LOAD MONITORING AND CONTROLLING OF DISTRIBUTION TRANSFORMER BY USING CLOUD TECHNOLOGY

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Abstract
This project is about intend and completion of a Distribution Transformer to commence our work on transformer health monitoring With the help of sensors which are mounted on transformer, we monitored the level and temperature of transformer oil. The acquired data real time data of transformer is further transmitted to the cloud server via cellular modem at set periodic intervals. This acquired real time data of transformer is finally be available at control room on the Computer / mobile of the concerned technical staff with alerts at the time of occurrence of faults. At the end, we validated the acquired real time data with the manually recorded data. Our monitoring system is capable to monitor the various key parameters of transformers. In future, if this system will be implemented by the power utilities of our country, a huge amount of money can be saved which is spent on the repair of transformers.
KEYWORDS: Distribution transformer, Temperature sensor, cellular modem, Voltage sensor, Current sensor, SATEC intelligent MFT EM133 meter.

I.INTRODUCTION

The Transformers are considered to be the most important part of substation and power system. Failures of transformers not only impact industries and consumers but also the economy of country affected by the same causing social and political ramifications. Transformers have expected life of 25 to 30 years but they fail in large numbers, within 3 years itself, due to various causes and factors. By determining the reasons of failure, we can take appropriate action to avoid faults at great extent and thus reduce the possibilities of fault in transformers and making the power system more reliable. A transformer is a very essential device that connects the generating stations to various types of loads. The appropriate design, manufacturing, testing, operation and protection inflate the operating life of transformer. These days, the power utilities are quite tensed as the rate of failure of distribution transformers and service has been increased to high extent. The rate of failure of transformers in India is around 12 to 15 % which is quite higher than developed countries which is less than 1% [3]. No one wants to share responsibility of failure i.e. neither the power utilities nor the manufacturers of transformers.

The manufacturers often blame the utilities for running the transformers in overload and unbalanced condition (Unbalanced loading of three phases).

It has been observed that very little efforts are made by utilities to find out the root cause of failure, which could be one of the reasons why a damaged transformer is replaced by a new one without removing the cause of damage, leading to failure immediately or within a very short period. It is necessary to identify the causes of failure without which we are unable to take corrective measures.

Following are some of the most common causes of transformer failure.

1. Prolonged Overloading of transformers
2. Unbalanced Loading
3. Leakage of Oil
4. Short circuit of transformers
5. Poor maintenance and lack of monitoring of transformers by utilities.

We need a distribution transformer real-time monitoring system to detect all operating parameters operation, and send to the monitoring centre in time. It leads to online monitoring of key operational parameters of distribution transformers which can provide useful information about the health of transformers which will help the utilities to optimally use their transformers and keep the asset in operation for a longer period. This will help to identify problems before any serious failure which leads to a significant cost savings and greater reliability. Widespread use of mobile networks and GSM devices such GSM modems and their decreasing costs have made them an attractive option not only for voice media but for other wide are network application.

II.CLOUD COMPUTING

Cloud computing is a technology that uses the internet and central remote server to maintain data and applications. Cloud computing allows user to use application without installation and access their personal files at any computer with internet access. This technology allows for much more efficient computing by centralizing data storage processing. Cloud computing is broken down into three segments: "application "storage" and "connectivity" each segment serves a different purpose.

Basically, cloud computing is a way to deliver IT services in which resources are retrieved from the server through tools and applications, as opposed to a direct connection to a server. **C**loud computing is the on-demand availability of computer system resource.

Basically its data storage and computing power, without direct active management by the user. The term is generally used to describe data centers available to many users over the Internet. Large clouds, predominant today, often have functions distributed over multiple locations from central servers. If the connection to the user is relatively close, it may be designated an edge server.

Clouds may be limited to a single organization (enterprise clouds[1][2]), or be available to many organizations (public cloud).

Cloud computing relies on sharing of resources to achieve coherence and economies of scale.

Figure 1

III.PROPOSED SYSTEM

Distribution Transformer to commence our work on transformer health monitoring. After selecting rating of transformer, we selected the sensors for the transformers to monitor fault parameters. One Level sensor was mounted on the top of the conservator to monitor the level of transformer oil as it is compulsory to maintain a standard level of oil in transformer. The temperature sensor was mounted on the top of tank cover to sense the oil temperature of the transformer.

