An IoT based Transformer Condition Monitoring & Automatic Oil Filling System

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Abstract— In the electric power system, distribution network plays a vital role in power distribution. There is numerous distribution transformers (DT) present in the distribution network. DT should be operated carefully for the effective distribution of electricity to the loads. The cost of DT is very high. So its lifetime is extended by proper monitoring that greatly useful in the electricity delivery in vast distribution system without any installation of new transformer. The condition of DT is assessed by monitoring various parameters include load current, over voltage, oil level and oil temperature. As the implementation of transformer condition monitoring system through the Internet of Things (IoT) connects Micro Controller Unit (MCU) interfaced to sensors and motor with Wi-Fi modem. This designed system is fixed to the transformer. The parameters values are collected by sensors and circuit are recorded by the MCU and displayed on the LCD. The data is communicated to the server webpage through Wi-Fi module by the MCU periodically. The server is designed to check for unusual condition in the DT. Then the server will send Short Message Service (SMS) to designated mobile phone of the lineman if there any unusual condition exists in the transformer. Automatically oil is filled to the transformer by using the motor when the oil level low is noticed as unusual condition. This system is useful in optimizing the transformer operation and reduces the manual labour. It is the improved system for transformer monitoring to prevent DT from catastrophic failure.

Key words: Wi-Fi Module; Micro Controller Unit; Distribution Transformer; Internet of Things (IoT); Oil Filling

I. INTRODUCTION

Nowadays electrical instruments and machineries are widely used in every field to do work in a smarter way without spending more effort. So electricity is the ultimate need for the fields like Medicine, Science and Industry to provide a sophisticated life to each human being in the universe. For the transmission and distribution of electricity, transformer is the equipment used in the electric power system. The distribution of electricity to the low voltage user is done by distribution transformer. Distribution transformer in the power delivery network is exposed to various natural circumstances for so many years. The installation of a new transformer requires high cost. So the operation of DT should be carefully handled. It is low voltage equipment which should not operate with fully loaded condition. DT needs monitoring system to maintain its operating lifetime. Nearly 700 transformers fail annually between 8000 DT in the electric power system due to unexpected conditions. So the average life time (20-25 years) is reduced because of overload current, high voltage, low oil level and high oil temperature [1]. Some other parameters such as winding temperature, oil viscosity, dissolved gas and oil moisture change will also be the reason for the abnormalities in the transformer condition. Due to the unusual condition, the delivery of electricity to the users is interrupted. Transformer is consisting of various internal parts and each of its status is necessary for the smooth operation. Thus various currently available methods are not quite enough. Because in the existing system, risk behind oil filling process is not considered and there is no solution is provided. During oil filling process the workmen get injured because of the exploding of oil. With regarding to this problem, automatic oil filling mechanism is provided to the transformer monitoring system. The abnormal condition the transformer is exactly find in the distribution system with the help of Internet of Things (IoT).This system perform the monitoring process efficiently and seek attention among the other available systems.

II. METHODOLOGY

Internet of Things plays the major role in our day to day life. It has lots of features that exactly suit for every field. The implementation of transformer monitoring and automatic oil filling system based on IoT will be very effective method. In this project human effort is greatly reduced. Because it is hard to find the abnormal transformer in a distribution system by human before the failure occurence. It takes more time to identify that particular transformer. The information about the transformer condition is acquired by the microcontroller and then it is stored in the server webpage. The communication between microcontroller and server is provided by the Wi-Fi module. This system does not need any human to check the information about the transformer all the time on the server. The designed system makes decision depending on the collected data. First initialization of sensors, microcontroller ATmega2560and Wi-Fi module process takes place. Then the system starts to read data collected by various sensors and components. The microcontroller then makes comparison with collected data and stored data values in memory. When microcontroller finds any abnormal condition automatically disconnect the load from the transformer. The transformer condition recorded by the MCU is transferred to server for the statistical analysis in future. If the abnormal condition exists due to low oil level, then motor is initiated to pump oil into the transformer.

