERATURE REVIEW

Pawar and Deosarkar et al. [6] Have presented a paper in which they have applied mobile embedded systems. There is GSMGPRS technology for monitoring distribution transformers. The control unit is divided into two parts, the first part is the remote control unit (RTU) which collects data from the sensors, and the second part is at the monitoring node, where software is located which monitors transformer parameters and displays the information on the screen of engineer screen.

Hongyan Mao et al. [1] has used GPRS for wireless communication and LPC2132 module as the main processor for the data communication, and GR47 module is used for data link. Configuration of GPRS and network is done before connecting as it creates a problem without configuring it. Different data transmission methods were also applied for communication as every time different IP addresses were received by the devices.

Avinash Nelson et al. [4] have shown an effective method for increased life of transformers. As the life of the transformer is shortened due to overloading and they approached the health index monitoring of the transformer by calculating with a certain algorithm for health status prediction. Humming noise is also used for prediction according to the frequency spectrum.

SH. Mohamadi et al. [3] has presented a model in which they have used DTMAS software for the analysis. A transducer box is used to make the measurement signal compatible for sending by GSM modem. DTMAS software can also be used when there are multiple transformers where different layers are used in the process. An alarming layer of DTMAS compares the values with the rated one and generate an alarm accordingly.

Diagnosis of vibration spectrum has been shown in the paper presented by Mohammad et al. [10] in which the frequency of vibration spectrum is disturbed when faults are introduced in it. They have also plotted the graph by which they have concluded that an increase in Short Circuit Current (SCC) results in an increase of the gap between the characteristic curve of healthy and faulty states which shows that SCC affects the vibration spectrum.

Hassan Jamal et al. [11] have presented the solution of overloading in Distribution Transformer in their paper. They have also eliminated the complete termination of the transformer and load shedding during faults. They have also used the backtalk feature in which the operator can reset control commands for protection. DC fan is also used for cooling.

An algorithm is designed for keeping the range of average value of current to compare with a threshold value. The mechanism consists of transistors connected with the ports of Node MCU (Microcontroller).

Priyanka R et al. [12] has used a Raspberry Pi microcontroller with a different approach. At first, the sensors and raspberry pi modem initialization occur. Then the required data are measured from the sensor and then raspberry pi starts comparing the incoming values with the saved values and even if any of the parameters denies the saved values then the action of sending alerts starts via the Twilio cloud server and this process continues till decision making output logic becomes negative.

J. Crossey et al. [2] have illustrated how Dissolved Gas Analysis (DSA) is a well versed and well-established method of transformer diagnosis. About 70% of the faults can be detected by it. The faults encountered by DGA include partial discharge called the corona. Every fault produces different key gases with different ratios of gases which can easily be identified.

Sajidur Rahman et al. [7] have used a wireless module system that uses SMS (short message service) to designate mobile telephones to get information about any abnormality at the transformer site. Since this method is wireless, it is highly costeffective. The use of PIC16F877A microcontroller enables the system to behave as a real-time embedded system that fulfills the industrial demands.

Puthawat Wiriyakitikun et al. [16] states that the probability of insulation failure is overcome by a failure rate of 41%, followed by failures of components such as windings, bushings and on-load tap changers at 14%, 10% and 10%% respectively. Other important causes of low are cooling system, core and operating failures which can also lead to system failure. Synchronizing its effects with the causes is another challenge in selecting sensors to correctly predict failures and take corrective action.

Mohsin Khan Janjua [12] have presented on this paper the "Thermal Monitoring and Protection for Distribution Transformer under Residential Loading using Internet of Things the transformer monitoring system it is observed, the complete module of transformer health monitoring systems proper functioning is based on effective connectivity and coordination among sensors, signal conditioning devices and internet connections. Here the major concerns are about the durability and reliability of sensors and connecting networks. signal conditioning devices and internet connectivity This is the main issue regarding the durability and reliability of sensors and connected networks Intelligent distribution transformer under load "using the Internet of Things". It is well known that these two factors are mainly affected by environmental conditions and data communication latency, which occurs in cloud storage due to millions of data connected to the same cloud. The second comes from several sources. Also, unwanted issues may occur due to data loss in cloud.

A new approach is tested by Tarun Kanti Roy et al. [9] in which they have used Messaging Queuing Telemetry Transport (MQTT) instead of HTTP as it is better for the response of client-server communication. MQTT uses lesser bandwidth than HTTP and also consumes less power. This can be accessed by logging in to the gateway even with mobile devices and this feature does not support by GSM.

Dr. S.B. Deosarka et al. [6] Presented on this paper of Health Condition Monitoring System for Distribution Transformer Here the major concerns are about the durability and reliability of sensors and connecting networks. It is well known that these two factors are mostly affected by environmental conditions and data communication latency, which arises in the cloud storage due to millions of data reporting to the same cloud within a second from several sources.