Several research works have been done in this field to develop a solution for health monitoring of transformers to prevent premature failure of distribution transformers and improving reliability of services to the customers. We also initiated our work in the same field and completed the same with better and advantageous results.

Transformers come in variety of sizes commonly ranging from 5 KVA Distribution transformers to 2000 MVA Power Transformers. So, first we selected a 400 KVA, 11/0.433 KV Distribution Transformer to commence our work on transformer health monitoring. After selecting rating of transformer, we selected the sensors for the transformers to monitor fault parameters.

One Level sensor was mounted on the top of the conservator to monitor the level of transformer oil as it is compulsory to maintain a standard level of oil in transformer. The temperature sensor was mounted on the top of tank cover to sense the oil temperature of the transformer.

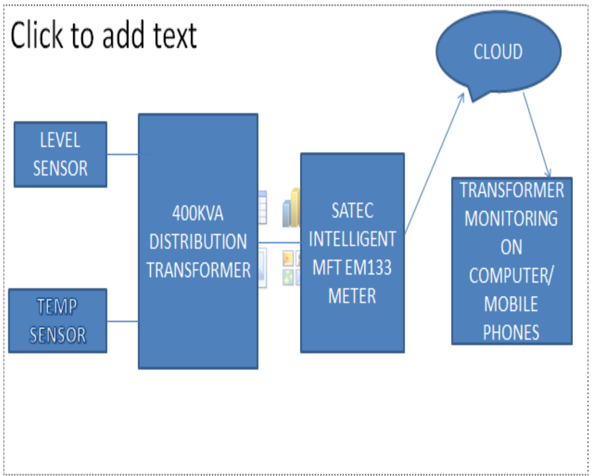


Figure 2

Figure 2 represents block diagram of online transformers monitoring system with arrangement of two sensors with 400 KVA Distribution transformer. These sensors were further connected to the input of SATEC Intelligent MFT EM133 Meter which is a smart, multi-function and GSM based meter. The output terminals of the transformers are also connected to this meter to acquire various parameters of the transformer.

The meter has intelligent features to monitor and acquire the real time data of the transformer. Being a GSM based meter, it further transmitted the real time data of transformer to the cloud server via cellular modem at set periodic intervals. We know that cloud computing has capability to save time especially for computational task in comparison with conventional method / calculation.

This acquired real time data of transformer is finally be available at control room on the Computer / mobile of the concerned technical staff with alerts at the time of occurrence of faults. At the end, we have validated the acquired real time data with the manually recorded data.

IV.EXISTINGSYSTEM

These state electricity boards and utilities suffers huge losses due to the reason that the transformers are damaged on account of overloading of distribution system, non-augmentation of transformers, poor maintenance and negligence on the part of maintenance staff of the board. According to the above discussion, we need a distribution transformer real-time monitoring system to detect all operating parameters operation, and send to the monitoring centre in time.

Transformers are a crucial part of the transmission and distribution system. The state electricity boards and utilities incur huge money to procure distribution transformers every year. These state electricity boards and utilities suffers huge losses due to the reason that the transformers are damaged on account of overloading of distribution system, non-augmentation of transformers, poor maintenance and negligence on the part of maintenance staff of the board.

Apart from this, there are several other drawbacks in the present system that are discussed below.

1. For proper maintenance of transformers, boards require huge man power to check each and every transformer spread over vast and remote areas where the transformers have been installed in villages, cluster of houses, in agricultural fields etc. which is not feasible for the technical line staff.

2. It involves financial cost to be incurred on travelling on vehicles to various sites where the transformers are installed.

3. The scheduled maintenance of transformers is not possible as the technical line staff is already overburdened with multiple types of duties assigned to them.

4. The critical weather conditions in various states of India make interruption for the technical staff in performing their duties.

Several research works have been done in this field to develop a solution for health monitoring of transformers to prevent premature failure of distribution transformers and improving reliability of services to the customers. We also initiated our work in the same field and completed the same with better and advantageous results

V.SENSOR MODULES

TEMPERATURE SENSOR:

- Basically a device which consists of a thermocouple, thermistor or thermostat which sense the temperature or heat.
- Comes in variety as per the application of sensor.
- It varies from a normal ON/OFF thermostatic device which is mostly utilized for domestic water heaters to highly sensitive types that are for industrial use.

