Health Monitoring of Transformer Using IoT

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ABSTRACT - Transformer is the important electrical equipment that is used in power system. By Monitoring transformer we can prevent faults before they occur. Faults are costly to repair and result in a loss of electricity. The main aim of using Internet of things in transformer health monitoring is to acquire real-time data of transformer remotely over the internet and also to reduce the human efforts and resources along with the enhancement of a smart grid vision. For this real-time aspect, we take real time data of the transformer by using different sensors and then send them to a monitoring node. These Sensors are interfaced with microcontroller-based system having wireless systems along with central system showing status of transformer, through internet or SMS for immediate action. Hence, the transformer health status will be updated.

KEYWORDS: Internet of Things, Microcontroller, Health monitoring of transformer, Sensors, Wi-Fi module.

I. INTRODUCTION

Transformer failure has a considerable economic impact on the operation of an electrical network. Therefore, the main aim is to ensure an accurate assessment of the transformer condition. As a large number of transformers are present to distribute the electricity over a wide area and the main utility center is far from the transformer, it's difficult to measure the condition manually of every single transformer.

Transformer suffers the effect of fault, mostly during short circuit condition as explosion causes severe damage. Whenever there is a fault on the transformer, power distribution will shut down entirely in the area of coverage by the transformer. It is difficult to find the failure reason of the transformer which is cause either by external fault or by some internal faults.

The restoration of the power supply of entire area takes more time and affects the services. Transformers are very expensive both in maintenance and repairs.

So we need to monitor all the essential parameters of the distribution transformer, and send the real time data to the monitoring system in time.

With the increasing average age of the transformer population there is an increasing need to know the internal condition of the transformer. For this purpose Online monitoring is very effective option to automate the system, during the operation of transformers continuous online monitoring offers a possibility to record different relevant stresses which can affect the lifetime of the transformer.

The automatic evaluation of these data allows the early detection of an Incoming fault. And provides the necessary information about the health of the transformer. This will help and guide the utilities to optimally use the transformer and keep this equipment in operation for a longer period.

1.1 Transformer Failure and Protection Failures:

There are various factors for transformer failures, which can be classified as External and Internal failures. Overheating, Winding resonance, Designing Defects, Loss of Winding clamping, insulating solid Contamination, Humidity, and Moisture are the causes of Internal Faults of transformer and Different causes of external faults are: System Overload, Partial Discharge System Overload, Lighting Strike, Switching Operation, and System Fault.

For the real-time aspect, we can monitor Humidity, temperature, Voltage, current and oil level of transformer by using sensor nodes. The sensor output values are recorded and processed by the system memory. Abnormal conditions are checked by the System programmed with some predefined instructions.

II. HARDWARE DEVELOPMENT

The proposed architecture of the system is designed so that the measurable information of the transformer is collected by the different sensors, sensors must be adjusted to the specific requirement of the particular transformer [1][11], This data is firstly received by a microcontroller and Led display is used to display all the data which are coming from the sensors before sending to gateway . Then the controller communicates to the main control center room through Wi-Fi module or through GSM .For communicating main control center GSM is used due to its long distance. [2][3]

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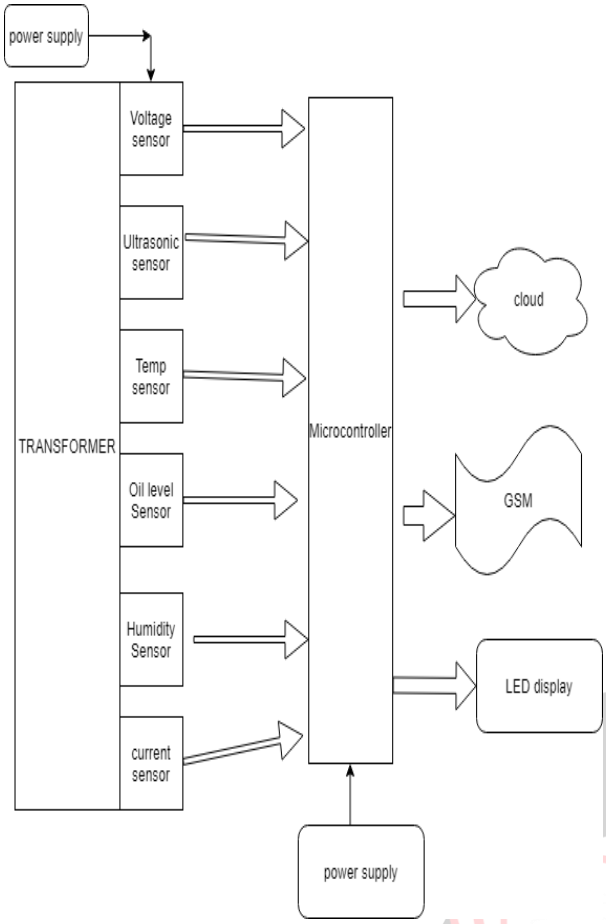
Fig.1. Generalized block diagram of system



