International Journal of Engineering Applied Science and Management
ISSN (Online): 2582-6948
Vol. 3 Issue 10, October 2022

A Review on IOT Based Transformer Health Monitoring System: A Survey

Dayam Sharfuddin[1], Mr. Nitin Choudary[2]
M.Tech. Scholar, Department of Electrical &Electronics Engg. Kopal Institute of science & Technology, Bhopal, India[1]
Assistant Professor, Department of Electrical &Electronics Engg. Kopal Institute of science & Technology, Bhopal, India[2]

Abstract: *The transformer is playing a vital role in the electrical power grid. As it deals with high voltage and current which can greatly affect the functioning and physical condition of the device, continuous monitoring has become an integrated part of its operation. This paper presents a review on IoT (Internet of things) based electrical parameters monitoring and controlling technology to avoid its successive catastrophic failures. Here, different sensors and server models are used for communication, mostly used is GSM- GPRS. In case of some abnormality, this advanced monitoring system will deliver a message to a dedicated device for further course of action. The work done in recent few years in the field of parameter monitoring using the internet is discussed here.*

Keywords: *Sensors, IoT, GSM, GPRS, Transformer Health Monitoring.*

1. Introduction

The transformer plays an important and crucial role in the network of the electrical system. In every area, we can see at least one transformer. We are in an era where it is impossible to live without electricity even for a minute. Every core activity whether it is residential or for plants and factories is dependent on the power supply. Without them, every business will come to standstill and may face huge financial consequences.

There are various implicit & explicit reasons due to which the performance of transformer may deteriorate. The most commonly observed contingencies are like partial discharge, insulation deterioration, humidity, moisture, overheating, winding resonance, loss of winding clamping, insulating oil solid contamination, lightning strike, system faults, system overload, switching operations etc. The conventional method of transformer health monitoring includes Infrared Emission Testing (IET) technique, used for transformer external surface temperature measurement. Transformer overheating may cause due to following reasons such as current, voltage or temperature. Cooling system blockages, hotspot locations and electrical connection problems can be detected using this method. Besides of this Dissolved Gas Analysis (DGA) is performed to identify emission of different gases released by transformer are hydrogen gas, carbon monoxide, carbondyoxide, Methane, Ethene, Ethyne and Ethane [15]. Emission of these gases indicates the following faults like Corona, Cellulose insulation breakdown, Low temperature oil breakdown, arcing respectively. Photo-acoustic emission spectroscopy or Laboratory gas chromatography involves a three step process to determine the probability of the kind of fault occurrences. This has become tedious processes to identify the same within the stipulated time so that the equipment can be saved well before occurrence of a hazard. This depicts that a periodical test needs to be conducted on regular basis to protect the device from failure. Hence for proper maintenance & monitoring of transformer new techniques like IoT provides a powerful mechanism in coordination with communication tools like GSM and GPRS. Data sent is in the form of packets from sending unit to the operating unit. GPRS supports internet protocol (IP) for communication. Different servers are used for the client- server request. Things speak server is a very useful platform and it also provides a backtalk feature that helps in controlling the commands. This communication process helps in sending messages to a designated device. An algorithm is also programmed so that if the incoming value goes beyond the threshold value the isolation of the system will take place to avoid failure. Because of these unique abilities , IoT technology has got large applications in various fields like Smart home,

Smart Building, Smart City, Smart transportation and traffic control, Smart water Management system, Smart industrial applications, Smart Healthcare, etc. Likewise it is also getting applications in upgrading the power grids systems surveillance and effective control. This is enhancing the transmission and distribution systems performance ability, service availability, reliability, safety and security of the equipment connected to .The pillar of IoT technology is based on the following building blocks like data through sensors and actuators, hardware or software gateways to communicate between controller, sensors and intelligent devices, Edge IT and data centre [8]. Fig.1 shows the basic building blocks of IoT technology.

