SMART MONITORING OF DISTRIBUTION TRANSFORMER

Chetan M [*1], Uttam R[*2], Deekshitha M[*3], Dense Lisha[*4], Sowmyashree N[*5]

*[*1]UG student, B.E. EEE, JSS Science and Technology University, Mysuru, Karnataka, India*
*[*2]UG student, B.E. EEE, JSSSTU, Mysuru, Karnataka, India.*
*[*3]UG student, B.E. EEE, JSSSTU, Mysuru, Karnataka, India.*
*[*4]UG student, B.E. EEE, JSSSTU, Mysuru, Karnataka, India.*
*[*5]Assistant Professor, EEE, JSSSTU, Mysuru, Karnataka, India.*

Abstract - In an electric power distribution network, a distribution transformer is a transformer that provides final voltage transformation. To distribute power across a large region, a greater number of distribution transformers is needed.As a result, it's critical to keep an eye on its working conditions to ensure that it runs smoothly over time. Data collecting, conditional monitoring, and health evaluations are becoming increasingly important as the number of distribution transformers and other components in the electrical system grows.Distribution is being closely monitored. transformer is a technique that may be used to monitor transformers in real time via the internet of things (IoT). For further processing, it is recommended that the central database be sent via GSM modem. An embedded system, GSM module, mobile users, and sensors deployed at the transformer site make up the online monitoring system. The operational characteristics of the distribution transformer are sensed and measured by sensors. The detected data is processed and recorded by the embedded system. It will have threshold and optimal operating settings pre-loaded. If an abnormality or an emergency occurs, the system sends SMS (short messaging service) messages to the specified cell phones with information on the relevant parameter based on the data captured by the microcontroller.

***Key Words*: Power system, Distribution transformers, Embedded system, sensors, GSM module, IoT.**

I.INTRODUCTION

Electricity is the lifeblood of the contemporary world. The industrial sector, customers in the Commerce and Services-related industries, and the household and residential sectors all demand electricity. Electrical power systems are real-time energy delivery systems, meaning that power is created, transferred, and delivered at the precise moment it is needed. Power transformers, which raise or reduce voltages as needed, and distribution transformers, which lower voltage to the level required by consumer devices, are modern electric power system components.

The produced power is stepped up to higher voltages, which are preferred for long-distance power transmission due to their benefits over low voltages. When the high voltage enters the utility area, it must be stepped down. The distribution transformer is crucial in this, since it reduces the voltage to the required levels.

Distribution transformers are in use 24 hours a day, which means they are always under strain. To avoid failure of their operation, they must be monitored and maintained on a regular basis.However, due to inadequate maintenance of the transformers on the distribution side, those transformers are prone to failure, resulting in a sudden power outage. According to reports, the failure of these transformers would cause significant annoyance to a large number of customers as well as significant financial losses to the utilities. As a result, avoiding transformer breakdowns is critical. If distribution transformers are used at the rated circumstances, they will last a long time. Despite its importance as an electrical component, the distribution transformer is extremely costly. Power distributors will lose a lot of money if transformers fail frequently. State governments in India have recorded more than 40% of distribution losses in recent years.One of the key reasons of this significant distribution loss is distribution transformer failure due to poor maintenance. Unfortunately, the failure rate of these transformers in India is approximately 25% each year. Continuous monitoring and appropriate maintenance of distribution transformers, as well as early detection and correction of any aberrant functioning, would extend the transformer's life and save the utilities money on costly replacements. As a result, distribution transformers must be continuously monitored and controlled.

II. LITERATURE SURVEY

A distribution transformer is a transformer used in a network's electric power distribution system to perform the final voltage transformation.. Great numbers of distribution transformers are required to distribute power over a wide area. That being the case, it is essential to keep an eye on its operating conditions for satisfactory operation over the years of any distribution network. Because of the presence of large number of distribution transformers and various components over a wide range in the power system, the data acquisition, condition monitoring and health assessments are of prominent. Real-time transformer health monitoring over the internet system is a system that can be used to monitor transformer health in real-time using the internet of things (IOT). It is also suggested that the central database be sent through Wi-Fi module for additional processing. There have been several techniques proposed for this, including based on the change in light intensity at output due to the change in refractive index of the cladding medium (in our case, transformer oil or air) in proximity to the non-cladding portions, as transformer oil has a higher refractive index than air. There have been several techniques proposed for this, including based on the change in light intensity at output due to the change in refractive index of the cladding medium (in our case, transformer oil or air) in proximity to the non-cladding portions, as transformer oil has a higher refractive index than air.