There are two types of temperature sensors which are Contact Type Sensor and NonContact Type sensor

LEVEL SENSOR:

- A device used to detect the level of any liquid or fluid kept in an open or closed system.
- The float type sensors comes with an floating arrangement through which it detects the level of any fluid or liquid.
- Situated on the top of conservator which detects the level of oil in the transformer.

EFFICIENCY OF TRANSFORMER:

Efficiency of Transformer η = Output power ……. (1)

Input Power of Transformer

Efficiency η = Input – Losses

= 1 –Losses ……. (2) Input

VI.DIAGRAM

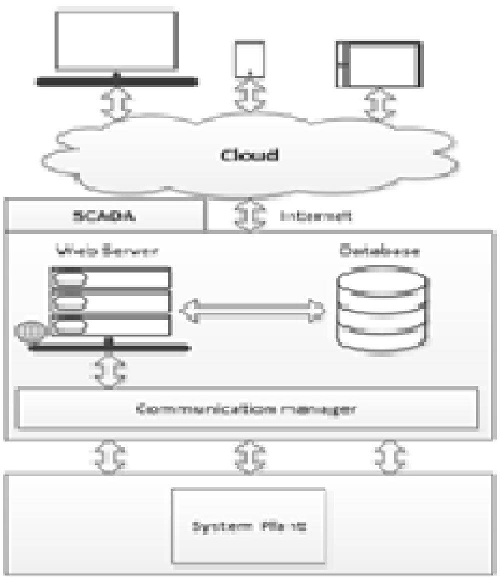


Figure 3 : Control Circuit

Figure 4: 400KVA DISTRIBUTION TRANSFORMER

VII.CONTACT TYPE TEMPERATURE SENSOR

These types of temperature sensor are required to be in physical contact with the object being sensed and use conduction to monitor changes in temperature. They can be used to detect solids, liquids or gases over a wide range of temperature.

B.PROCESSING MODULES

SATEC intelligent MFT EM133 Meter:

SATEC EM133 is a Smart DIN Rail TOU Energy Meter, part of SATEC best-selling 130 series. It includes all PM130EH functionality plus a 16×2-character LCD display, 2 Digital Inputs, 1 Digital Output, IR (Infra-Red), battery backed up real time clock (RTC) and up to 8MB memory for data logging.

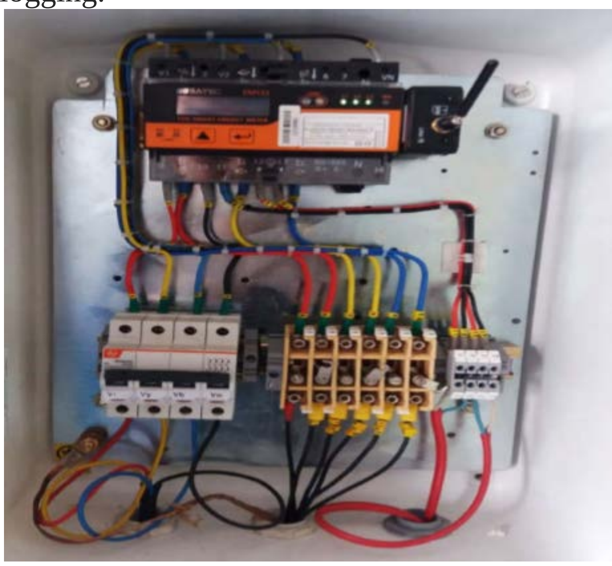


Figure 5 :

C.COMMUNICATION MODULES:

VIII.GOALS OF CLOUD COMPUTING:

The goal of cloud computing is to allow users to take benefit from all of these technologies, without the need for deep knowledge about or expertise with each one of them. The cloud aims to cut costs, and helps the users focus on their core business instead of being impeded by IT obstacles. The main enabling technology for cloud computing is virtualization. Virtualization software separates a physical computing device into one or more "virtual" devices, each of which can be easily used and managed to perform computing tasks. With operating system–level virtualization essentially creating a scalable system of multiple independent computing devices, idle computing resources can be allocated and used more efficiently. Virtualization provides the agility required to speed up IT operations, and reduces cost by increasing infrastructure utilization. Autonomic computing automates the process through which the user can provision resources on-demand. By minimizing user involvement, automation speeds up the process, reduceslabor costs and reduces the possibility of human errors.

Cloud computing uses concepts from utility computing to provide metrics for the servicesused. Cloud computing attempts to address QoS (quality ofservice) and reliability problems of other grid computing models.