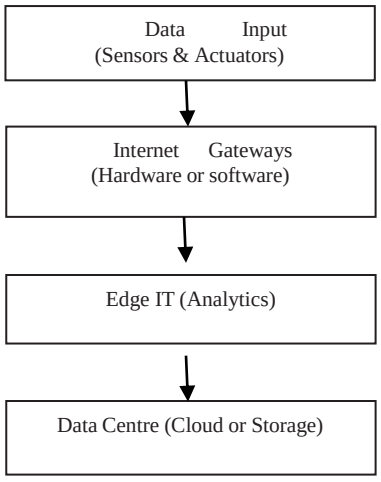

Fig.1 Basic Building Blocks of IoT Technology

2. Literature Review

Pawar and Deosarkar [6] have presented a paper in which they have applied a mobile embedded system. There GSM- GPRS technology is used for the monitoring of the distribution transformer. The control unit was divided into two parts in which the first part is the Remote Controlling Unit (RTU) which collects data from sensors and the second part is at the monitoring node where software is there for monitoring of parameters of the transformer and the information is displayed on engineers screen.
Hongyan Mao [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, Gajanan, Makarand, and D.R. Tutakne [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.

A new approach is tested by Tarun Kanti Roy and Tusher Kanti Roy [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.
SH. Mohamadi and A. Akbari [3] 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 Md. S Naderi and Oveis Abedinia [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, Ayesha Anjum, and Mohsin khan Janjua [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. Chaithshree N [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.

Sajidur Rahman and Nipu Kumar Das [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 cost-effective. The use of PIC16F877A microcontroller enables the system to behave as a real-time embedded system that fulfills the industrial demands.

J. Crossey, W. Ferguson [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.

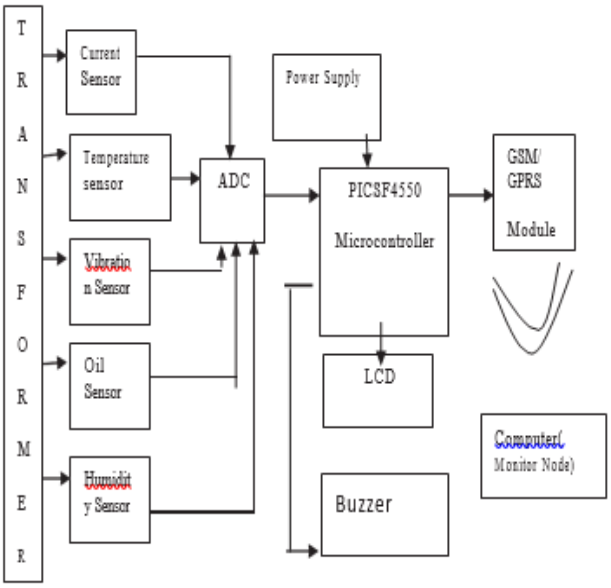

Fig.2. Transformer condition monitoring hardware setup

The block diagram Fig.1 [13] shows hardware set up of transformer health monitoring with 3D modeling. Authors have proposed that PIC 18F4550 Microcontroller is connected with current sensor, temperature sensor, vibration sensor, oil level, humidity as input devices at Remote Terminal Unit (RTU). After receiving inputs from different sensors microcontroller sends the signal to display on LCD and webpage. It translates all physical inputs as quantitative values and display on webpage as online interface to engineers. During, any abnormal situations like overvoltage, over current, change of oil level, rise in temperature, unwanted vibrations and change in humidity, notification is auto generated by SMS through GSM and informs the concerned engineers for immediate course of action. Also it is displaying the real time status of the device on LCD with buzzer sound at Remote Terminal Unit (RTU). At monitoring node whole system can be accessed by webpage. Alternatively using Arduino UNO and Wi-Fi modem also condition can be monitored [14].

3. Challenges and Issues: IOT Based Monitoring

As 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. 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. Apart from it, the adverse issue may arise due to data drop in cloud. In such situation the proper protective signals may not be generated on time and successive safety notifications may be missed from generation and there may be a message delivery fails [5]. In that case, the non-reported spurious faults may lead to the severe damage of the device and the systems connected to it. The study on these issues is not getting the attention of authors yet.

Based on several investigation and analysis of power and distribution transformers, following basic causes are identified as the major occurrences of transformer failures. In this list, insulation failure probability is taking the lead with 41% failure rate, followed by components failure like windings, bushings and on –load tap changers with 14%, 10% and 10% respectively. Other low significant causes are cooling system, core and operating errors which may also lead to failure of the system. Synchronizing its effect with cause is another challenge in selection of sensors for correct prediction of failures and taking the right corrective measures [16].

