IoT based Monitoring of Distribution Transformer

Manoranjan Kumar[1] Ashish Ranjan[2] Abhishek Sharma[3]
[1,2,3]B. Tech. Student
[1,2,3]Department of Electronics & Communication Engineering
[1,2,3]SRM University, Chennai, Tamil Nadu, India

Abstract— Distribution transformer used for the circulation of electricity. It provides the final voltage transmission in the electrical power distribution system, stepping down the voltage used in distribution lines to the level used by customers. So, maintenance of distribution transformer is a daunting task for Electric Board department to monitor those transformers regularly. This paper presents an idea to follow the transformer online by analyzing its various parameters like temperature, voltage, current, and oil level. For this, sensors are used to sense the actual readings from different parameters with the help of the microcontroller. Data of operation and abnormal condition of transformer receives in the IoT module, and this data saved in computer server from where we can monitor these parameters on system screen with the help of a particular web address. Using the suggested online monitoring system will help utility operators to keep transformers in service for a longer time.

Key words: Distribution Transformer, IoT

I. INTRODUCTION

Distribution transformer plays a vital role in the electrical distribution of carrying high voltage electricity to end consumers converting it into 220V and make it safe and efficient for use. There is some rating of transformers, if they operate within rated readings it increases the lifetime of a transformer. However, sometimes there are fluctuations in overloading voltage, surrounding temperature, change in oil level which decrease their efficiency and damage to the transformer. So, there is a need to online monitor those transformers regularly to avoid its failure.

Fig. 1: 2000 KVA Step Down Transformer

II. EXISTING SYSTEM

The existing system to monitor the transformer include the manual calculation of various parameter of the transformer. It includes their size, core type, how much load gets HV (High Voltage), LV (Low Voltage), phases, the number of winding, oil temperature (Fig 2), winding temperature, operating frequency. If load supply gets fluctuated, then OLTC (On Load Tap Change) will be done (Fig 3). In this tap change, there are many nodes, e.g., 0-24, it means we can increase or decrease voltage up to 25V only. This load tapping did manually, and the EB department maintains a data sheet of variation in various parameters. One more big issue occurs in the transformer is with windings.

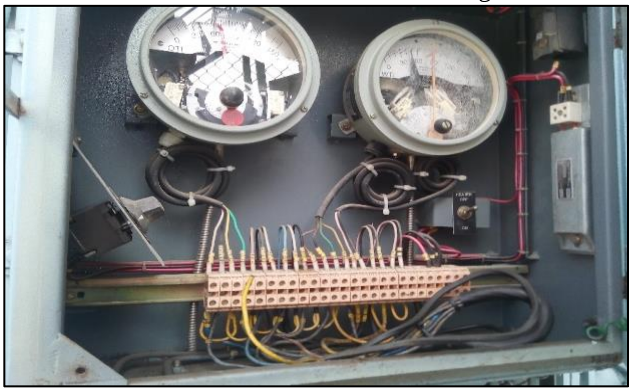


Fig. 2: Oil and Winding Temperature

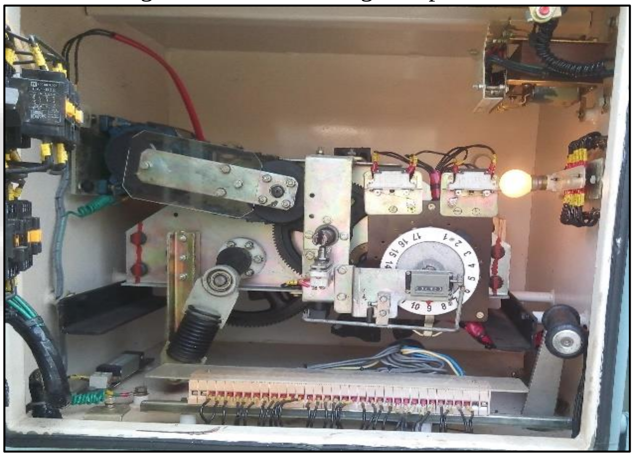


Fig. 3: OLTC (On-Load Tap Changing)