An intelligent framework for power transformer status monitoring and assessment. Various signal processing and pattern recognition algorithms are used in this framework to de-noise sensor collected signals, extract representative features from raw data, and identify different types of transformer failures. The proposed framework includes strategies for managing power transformer assets.

Another way is to build a transformer internal temperature measurement platform with FBG temperature sensors, then use the short-circuit method to mimic the process of winding heat under various load circumstances, using the measuring principle of FBG (Fiber Bragg Grating) sensors. According to the findings of the experiments, FBG sensors reflect the fast changes in temperature in the transformer throughout each process of current changes when employing the concept of FBG sensing.

III. Reason for failures of distribution transformer

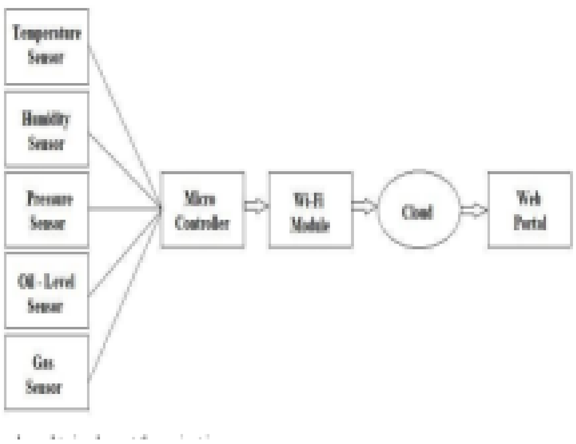
Despite being one of the most dependable components of the electrical grid, DSTs are vulnerable to failure owing to a number of internal and external causes. A transformer can fail due to a number of factors, however the following are the ones that can result in catastrophic failure:

- Mechanical Failure
- Dielectric Failure

The transformer is no longer capable of bearing the load and stepping down (or up) the voltage as planned in either situation. When it comes to transformer ageing and life expectancy, the quality of the insulating system, which is generally based on organic materials, is the major cause of worry.The organic compounds in a transformer deteriorate with time, and they eventually lose their capacity to endure the pressures that a transformer may encounter on a daily basis. Transformer failure can express itself in a multitude of ways, depending on the kind of construction.Some failure mechanisms can occur regardless of the kind of construction. Failures of the tap changer, bushings, tanks, moisture intrusion, and other forms of dielectric fluid contamination are all possible. It's possible that the failure is due to a lack of regular maintenance or knowledge. Natural phenomena such as lightning, which creates an electrical surge in the power lines, might also be to blame. Snakes, squirrels, and other animals have also been known to cause it.

IV. METHODOLOGY

The goal of this technique is to design and deploy smart distribution transformer monitoring (SMDT).The major goal of this approach is to access the transformer's health from a remote location with little human involvement and errors (a typical person produces 3-6 errors per hour on average). SMDT is a smart system that can make judgments based on data that has been pre-programmed.

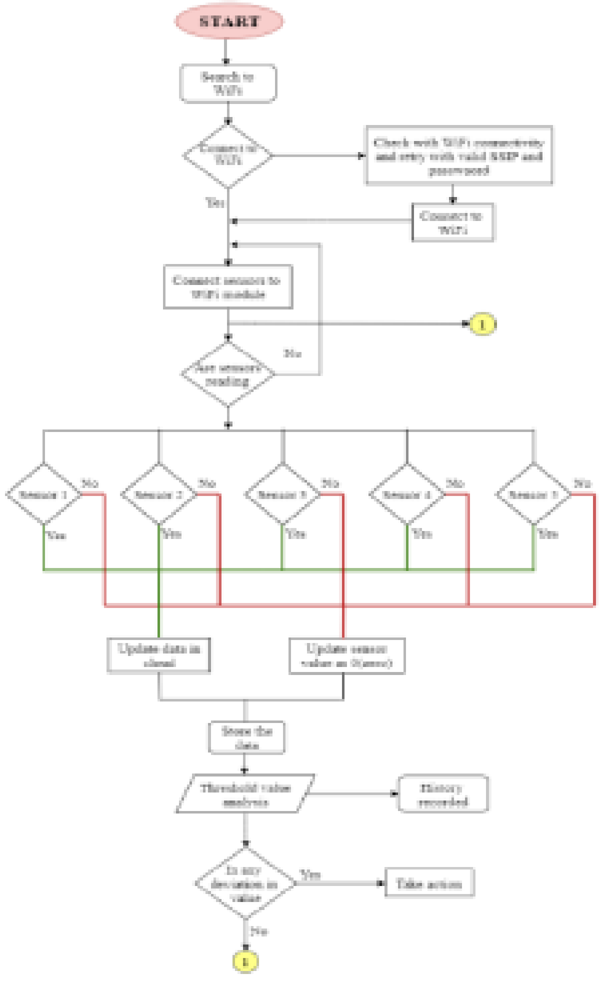


The approach used to implement the project is:

1) Selecting the sensors based on the application and environment which is employed.
2) To develop a circuit based on the block diagram.