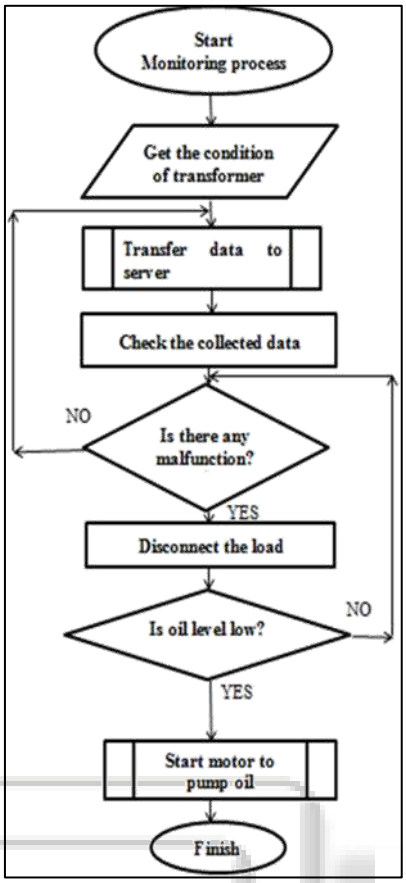

Fig. 1: Flow Chart of Monitoring System

III. SYSTEM IMPLEMENTATION

We divided our system into three parts. These are data collector, data processor and communicating part. In this part we talks about the combined system or control unit for transformer condition monitoring system. The system hardware has four hardware units .The data collector unit is actually different sensor modules which is located at the transformer site. It is utilized to acquire the continuous data from the transformer side. Then these data processed and measured in the micro controller. In the communicating part Wi-Fi module is connected. This module is used for the data transfer from transformer to the server webpage [3]. In the message receiving section an operator (line man) can take steps by reading the message about what fault occurs. Thus the controller can isolate the faulty transformer before any accident in the electric power distribution network.

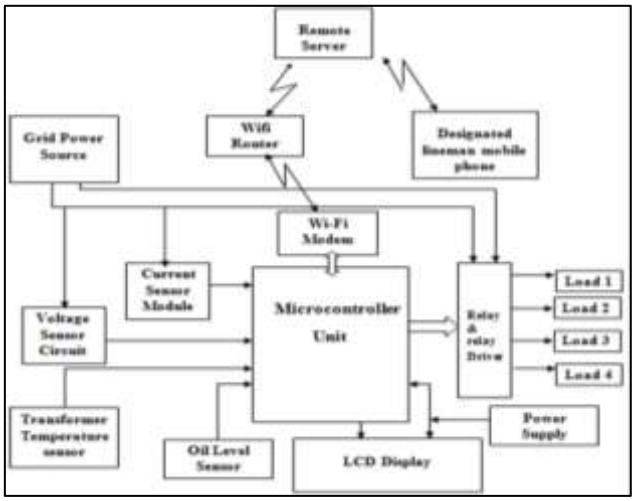

Fig. 2: Block Diagram of IoT based Transformer Condition Monitoring System

ACS712 is the current sensor used in the system to measure the current. It consists of Hall circuit with copper path to convert the current into magnetic signal. The conduction path is for sampling the current to indicate current value.

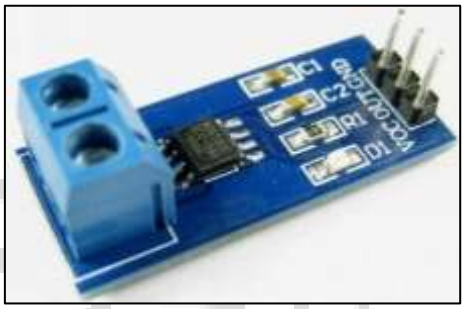

Fig. 3:

IV. CURRENT SENSOR

To determine the voltage in the transformer a capacitor divider was utilized and after that the partitioned voltage changed over to DC for estimation reason and after that through an ADC channel of microcontroller. As the deliberate esteem fluctuates as often as possible a number of 1000 examples taken and the normal esteem figured and after that duplicated with particular consistent to get genuine AC RMS esteem.