III. PROPOSED SYSTEM

In the proposed system, we are implementing IoT technology which helps in maintaining the database of transformer monitoring parameters like load voltage, load current, winding temperature, and oil level. For this, we are using PIC Microcontroller 16F877A, which is a 40 Pin DIP (Dual Inline Package) to make in-circuit serial programming with the input sensors which is used to sense the various parameters. These input sensors include Temperature sensor LM35, Current Sensor ACS712, Voltage sensor 0-25 V, Oil level sensor. The power supply 230V AC is given to step down transformer which converts to 5V dc. The PIC microcontroller having A/D pins and the sensors used generates an analog signal which converts to the digital signal which read by the microcontroller and the parameters displays on LCD. Simultaneously the data is sent to the system using IoT module via RS 232 IC. As we vary the load i.e. 12V dc motor, there is fluctuation in voltage and current reading, and it will observe on the monitoring screen.

The IoT module communicates with the embedded system in a unique way. The messages code into Pdf form and the embedded system is capable of decoding the message with a suitable algorithm.

IV. BLOCK DIAGRAM

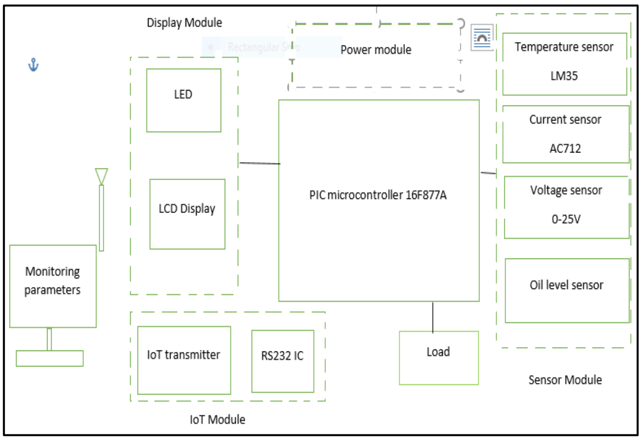


Fig. 4: Block Diagram of Circuit

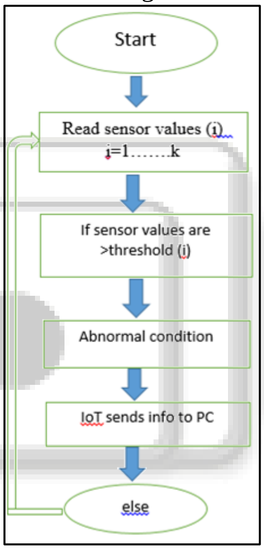


Fig. 5: Flowchart

V. SENSOR MODULE

The sensor module contains Temperature Sensor, Current sensor, Voltage Sensor, and Oil Level Sensor.

A. Temperature Sensor [LM35]

It is a precision IC temperature sensor with its output proportional to the temperature. The sensor circuitry is sealed and not subjected to oxidation and other processes. It also poses low self-heating and does not cause more than 0.1 degree Celsius. Operating temperature range from -55 to 150.

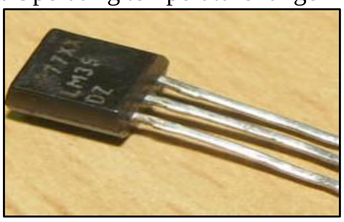


Fig. 6: Temperature Sensor

B. Current Sensor [ACS712]

This sensor is based on Allegro ACS712ELS chip and offered with full-scale values of 5A, 20A, and 30 A. The device consists a low offset, Linear Hall Circuit with a copper conduction path located near the surface.