3) Write the code for the micro-controller and Wi-Fi – Module.
4) Develop the Web portal to store the data.
5) Simulate the entire project and check for the results obtained.

The flow chart below depicts the individual steps in this method's graphical portrayal of the process in sequential sequence. The first step is to set up the system with all of the required connections. The preloading of sensors with threshold and optimal values is part of this process. Once the connections are completed, the modem should be started and set with the IP address and MAC address for each transformer, which will be unique, and the IP address may also be used to track the transformer's position. Depending upon the manufacturer's transformer rating and parameter, the SMDT is programmed according to the data provided. The parameters will be continually monitored by the different sensors employed in this approach. After reading the values of operational parameters, the sensors will verify if they are within acceptable limits. After reading the values of operational parameters, the sensors will verify if they are within acceptable limits If any of the detected values are violated, the SMDT will send a message to the targeted mobile phone through the GSM module and wait for a response from the authorities. If the system receives a response to the message, the SMDT takes the appropriate action depending on the response. If the response is to turn off the transformer, the relay controlled by the SMDT will turn on. If the response is to turn off the transformer, the relay controlled by the SMDT will turn on. The SMDT will update the time required for maintenance on the web site after the transformer has been shut down.



V. HARDWARE COMPONENTS

V.I Arduino Mega 2560

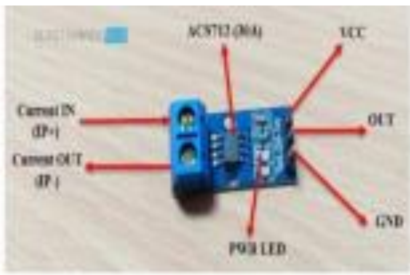
The Arduino Mega 2560 is a microcontroller board based on ATmega2560. It has 54 digital I/O pins (out of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It consists of everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

V.II Gas sensor: MQ2

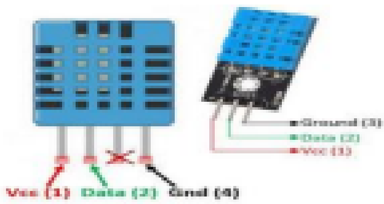
The MQ2 sensor is one of the most often used gas sensors in the MQ sensor family. It's a Metal Oxide Semiconductor (MOS) type Gas Sensor, commonly known as chemi-resistors, since it detects gas by changing the resistance of the sensing material when the gas comes into contact with it**.** Gas concentrations may be monitored using a voltage divider network.Gas concentrations may be monitored using a voltage divider network.

V.III CURRENT SENSOR:ACS712

The Allegro® product, ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The circuit is made up of a precise, low-offset linear Hall circuit with a copper conduction channel near the die's surface. The Hall IC transforms the magnetic field generated by the applied current flowing via this copper conduction channel into a proportionate voltage. The ACS712 Current Sensor's output is an analogue voltage proportional to AC or DC currents. Its most common application



V.IV TEMPERATURE & HUMIDITY SENSOR:DHT11 DHT11 is a Humidity and Temperature Sensor, which generates calibrated digitalized output. DHT11 can be interfaced with any microcontroller like Arduino, Raspberry Pi, etc. and can get instant results. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and outputs a digital signal on the data pin (no analog input pins needed). It is very simple to use. It has high reliability and excellent long-term stability.



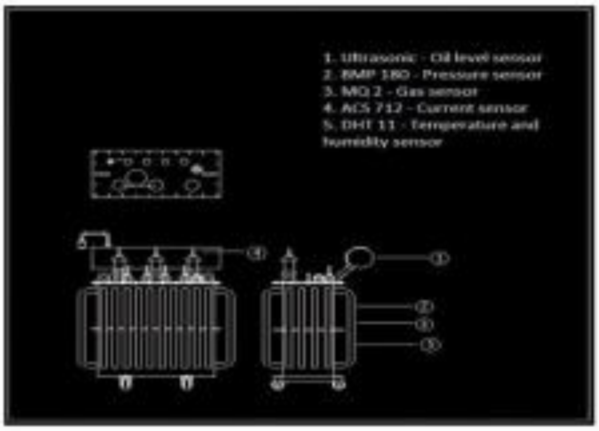
V.V ULTRASONIC SENSOR:HC-SR04

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. It uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High frequency sound waves reflect from boundaries to produce distinct echo patterns.