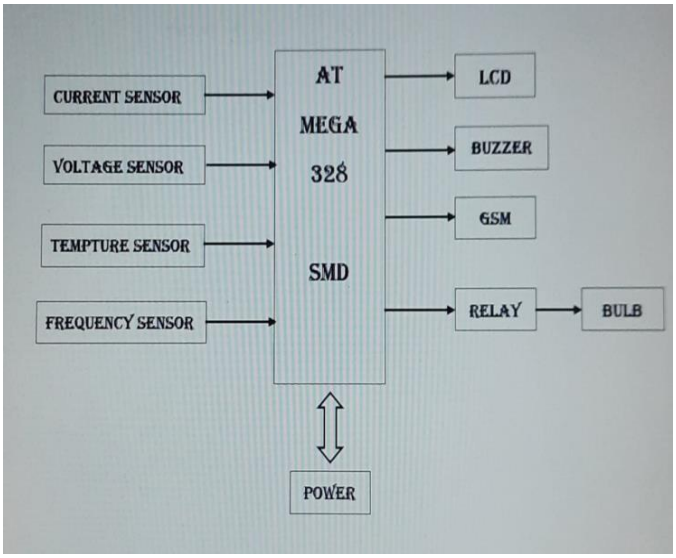
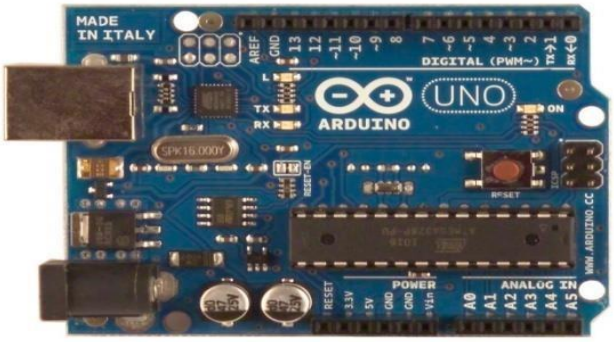


Fig. 2: Block diagram of GSM based Distribution Transformer Health monitoring system

3.MATERIALS AND METHODS

Distribution transformer health monitoring and protection system is real time monitoring of the condition of distribution transformer using Arduino technology. The parameters like temperature ,frequency voltage and current of the transformer are monitored processed and recorded in the server from the condition of the transformer can be known and appropriate action can be taken to protect the transformer from damage.

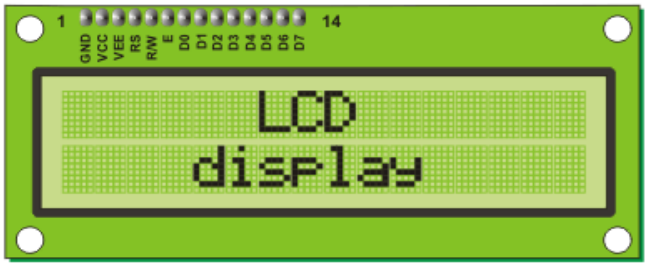
3.1 ARDUINO:



ARDUINO AT MEGA 328

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. 1The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.MicrocontrollerATmega328.

3.2 LCD DISPLAY



LCD stands for Liquid Crystal Display. LCD is finding wide spread use replacing LEDs (seven segment LEDs or other multi segment LEDs) because of the following reasons:
The declining prices of LCDs.
The ability to display numbers, characters and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.
Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD. In contrast, the LED must be refreshed by the CPU to keep displaying the data.
Ease of programming for characters and graphics.
These components are "specialized" for being used with the microcontrollers, which means that they cannot be activated by standard IC circuits. They areused for writing different messages on a miniature LCD.

PIN FUNCTION

Function	Pin Number	Name	Logic State	Description
Ground	1	Vss	-	0V
Power supply	2	Vdd	-	+5V
Contrast	3	Vee	-	0 - Vdd
Control of operating	4	RS	0 1	D0 – D7 are interpreted as commands D0 – D7 are interpreted as data
	5	R/W	0 1	Write data (from controller to LCD) Read data (from LCD to controller)
	6	E	0 1 From 1 to 0	Access to LCD disabled Normal operating Data/commands are transferred to LCD
Data / commands	7	D0	0/1	Bit 0 LSB
	8	D1	0/1	Bit 1
	9	D2	0/1	Bit 2
	10	D3	0/1	Bit 3
	11	D4	0/1	Bit 4
	12	D5	0/1	Bit 5
	13	D6	0/1	Bit 6
	14	D7	0/1	Bit 7 MSB