2.1 Sensors and its Specifications:

1. **SHT31-D Humidity Sensor:** The SHT3x humidity sensor series combines multiple functions and various interfaces with an applications-friendly, very wide operating voltage range.
   Output: I²C, Analog Voltage Out
   Operating Voltage: 2.15Volt to 5.5Volt
   Operating Range T: 40 to +125°C (-40 to +257°F)
   Low-cost version: SHT30 humidity sensor,
   Standard version: SHT31 humidity sensor, and
   High-end version: SHT35 humidity sensor.

2. **Current Sensor:** Current transformer of CT ratio 50 amperes/10milliamperes is used at the secondary of transformer to measure variation in load current. An arduino based current sensor ACS712 produces an analog output voltage proportional to the current sensed by the terminals. The current sensor can operate from a voltage of 5 Vdc. Even high AC mains current can be measured.
   The sensors are based on the Allegro ACS712ELC chip.
   These sensors are available full-scale reading of 5 A, 20 A and 30 A.
   For a 30 A sensor the output sensitivity is 66mV/A, and it can measure a current from 30 A to – 30 A range.
   ACS712 consists of a low offset, precise linear Hall Effect sensor circuit having a copper conduction path around the die surface. The Hall Effect circuit converts the electromagnetic field produced during current flow through the copper part to output voltage [5].

3. **Temperature Sensor:** The PT100 Resistance Temperature Detector has a resistance of 100.00Ω at 0°C and temperature coefficient of resistance of 0.0038. The principle of operation of PT100 platinum thermometer is to measure the resistance of platinum element.
   A temperature sensor (3 wires RTD PT100) can measure the temperature over a wide range of-200 C to 850 C.
   This sensor measures the temperature of oil in the conservator tank by simply inserting it in the oil.

4. **AC voltage Sensor.** ZMPT101B an ideal to measures the AC voltage. ZMPT101B has a high accuracy, good consistency for power measurement up to 250Volt AC. Easy to use and comes with a multi turn trim potentiometer for adjusting the ADC output.
   Output Signal: Analog 0-5Volt
   Operating Voltage: DC 5Volt-30Volt
   Measure within 250Volt AC
   Input rated current: 2 mill amperes

5. **Oil Level Sensor:-**Oil level sensor is a device which is used to check the oil level in the transformers conservator tank. JSN-SR0T4-2.0 is an easy to use waterproof ultrasonic sensor. This distance measurement module provides range 20cm to farthest range 600cm non-contact distance sensing function; it has ranging accuracy up to 2mm. This sensor provides with an integrated closed waterproof cable probe having 40 KHz frequency which is suitable for wet, bad measurement occasion.

III. METHODOLOGIES

IoT based approach enable the objects to connect with cloud and share the real time information which can be used in monitoring and self protection of the devices[6][8]. Data Monitoring System for the transformer based on IoT is the proposed approach to overcome the shutdown or sudden failure of the transformer [7][9]; this approach includes two subcomponents i.e. Transmitter subsystem and Receiver subsystem

TRANSMITTER: Bridge rectifier, rectifies the input dc supply i.e. 230 volt and it will fed to the 5 volt regulator. Regulator will regulate input voltage to 5 volt. Then the

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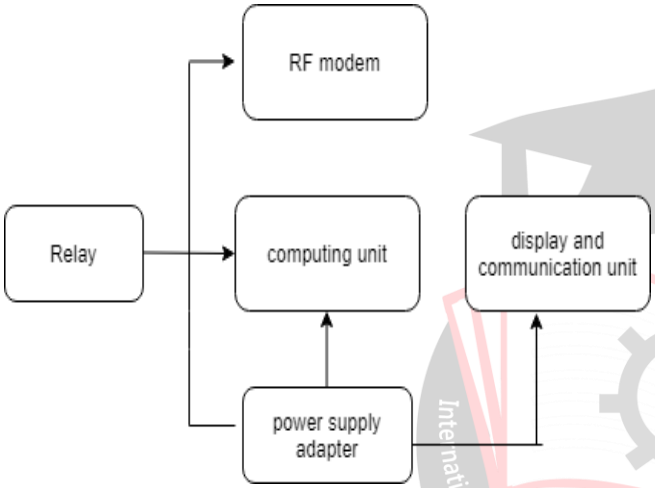
regulator output is given to the microcontroller and this is viewed in blynk web server through internet. In this Output can be viewed as digital form. Sensors outputs are the input of controller Wi-Fi module.