V.VI PRESSURE SENSOR: BMP180

BMP180 is a high-precision sensor designed for consumer applications. Barometric Pressure is nothing but the weight of air applied to everything. The air has weight and wherever there is air its pressure is felt. BMP180 sensor senses that pressure and provides that information in digital output.

VI. LOCATION OF SENSOR'S IN THE TRANSFORMER



VI. WORKING AND IMPLEMENTATION

This suggested system consists of both hardware and software components. The hardware here refers to the connections of the sensors, microcontroller, and Wi-Fi module to the Transformer, while the software refers to the analysis in MATLAB and the thingspeak web page, with the code design in the Arduino IDE serving as a bridge between the two. The project's NodeMCU will first attempt to connect to the Wi-Fi hub, after which the server, in parallel with the Transformer's sensing unit, will begin to initialise. The sensor positioned across the transformer will begin collecting data as soon as the procedures of connecting to the server and initialising the sensors are finished.

The operational characteristics of the distribution transformer are sensed and measured by sensors. The detected data is processed and recorded by the embedded system. It will have been pre-programmed with threshold and optimal operating parameters. Additionally, sensors will begin transferring detected data to the server through Wi-Fi, with all data transmitted being saved as information in the cloud database. If there is any abnormal behaviour in the Transformer condition or the sensor value is above or below the threshold value during this operation, the virtual monitor will display the fault or abnormality and indicate the action performed by the system as programmed in the micro- Controller.

Threshold value defined for the testing the system is:

PARAMETER	VALUE
PRESSURE	80-85 Pa
TEMPERATURE	20-40°C
HUMIDITY	60-80
GAS DETECTED	G=20 IF NOT G=10
OIL LEVEL	<75

VII. RESULTS AND DISCUSSION

The prototype was developed to monitor distribution transformers remotely using IoT devices. Devices used for this purpose are Arduino Mega 1280, MQ2 gas sensor, ACS712 current sensor, DHT11 temperature & humidity sensor, HC-SR04 ultrasonic sensor, BMP180 pressure sensor. All these sensors read the data and using the Arduino WiFi module, these data are sent to Thingspeak for real-time monitoring and analytics.

In the below circuit diagram, all the sensors are connected to Arduino and Arduino uploads all the sensors reading to the cloud server for real-time remote monitoring of distribution transformers.

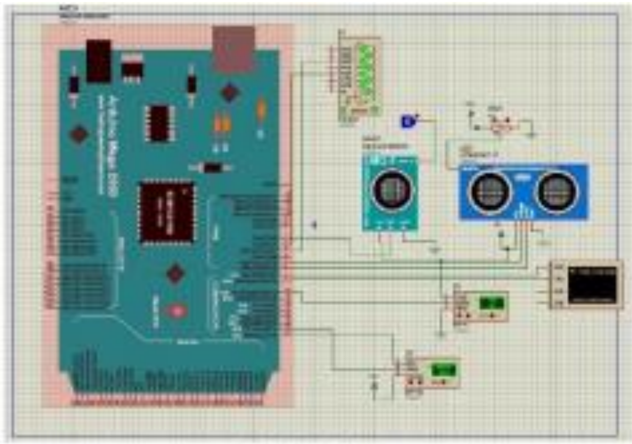


Figure 1: Circuit diagram

Arduino will read all the data from the sensors in real-time and will upload it to the thingspeak cloud database over Wi-Fi in Real-time for monitoring all the sensor readings.

Data upload to thinkspeak server will be used for real time monitoring, alerts system as well as for analytics purpose.

We can access these sensor values in the thinkspeak dashboard in real-time as well as for any specific duration in the time series graph for analytics purposes. Each sensor data is available to access in thinkspeak. Fig - 3,4,5&6 represents the thinkspeak graph for sensor access for a specific duration.

These sensors real-time data give all the health information for distributed transformers remotely and we can easily detect any issue in the transformer remotely which will help in timely fixing of issues to reduce damage to transformers.

VIII. CONCLUSIONS

The system designed is a high-performance, highly efficient, real-time monitoring system. It makes use of sensors and cloud technology to assess the health and performance of the distribution transformers. All these sensors connected to Arduino and uploading real-time sensors reading to thinkspeak will help in monitoring health status for the Distributed transformers remotely all the time and helps in detecting issues in real-time, as well as immediately alerting the concerned person in case of any abnormality in functioning to cell phones via SMS and emails.

Thus, this system increases the durability and shelf life of the transformers under the distribution region and provides an uninterrupted power supply to the consumers.

IX. ACKNOWLEDGEMENT

We are grateful to the institution, JSSSTU for making it possible for us to study here. We would like to express our deep gratitude to all the Professors and lecturers at the department, non-teaching faculties, the librarians, and other workers of the institution.

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