4. Conclusion

From the above discussion it is observed that online health monitoring with the help of the internet provide better and accurate results rather than traditional methods. It has been also observed that less time is required in the detection of Faults and saves the system from any catastrophic failure. The latest IOT technology provides good comfort in the electrical domain in coordination with GSM GPRS to make communication between the control and remote unit.

The work done in this field in the last few years is summarized here. But yet the concern discussed in section III, gives a pose in our thought that is this IoT based Transformer health monitoring system is hundred percent reliable? As no study has yet covered this analysis and recommended with their findings, it can be assumed that it may reduce the cost of preventive maintenance by reducing the frequency of physical preventive check and consider this as a redundant protective system in parallel to manual and laboratory based investigation of these vital equipment.

References

[1] Hongyan Mao, "Research of Wireless Monitoring System in Power Distribution Transformer Station Based on GPRS", Volume 5,IEEE, 978-1-4244-5586-7/10 (2010)

[2] J. Crossey, W. Ferguson, "On-line monitoring and diagnostics for power Transformers", IEEE- 978-1-4244-6301-5,(2010).

[3] SH. Mohamadi, A. Akbari, "A New Method for Monitoring Distribution Transformer" IEEE, 978-1-4577-1829-8, (2012).

[4] Avinash Nelson, Gajanan, Makarand, D.R Tutakne, C Jaiswal, and S Ballal, "Remote Condition Monitoring System for Distribution Transformer", IEEE, 978-1-4799-5141-3/14 (2014).

[5] I. Choudhury, H. Altab and S. H. Bhuiyan, "Issues of Connectivity, Durability, and Reliability of Sensors and Their Applications", DOI: 10.1016/B978-0-08-096532-1.01320-0, (2014)

[6] Rohit R. Pawar, Dr. S.B. Deosarka, "Health Condition Monitoring System For Distribution Transformer Using Internet of Things (IoT)", IEEE, 978-1-5090-4890-8/17,(2017)

[7] Shajidur Rahman and Nipu kumar Das, "Design and implementation of real time transformer health monitoring system using GSM technology", IEEE-978-1-5090-5627-9,(2017).

[8] Kavleen Kour, Jaspreet Kour, Parminder Singh, "Smart Applications of Internet of Things", IEEE 978-1-5386-6373-8, (2018)

[9] Tarun Kanti Roy, Tusher Kanti Roy, "Implementation of IoT: Smart Maintenance for Distribution Transformer using MQTT", IEEE - 978-1-5386-4775-2, (2018).

[10] Mohammad S. Naderi, Oveis Abedinia, "Transformer Active Part Fault Assessment Using Internet of Things", 2018 IEEE- 978-1- 5386-5928-1, (2018).

[11] Hassan Jamal, M. Faisal Nadeem Khan, Ayesha Anjum, Mohsin Khan Janjua, "Thermal Monitoring and Protection for Distribution Transformer under Residential Loading using Internet of Things", IEEE: 978-1-5386-8509-9,(2018).

[12] Priyanka R , Chaithrashree N , Sangeetha S. Bhagyalakshmi , Divyashree A, "Design and Implementation of Real-Time Transformer Health Monitoring System using Raspberry-Pi", IJERT Issue 2018, ISSN: 2278- 0181,(2018)

[13] D.Sarathkumar, Uvaraj.M, Kabilesh Kumar C V,Kalaiselvi A," Real Time Transformer Health Monitoring System using IOT", IJARSET ,Vol. 5, Issue 11, (2018)

[14] Ammuthaelakkiya. K, Kavipriya. N, Kayalvizhi. J3, Renukadevi. R4, L.V. Revathi5,"Transformer Health Monitoring System using IoT and GSM, IJESC, Volume 9 Issue No.3 (2019)

[15] Shuvam Pathania, "IoT Based Distribution Transformer Health Monitoring System", submitted to Thapar Institute of Engineering &Technology, Patiala, (2019)

[16] Quynh T. Tran Kevin Davies, Leon Roose, Puthawat Wiriyakitikun3,Jaktupong Janjampop, Eleonora Riva Sanseverino and Gaetano Zizzo, "A Review of Health Assessment Techniques for Distribution Transformers in Smart Distribution Grids", Appl. Sci. 10, 8115, (2020)