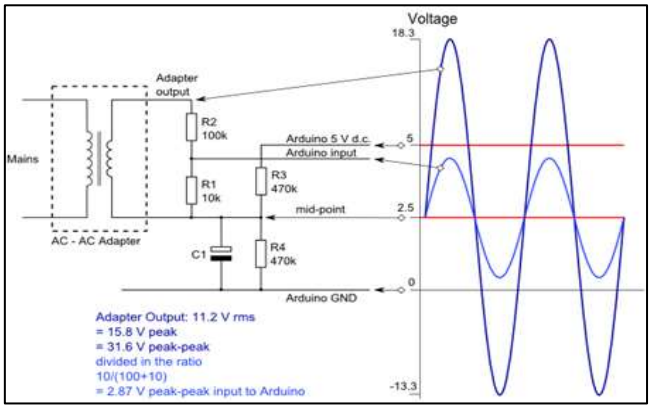

Fig. 4: Voltage Divider Circuit

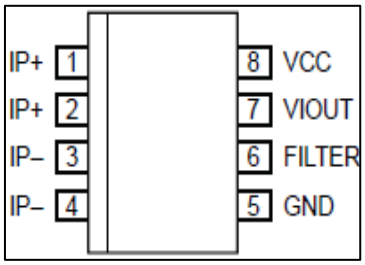

Fig. 5: Pin diagram

Oil level in the transformer is measured by using an ultrasonic sensor. Ultrasonic transmitter starts timing when ultrasonic sound wave are emitted and stops timing after detecting the presence of object by reflected waves The waves are spreading with velocity(3*10^8). It calculates the distance based on the timing and the velocity.

Distance=velocity*time

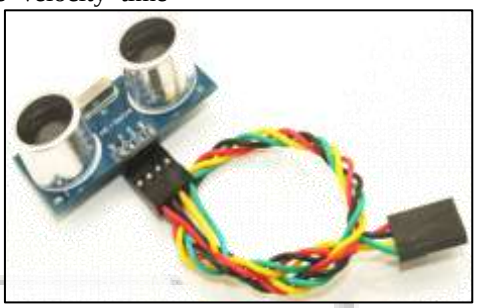

Fig. 6: Ultrasonic Sensor

DB18B20 is the digital thermometer used the measure the transformer oil temperature in Celsius. Each temperature Celsius is converted into digital data by temperature sensor and it is recorded in the MCU.

Fig. 7: Temperature Sensor

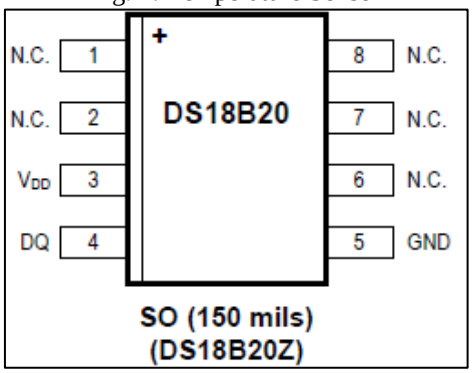

Fig. 8:

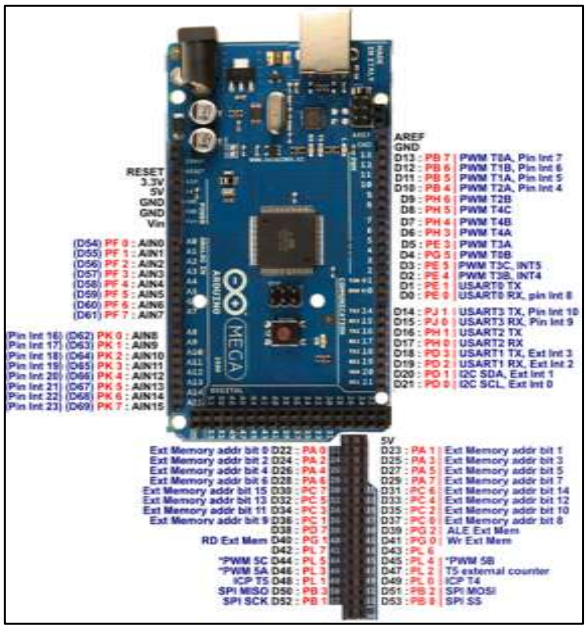

Fig. 9: ATMEGA2560 MCU

The Mega 2560 is a microcontroller board in light of the ATmega2560. It has 54 advanced information/yield pins (of which 15 can be utilized as PWM yields), 16 simple sources of info, 4 UARTs (equipment serial ports), a 16 MHz precious stone oscillator, a USB association, a power jack, and a reset catch. It contains everything expected to help the microcontroller; basically interface it to a PC with a USB link or power it with an AC-to-DC connector or battery to begin. The Mega 2560 board is good with most shields intended for the Uno and the previous sheets.

ESP8266EX is used for the communication of data between MCU and server. TCP/IP protocol is the dominant protocol in internet. The collected data is transferred to the server webpage. The maximum size of the SMS sent and received by Wi-Fi modem is 160 characters [8]. Gadgets on the system to associate with the Internet, the switch must be associated with a modem. A modem is a gadget that gives access to the web. The modem associates with your ISP, which normally gives either link or DSL Internet benefit.

A switch is a little box that enables various PCs to join a similar system. These remote switches frequently have maybe a couple moveable reception apparatuses on the side; however a few models house the radio wires inside the fenced in area. Remote switches permit different PCs and different gadgets, for example, cell phones and tablets, to join a similar system.

Motor is used to pump the oil automatically into the transformer when the oil level is low is identified during the monitoring process.

Relays are straightforward switches which are worked both electrically and mechanically. Relays comprise of an electromagnet and furthermore an arrangement of contacts. The exchanging system is completed with the assistance of the electromagnet. It disconnects the load from transformer when abnormal condition exists.

An LCD is used to display the transformer condition that indicates whether distribution transformer operation is normal or abnormal. The data is obtained from the MCU interfaced with sensors. It is very useful for the lineman to

know the current condition of the transformer without making any manual calculation.