RECEIVER: Receiver side having blocks i.e. GSM, Internet and blynk web server. Blynk is an application which can view through mobile phone. The digital output of real time data of the transformer can display in phone. The GSM module will send SMS which contain the information about the abnormality of the transformer to designated mobile telephones according to the predefined instructions [4] [10][12].

Control Unit:

The control unit consists of Arduino, display unit, relay and relay driver.

Fig: 2 Control Unit



- Arduino: Arduino is a single-board microcontroller to make using electronics in multidisciplinary projects more accessible. This single board microcontroller consists of a simple open source hardware board and easy to use software (IDE).Hardware
  Designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. The open source arduino software (IDE) consists of a standard programming language compiler and a boot loader that executes on the microcontroller.

- Relay driver: Relay driver is a fully programmable four channel logic controller and it is used for driving a relay. These relays driver uses Boolean expressions for activating or to turn ON. And Use to control various equipments with large current. It can be controlled directly by Microcontroller. So, to show ON and OFF (Based on the requirement), driver circuitry is require by relays.

- Relay: Most widely used switching device in electronics as it works to change the state of electric circuit from one state to another state (low power device to high power device). When sensing device detect above threshold level, automatically the relay will trip of the supply and protect the circuit from any damage

- Display and Communication Unit. These sensors sense the value and microcontroller will convert the analog values to digital value and display it on LCD at the same time the data send to the server via Wi-Fi module. If we get any unsecure data about transformer we can protect the device before damage.

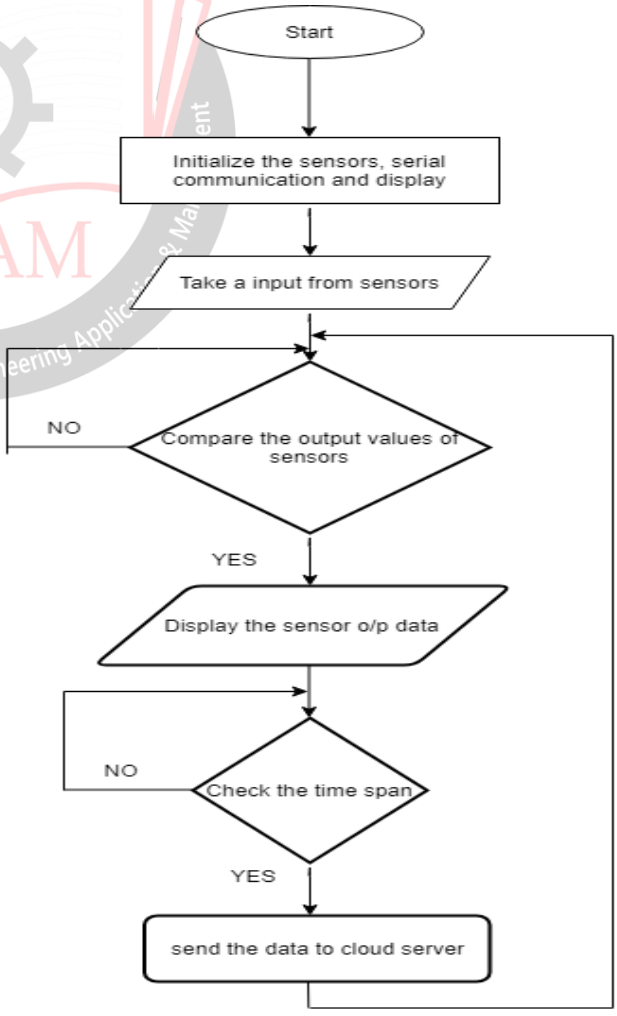
IV. SOFTWARE DEVELOPMENT

Fig: 3 show the flow chart of the system using controller Wi-Fi module.

At the start the system initializes the sensors and serial communication within the microcontroller. System takes all the measurable sensors data and after comparing the different sensors data, The information sends to the server form the location by using Wi-Fi module.

The output result is displayed in virtual mode.

Fig: 3. *Flow chart of the System*



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This monitoring system has many advantages such as easy implementation, low power consumption, long-term monitoring and long distance communication.

V. CONCLUSION

Iot base transformer Health Monitoring system can display real time state of transformer and will help to recognize unexpected situations before any serious failure, this leads to greater reliability and significant cost saving.

The main purpose of this paper is to spread the basic knowledge and the advantages of the IoT in transformer heath monitoring system.

Health monitoring system can monitor real time condition of the transformer and send real time data from the different sensors through the Wi-Fi and display over the IoT platform. This data can also be used for the discussion and analysis of the results.

If there is abnormal operating condition of the transformer the monitoring center will get the information and take the immediate action for it as soon as possible. This will save the sudden breakdown of transformers.

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