IX.TRANSFORMER

Single-phase electric power is the distribution of alternating current electric power using a system in which all the voltages of the supply vary in unison. Single-phase distribution is used when loads are mostly lighting and heating, with few large electric motors. A single-phase supply connected to an alternating current electric motor does not produce a revolving magnetic field; single-phase motors need additional circuits for starting (capacitor start motor), and such motors are uncommon above 10 kW in rating .Because the voltage of a single phase system reaches a peak value twice in each cycle, the instantaneous power is not constant.

A single-phase load may be powered from a three-phase distribution transformer in two ways: by connection between one phase and neutral or by connection between two phases. These two give different voltages from a given supply. For example, on a 120/208 three-phase system, which is common in North America, the phase-to-neutral voltage is 120 volts and the phase- to-phase voltage is 208 volts.

This allows single- phase lighting to be connected phase-to-neutral and three-phase motors to be connected to all three phases. This eliminates the need of a separate single phase transformer. Standard frequencies of single- phase power systems are either 50 or 60 Hz. Special single-phase traction power networks may operateat 16.67 Hz or other frequencies to power electric railways.

X.REALTIME ONLINE MONITORING SYSTEM

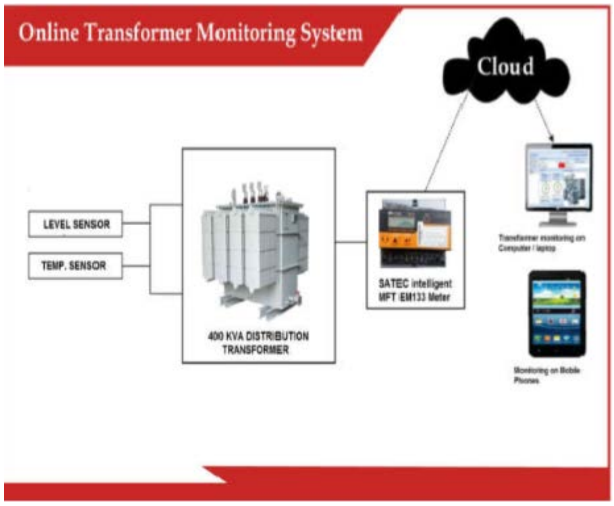


Figure 5 :

XI.COMPARISON WITH EXISTING METHODS

1. Reference to paper presented by Vadirajacharya.K et.al [11] in 2012, they have discussed on Transformer Health condition monitoring through GSM technology but they don't have feature for real time monitoring of transformer. Our system is capable to monitor real time parameters of transformers with alerts in form of SMS.

2. Reference to paper presented by A.R. Al-Ali et.al [18] in 2004 have discussed on GSM based distribution transformer monitoring system. This system is capable to monitor few parameters whereas our system can monitor multiple parameters of transformers.

3. Reference to the paper presented by SH. Mohamadi, A.Akbari [23] in 2012, they

emphasized GSMbased system for the monitoring of Distribution transformers. This system diagnoses and capture parameters of distribution transformers but they have few parameters in comparison to our system. Our system is capable to monitor multiple parameters of transformers.

4. Reference to the paper presented by Sajidur Rahman et.al [24] in 2017, they proposed a method for the real time monitoring of transformers using GSM technology. This system is not capable to trace the geographical location of Distribution transformer whereas our proposed method is capable to identify the geographical location of Distribution transformer

XII.RESULT & DISCUSSION

In this paper As discussed in our methodology, we have utilized sensors and advance SATEC Intelligent MFT EM133 Meter for monitoring of Distribution transformer. This meter will collect required parameters from the distribution transformer and transmit the same to control center via cellular modem at set periodical intervals. Alarm events will be transmitted immediately.

A 400 KVA distribution transformer which was used for the purpose of online monitoring. As circled in red, one Level sensor was mounted on the top of the conservator to monitor the level of transformer oil and the temperature sensor was mounted on the top of tank cover to sense the oil temperature of the transformer. SATEC Intelligent MFT EM133 Meter installed in it. It also shows connections of sensors to the input of meter and the output terminals of the transformers are also connected to acquire various parameters of the transformer.

Further, the meter monitors and acquires real time data of transformer. This acquired data will be transmitted to the cloud server which can be accessed on either desktop / laptop or our mobile phones / tablets. The user shall be provided with an id and password through which he / she can login on portal of Expert Power i.e. www.expertpowerplus.com using any standard web browser.

