A Survey on Different Technologies used in the Monitoring of Distribution Transformers in Power System

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Abstract **- The integration of distribution network with the advanced communication technologies enhanced the monitoring and control of electrical network as well as monitoring the functions associated with the distribution transformer. These transformers are important equipments in the power system of a nation, their proper monitoring and control are very necessary for a healthy and continuous electrical system. The monitoring of distribution transformer includes- voltage, current, power and frequency of all loads connected to the distribution transformer. The collected data are sent through the suitable communication technology. So there is a need for energy efficient secure distribution transformer monitoring technology. In this paper a survey on different technologies used in the monitoring of distribution transformer is discussed.**

Index Terms **- Distribution network, Distribution transformer, electrical system, communication technology.**

I. INTRODUCTION

Transformers are important equipments in power system network. A healthy power supply at the customer end mainly depends on the performance of the distribution transformer. The monitoring and control of distribution transformer is an important procedure for diagnosing the rapid alerts of the electrical network and also for the proper functioning of the electrical network.

The monitoring of distribution transformer is done by an electronic system with the capacity of sampling, storage, prosecution and mailing of information. If there is a real time monitoring or inspection of the system, so that we can prevent the sudden breakdown of the transformer that may lead to stop serving the electric power to several charges and produces serious affectations to the functioning of the electrical network. The monitoring of distribution transformer includes the measurement of transformer parameters like voltage, current, power and frequency.

The important factor that necessary to consider is the inspected information regarding the distribution transformer should be transmitted properly by considering the coverage to the electrical network. So it's necessary to select an energy efficient, reliable, low cost technology for the advanced monitoring of distribution transformer.

The compiled information is very useful for studies of the electrical network and the planning of future enlargement in fact the common procedure is to substitute the transformer due to the aging of the transformer, which is a huge loss for the government. If we consider the solutions like smart inspection system of the distribution transformer frequently, may lead to increase in the life span of the distribution transformer. At present there are several methods for the monitoring of distribution transformer due to the advancement in the electronics and communication technology. By suitable implementation of varying technologies with the electrical service results in the vast development of power system and its proper management.

II. DISTRIBUTION TRANSFORMER MONITORING TECHNOLOGIES-A SURVEY APPROACH

A. Online Monitoring by using SCADA

The most commonly used online monitoring of power transformer is accomplished by supervisory control and data acquisition system (SCADA). It's a system of software and hardware elements that allows controlling industrial processes locally or in the remote locations and it's capable of monitor, gather, and process the real time data. But the main disadvantage of this system occurs when we extend SCADA for large electric network monitoring, which is very expensive.

B. Using GSM

The large data about the transformer condition can be processed by using the devices like GSM modem, programmable logical controller and PC as a monitor device and sensors like current transformer and potential transformer. This technology is used by many of the monitoring system. Abdul Rahman Al-ali [1] this paper deals with the recording of transformer load currents, transformer oil and ambient temperature by implementing a mobile embedded system. In this type of monitoring, the system is connected to a distribution transformer and is able to record and send the abnormal values of the transformer parameters to a mobile device using a GSM network. An example of transformer monitoring system using GSM technology is shown in the **Fig. 1**: The hardware required for this system includes; Controller: programmable logical controller, PC as a monitor device, Sensors: current transformer, potential transformer and temperature sensor.

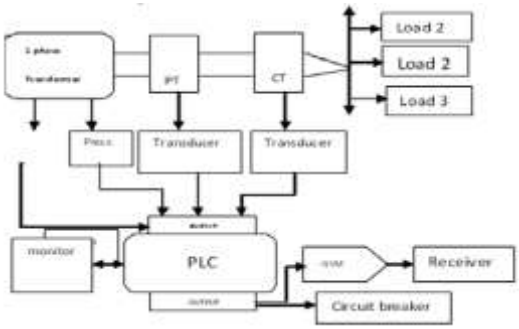

Fig. 1 Monitoring using PLC

C. Using GPRS

The reliable operation of distribution network can be improved by implementing a centralized monitoring. It's usually accomplished or feasible by implementing GPRS to achieve wireless transmission. This type of monitoring system is capable to communicate in both directions. The parameters that will be monitored include voltage, current and temperature. The hard ware of such a system includes: GPRS, PIC microcontroller, and the monitored output is displayed on a PC through a wireless communication network. The monitored outputs are compared with the rated values of the transformer, accordingly microcontroller programmed to control the transformer parameters.