3.3 GSM/ MODULE

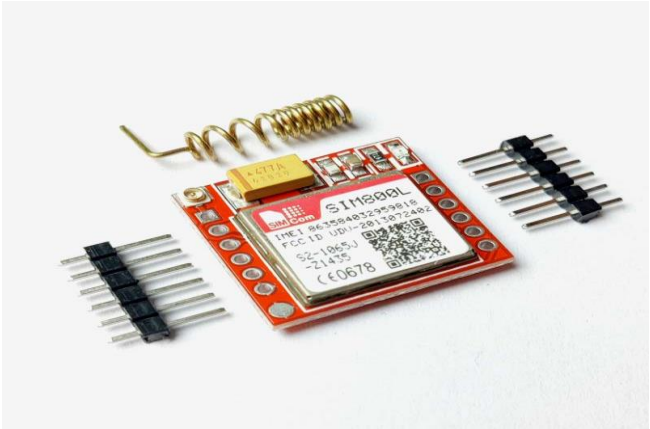
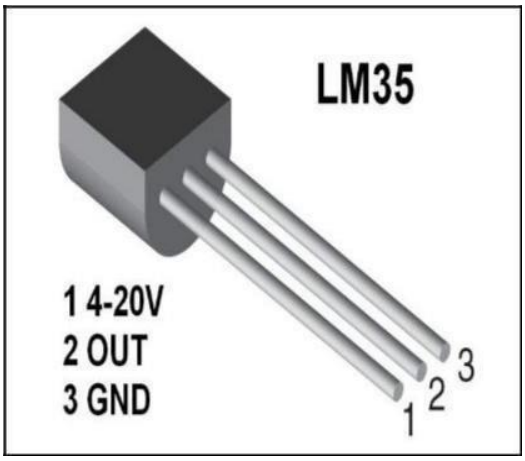


FIG. SIM800L GPRS GSM Module

The **SIM800L** is a micro-SIM low-cost **GSM/GPRS Development Module**. The Module supports TTL communication and hence can easily communicate with Microcontrollers without the need of additional data converters like MAX232. The module also supports antenna with IPX connector.**SIM800L** module can be used to make a cell, receive a call, send and receive text messages, connecting to internet through GPRS, TCP/IP, etc. Moreover, the module supports quad-band GSM/GPRS network, so it can operate globally.The **SIM800L GPRS GSM Module** is compact in nature and hence can be directly used on final Designs. The

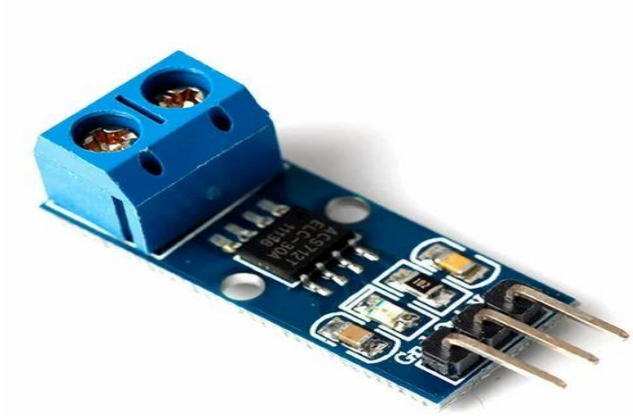
on-board LED indicates the connection status of the Board, when there is no signal the LED flashes quickly and when a signal is established, it flashes slowly

3.4 TEMPERATURE SENSOR



It is a device that uses electrical signals to measure temperature. Temperature measurement can be done
in two ways: direct contact with the heat source material or indirect contact with the heat source using radiant energy.

3.6 CURRENT SENSORS



Current sensors are used to find amount of current used or applied. These sensors are fully integrated, satisfy the hall effect , linear based current sensors with voltage isolation of 2.1kVRMS and also low resistance conductors.

3.6 BUZZER

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke.

3.7 RELAY

Relays are the devices used as a switches which are controlled by power, in this the power automate power to switch electrical signals on and off. These can also helps to switch between multiple circuits includes different voltage types with the same relay and time.

4. ALGORITHM

Step 1: Start

Step 2: Initialize Arduino uno

Step 3: Initialize the all sensor and GSM module.

Step 4: Capture data through sensor

Step 5: Process and analyze the data.

Step 6: Analyze the data If any problem in transformer sends the message to control room and act. Otherwise turn of the transformer or stop.

Step 7: Check the information, or analyze the data, If no problem then Continue, distribute the current.