Our system can provide following parameters from distribution transformers.

1. Geographical location of transformers
2. Real time parameters via tabular and trend graphs
3. Energy parameters via tables and trend graphs
4. Alarm on event of fault
5. Generated Reports

via email at set interval of time Apart from monitoring the real time data of transformers, it is also necessary to access the geo-graphical location of a transformer.

There are thousands of transformers which are installed at the remote locations which are completely out of reach for the technical team / maintenance team of utilities. At the time of occurrence of fault in transformer installed at remote location, it is first necessary of identify the geo-graphical location of that transformer so that the technical team shall reach the location and take necessary action for the same.

Our system is capable to track geo-graphical location of a transformer. location of our transformer which is installed in the premises of a company situated at New Focal Point, Dabwali Road, Bathinda.

The next advantage of our monitoring system is the capability to monitor the oil level and temperature. In a transformer, it’s must to maintain these parameters as per standards and requirements. The main trouble is to conserve a neutral oil level in transformer to avoid over flow from the tank with respect to the change in temperature.

The level of oil in transformer tank is never same or constant rather it is dependent on the function of the following parameters- ☐ Temperature of the transformer oil (average value). ☐ Ambier radiation ☐ Transfor hand, the oil temperature should also be maintained to avoid to over flow of oil from the tank. As per IS 1180 (Part 1) 2014, the specified limits of temperature rise for oil and winding over maximum ambient temperature of 50 oC are described in tabular.

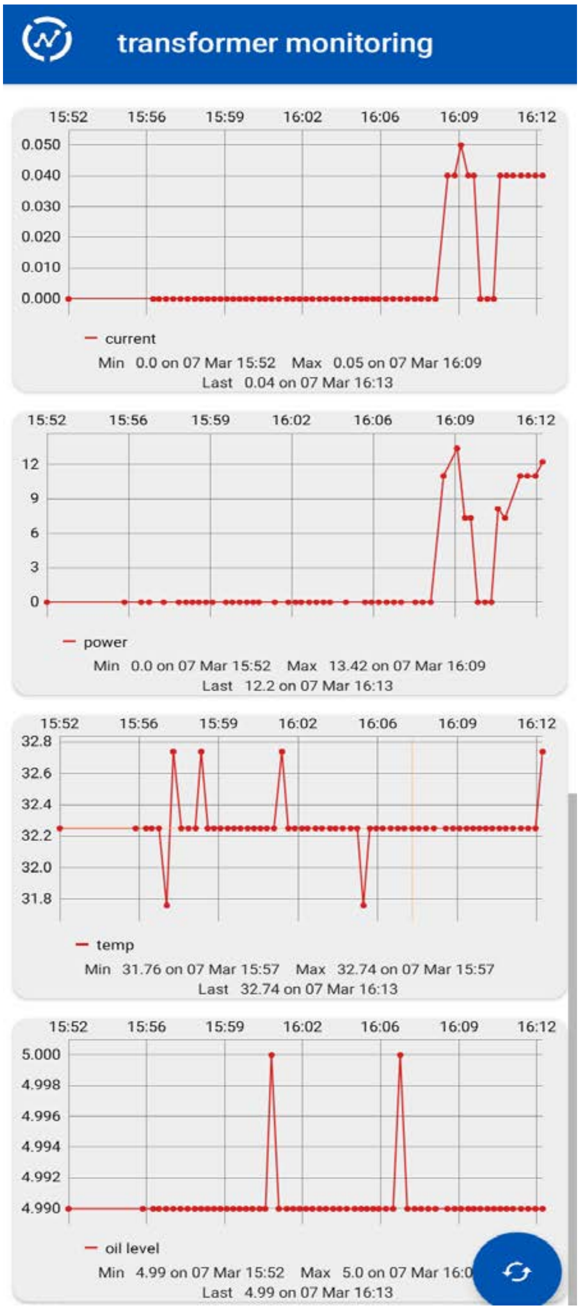
Our monitoring system has the ability to diagnose the abnormality in level and temperature of transformer oil. Different figures shows the multiple conditions of transformer oil level and temperature. two

Green signals indicating the normal oil level and temperature.

Second one green and one red signal in the figure indicating the normal oil temperature and abnormal oil level respectively.

The third one red and one green signal in the figure indicating the abnormal oil temperature and normal oil level respectively.

Finally two red signals in the figure indicating the abnormal oil temperature and oil level.



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