D. Using SFRA

There are technologies developed for the condition monitoring of the distribution transformer which measures the mechanical movements in transformer especially of the transformer's core and winding. Sweep Frequency response analysis (SFRA) of transformer provides mechanical information of core and winding.Sweep frequency response analysis is a proven technique to assess the mechanical integrity inside transformer core and coil before the incidence of a major or catastrophic failure. This type of measurement is based on the transfer function concept which is the ratio of voltage/current output to voltage/current input. The generated signal is a sinusoidal voltage with sweeping frequency between 20Hz and 20MHz. Such a system is shown in **Fig. 2.**

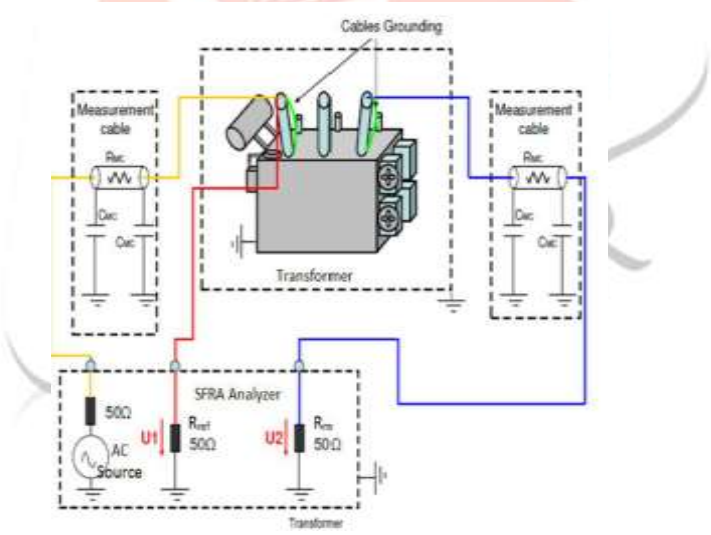

Fig. 2 Illustration of SFRA concept

The communication based on GSM or GPRS, which does not take the data continuously which is a drawback. Another model proposed where different parameters like temperature and oil level that directly acts as a health monitor are incorporated. This type of model is explained using the functional diagram of the SFRA. It consists of data acquisition, power supply for different components, processing, communication and Human Machine Interface (HMI). Monitoring is established by sensing the parameters and send to the processing unit .The processing unit is a single board computer. Then it's communicated to the remote end where we control and protection maintenance of the transformer is done by taking suitable decisions. The functional block diagram of such a system is shown below in **Fig. 3**: where we are monitoring the parameters like temperature, oil level, loading and humming noise of the transformer.

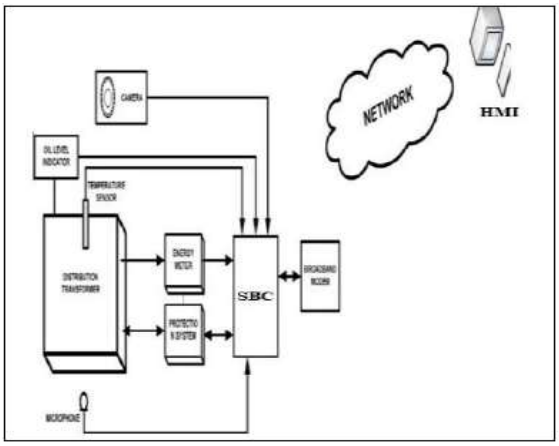

Fig. 3 Block Diagram

E. NETCBM Based Monitoring.

An important technology used for the effective management of distribution network based on the network condition based monitoring (NetCBM). The use of NetCBM in smart grid is capable of monitoring distribution transformer by detecting the partial discharge, electrical arcs and hot spots which helps to identify the deteriorating condition of transformers. Magnetic radio-frequency capacitive coupling based partial discharge detection sensors are used in the NetCBM. Infrared thermal sensors are used to detect thermal hotspots in critical elements of the transformer. The architecture of the NetCBM is shown in the below **Fig. 4**:

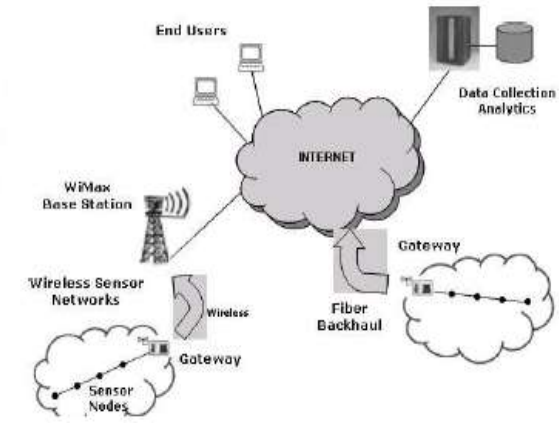

Fig. 4 NetCBM Architecture

III. DISTRIBUTION TRANSFORMER MONITORING USING ZIGBEE AND ARDUINO BOARD.

This is a novel proposed method for a reliable, low cost and energy efficient transformer monitoring system. In this system the important components used are Kit of development Board, Inbuilt ADC, 1 modulate ZigBee Pro. This electronic device obtains fundamentally the following magnitudes.