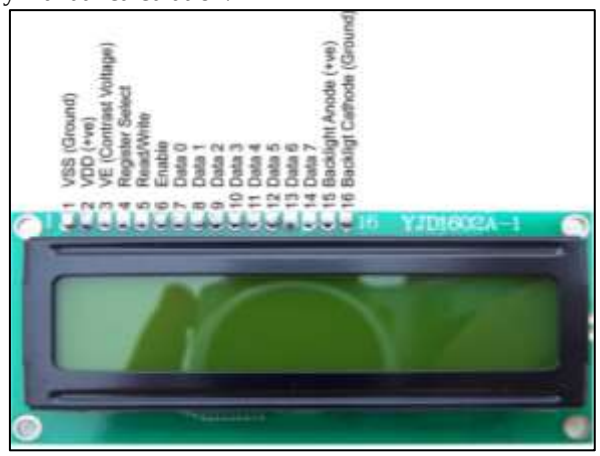

Fig. 10: LCD

Fig. 11: Hardware Implementation

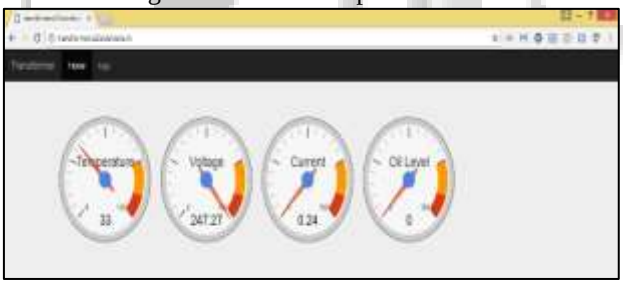

Fig. 12: Monitoring the parameters value in server

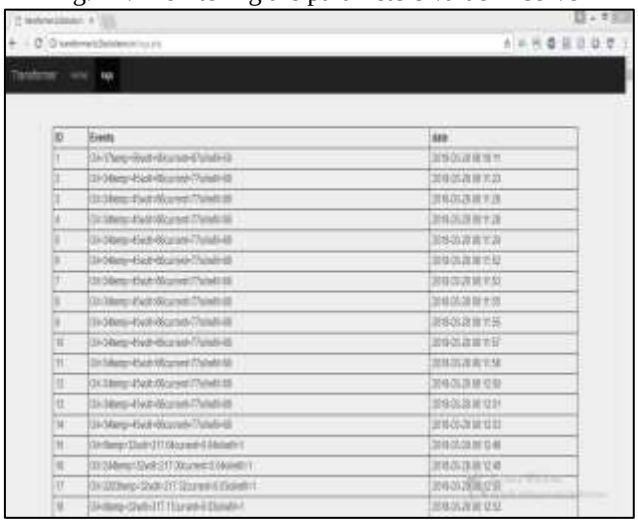

Fig. 13: Data base Stored in Internet

V. CONCLUSION

The monitoring process based on IoT is effectively carried out by using Wi-Fi module .It offers better communication for transferring data between the MCU and server. Wireless communication that eliminates the use of large cables which are of high cost, low reliability and maintenance [6] [7]. The monitoring system is essential for reliable electricity delivery by transformers to the low voltage users. Internet of Things is useful in coordinating all the components and devices work together in the transformer monitoring process. The data from MCU is stored in the server webpage will useful for further statistical analysis in future regarding to transformer monitoring maintenance. SMS is send to the designated mobile phone by the server when unusual condition exists in the transformer operation. The transformer installed with the designed system is very helpful in finding the exact fault location in the power distribution system. This project work reduces the human effort and reduces the risk in the oil filling process. Thus the outcome of this experimentation is obtained efficiently as expected in the monitoring process.

REFERENCES

[1] Vivek Landage, Ashish Khsrche, Vadirajacharya. K, HarishKulkarni, 'Transformer health condition monitoring throughGSM Technology", International Journal of Scientific&Engineering. Research Volume 3, Issue 12, December-2012, ISSN 2229-5518.

[2] Anurudh Kumar, Ashish Raj, Abhishek Kumar, Sikander Prasad & Balwant Kumar, "Method For Monitoring of Distribution Transformer", Undergraduate Academic Research Journal, ISSN: 2278 – 1129, Volume-1, Issue-3,4, 2012.

[3] Abdul Rahman, Ai Ali, Abdul Khaliq & Muhammad Arshad, "GSM-Based Distribution Transformer Monitoring System", IEEE MELECON 2004, May 12-15, 2004, Dubrovnik, Croatia.

[4] S. Dharanya, M. Priyanka, R. Rubini & A. Umamakeswari,"Real time monitoring and controlling of transformers", Journal of artificial intelligence 6(1):33-42, 2013, ISSN 1994-5450/DOI: 10.3923/jai.2013.33-42.

[5] Zhang Xin, Huang Ronghui, Huang Weizhao, Yao Shenjing,Hou Dan & Zheng Min, "Real-time Temperature Monitoring System Using FBG Sensors on an Oil-immersed Power Transformer", DOI: 10.13336/j.1003-6520.hve.2014.S2.048,Vol.40, Supplement 2: 253-259v, August 31, 2014.

[6] N. Nagaraju & M. S. Kiruthika, "Fault Sensing in a Remote Transformer Using GSM", Vol. 2, Issue 10, October 2013.

[7] Prof. M. S. Sujatha & Dr. M Vijay Kumar, "On-Line Monitoring And Analysis of Faults in Transmission and Distribution Lines Using GSM Technique", Journal of Theoretical and Applied Information Technology, ISSN: 1992-8645, E-ISSN: 1817-3195, 30th November 2011, Vol. 33 No.2.

[8] Sh. Mohamadi & A. Akbari, "A New Method for Monitoring of Distribution Transformers", 978-1-4577-1829-8/12/$26.00©2012 IEEE.

[9] Sajidur Rahman, Shimanta Kumar Dey, Bikash Kumar Bhawmick & Nipu Kumar Das "Design and Implementation of Real Time Transformer Health Monitoring System Using GSM Technology", SajidurInternational Conference on Electrical, Computer and Communication Engineering (ECCE), February 16-18, 2017, Cox's Bazar, Bangladesh