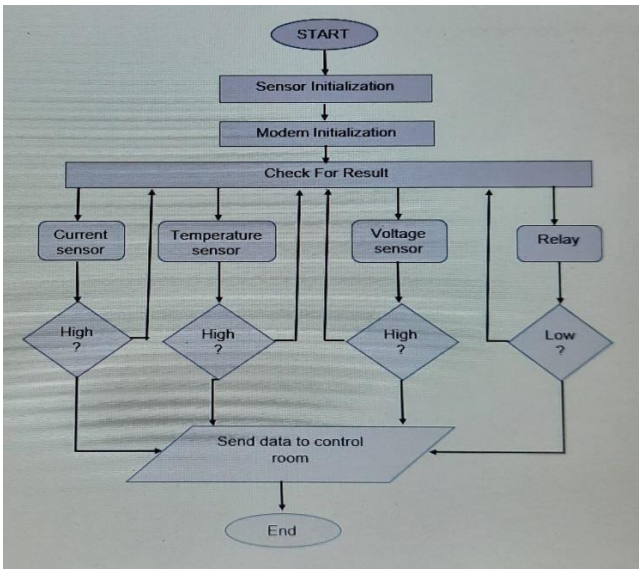


Fig 2: Flow chart of Distribution Transformer Health monitoring system.

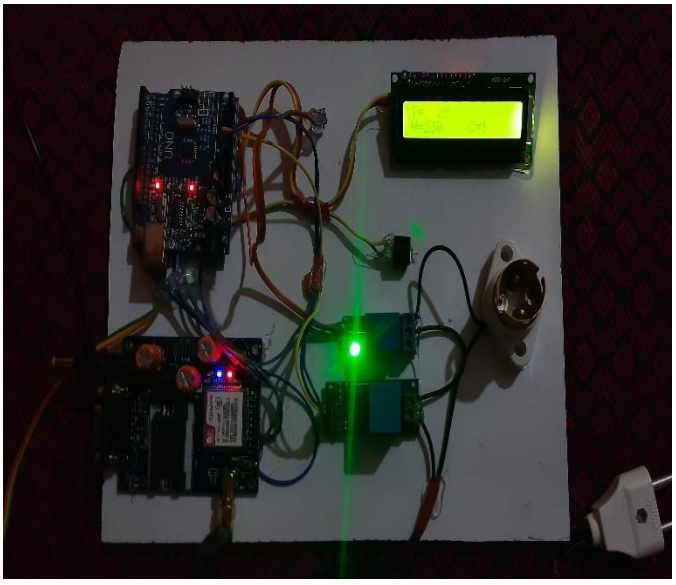


Fig 3: Practical circuit arrangement of Distribution

5. SPECIFICATIONS OF PROPOSED SYSTEM

Hardware Requirements:

- Arduino (ATMEGA 328 smd)
- Current Sensor (ACS712)
- Voltage Sensor (0 To 25V)
- Temperature Sensor (LM35)
- Frequency Sensor
- LCD
- GSM Module (SIM800L)
- Buzzer
- Relay (12VDC)

6. ADVANTAGES, DISADVANTAGES & APPLICATION

Advantages

- Enhances the life of transformer.
- Individual phase transformer.
- Temperature monitoring of Transformer.
- Reporting of power quality values.
- Real-time alarms for power outage, tampering and power quality threshold exceedances.
- Data can be used for carrying out Energy Audit, Load Survey, and Fault.
- Real-time dashboard reporting overall transformer and communication.
- Easy to apply.
- Provides a move effective solution to complex issues.
- system performance inexpensive sensors can be used which helps you to keep the overall system cost and complexity low.
- Easily be modified to improve or alter system performance.

Disadvantages

- Firing of transformer can easily occurs.
- Not accurate.
- Frequency interference in system.
- Noise problem in network

Application

- Distribution Transformer.
- Industrial Applications.
- On High Grade Motors.

RESULT :

The system consisting of Arduino and sensors senses the transformer health parameters. The data are collected and a GSM unit communicates with Thing Speak. The received real time data is processed by it.

Conclusions:

An Arduino based Distribution transformer Health monitoring and Protection system for power transformer was designed, implemented and tested. It is quite useful as compared to manual monitoring and also it is reliable as it is not possible to monitor always the oil level, oil temperature rise, ambient temperature rise, load current manually. A server module can be added to this system to periodically receive and store transformer parameters information about all the power transformers in a database application. After receiving message on any abnormality, we can take immediate action to prevent any catastrophic failures of power transformers. We need not have to check all power transformers and corresponding phase currents and voltages and thus, we can recover the system in less time and faults before any uncertain failures thus resulting in significant cost saving as well as improving system reliability. The proposed technique with results has shown that the protection scheme works properly with accuracy, sensitivity of this scheme very high for the abnormal and faulty conditions. Transformer Health Monitoring will help to identify or recognize unexpected situations before any serious failure, which leads to greater reliability and significant cost savings.

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