1. Effective electrical tension
2. Effective electric current
3. Frequency
4. Active energy
5. Power

The architecture of monitoring the transformer is shown below **Fig. 5**:

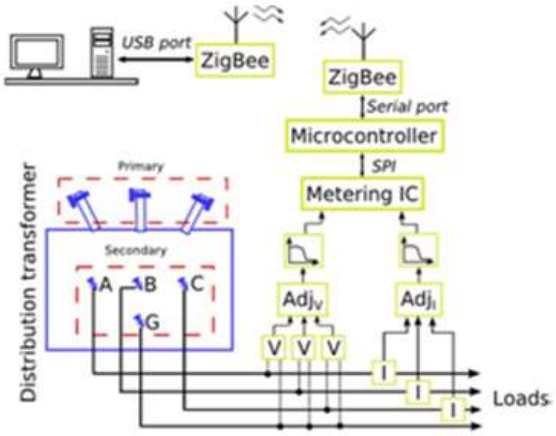

Fig. 5 General architecture of the system

In this type of system of monitoring the communication between the system of present measurement in the transformer of distribution and the computer takes place by means of a wireless network ZigBee. The computer realizes the function of storage and visualization of the information. At present modules of this technology exist already with the sufficient potency to reach 1,5 Km of distance between node and node of the network and maintaining its characteristics of low consumption. The technology ZigBee was developed with the intention of creating wireless networks of communication of instrumentation and control, maintaining a low consumption for a better use of the batteries. The information is accessed by the microcontroller in the arduino development board.

The kit of development board arduino includes in its services a microcontroller based on the AT mega 328p of 8 bit, has 14 digital input/output pin, 6 analog inputs a 16MHz crystal ,a USB connection and power jack ,ICSP header and a USB button. The integrated circuit ADC is developed for the measurement single phase of multiple electrical magnitudes. The use of tin built ADC of 8 channels, 10 bit guarantees the measurement of the magnitudes in a system three phase voltage.

IV. OTHER METHODS OF MONITORING

We discussed several methods for monitoring distribution transformer. There are also other methods like Drasko furundzicet [6] proposed based on neural networks, which are widespread technique for transformer health monitoring system. Suraj Pardeshiet [7] proposed a method for the solution for monitoring and automatic voltage regulation . In this system they developed a modular and intelligent units result in cost effective solution for online monitoring transformer.

Mallikarjun Sarsambaet [8] proposed a monitoring of load and power lines using sms based GSM technology. This system is designed and implemented using embedded system which detects the load fluctuations with respect to voltage and current in power lines. Satya Kumar Behera [9] implemented a system to detect the internal faults as well as the external faults of transformer. Such a system is implemented by automatic control used in PLC system.PLC systems are designed to monitor the transformer parameters continuously.

Viswanath [10] presented a paper uses a temperature sensor , pic microcontroller, LCD display ,GSM board and Xbee which is used for send the message to the electricity board. This system is capable of detecting multiple faults in the three phase transmission lines. Mohamed Ahmed Eltayeb Elmustafa Hayatiet [11] have designed decision support system to grid operation engineers with information helps to estimate the loads, fix problems and identify week points in the grid. Distribution transformer monitoring is very important in the grid in fact its abnormality adversely affects the smooth functioning of the smart grid. In this paper they suggested and implemented a method to remotely monitor a group of distribution transformers. Here the microcontroller is used for data acquisition and transmission.

There are articles analyses the economical aspects of distribution transformer with remote condition monitoring system which gives necessary information regarding operational status. Distribution transformer with and without condition monitoring is analyzed in terms of revenue loss to utility as well as consumers and economic life cycle.

The implementation of any of the efficient systems is very necessary for the better electrical network and to avoid unnecessary losses. In fact Research has shown that distribution transformer losses comprise a significant amount of the overall losses on a distribution and transmission system. Although some of the losses are considered the cost of operations, it may be possible to reduce the total losses associated with overloaded transformers depending upon the amount of overload and the efficiency of the replacement transformer. This can be identified by the establishment of suitable monitoring systems.

V. CONCLUSION

For a healthy distribution network, the monitoring of distribution transformer is very vital. Any of the methods explained in the survey of different methods of monitoring is inevitable. The only factor that to be considered is solution must be energy efficient, low-cost and reliable. So the government of each country should have to provide technological support to utilities and industries for implementing advanced information and communication technology including sensor and control technologies by the support of educational institutions and researchers. The government may acquire the same from other countries by bilateral agreement. The utilities, industrialists and government in a county should be worked as a union to achieve the technology development for the implementation of monitoring systems for distribution transformers.

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