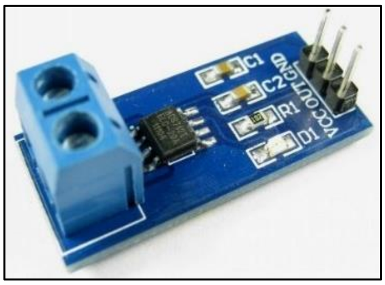


Fig. 7: Current Sensor

C. Voltage Sensor [0-25V]

It is a potential divider to reduce any input voltage by a factor of 5.It allows using the analog input microcontroller to monitor voltage much higher than it capable of sensing. e. g. for a voltage of 0-5V analog input range, we can measure a voltage up to 25V. Based on the principle of resistive voltage design which makes input voltage five times smaller.

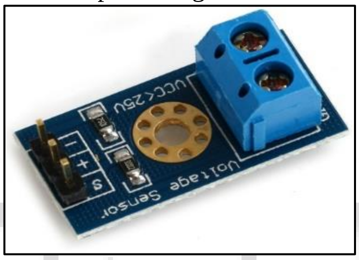


Fig. 8: Voltage Sensor

D. Oil Level Sensor

Oil level sensor senses the fluid level. It having a supply voltage 0f 18-30 V DC, maximum load current 200mA, voltage drop<2.5 V, current consumption < 80 mA. Its wetted part is stainless steel. It having medium temperature range is 0-80oC.

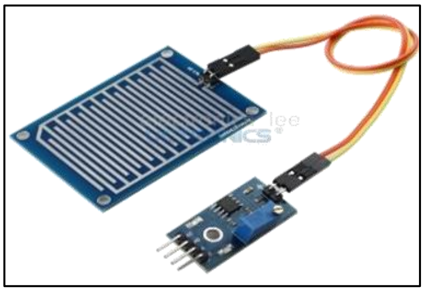


Fig. 9: Oil Level Sensor

VI. DISPLAY MODULE

The display module contains LCD and LED.

– The display used is 16x2 LCD, which means 16 characters per line by two lines. It receives data from an external source (PIC) and communicates directly with the LCD and another sensor.

Fig. 10: LCD Display

VII. IOT MODULE

The IoT module is an open hardware network connecting many devices at a single time and makes it exchange data with the server. The IoT module consists of USART, transmitting antenna, and Wi-Fi chip to exchange data.

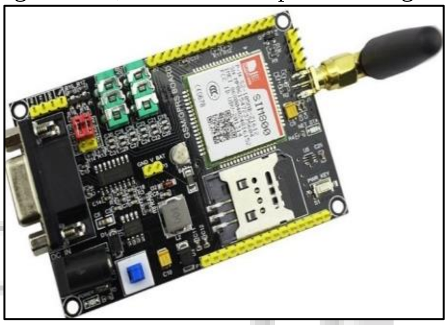


Fig. 11: 302 IoT Module

VIII. SCHEMATIC DIAGRAM

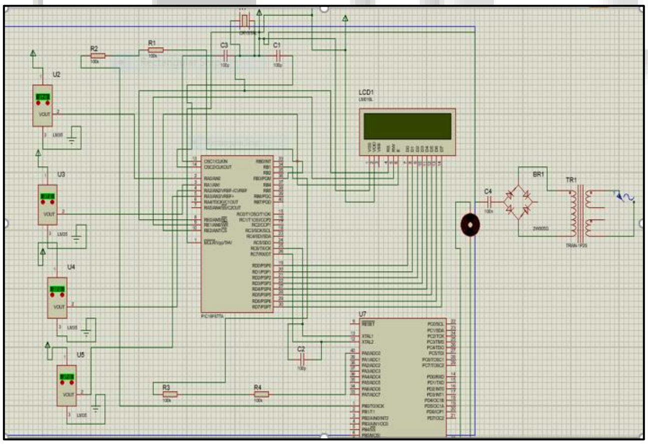


Fig. 12: Schematic Diagram of Circuit

IX. RESULTS & DISCUSSION

From the experimental analysis of monitoring distribution transformer size 0-12V, we get the following threshold values of various parameters:

- Nameplate rating of Distribution Transformer:
- KVA rating: 0-12V
- Threshold values:
- Temperature: 40oC
- Voltage: 6V
- Current: 5.9mA
- Oil level: 3ml

A. Hardware Assembling

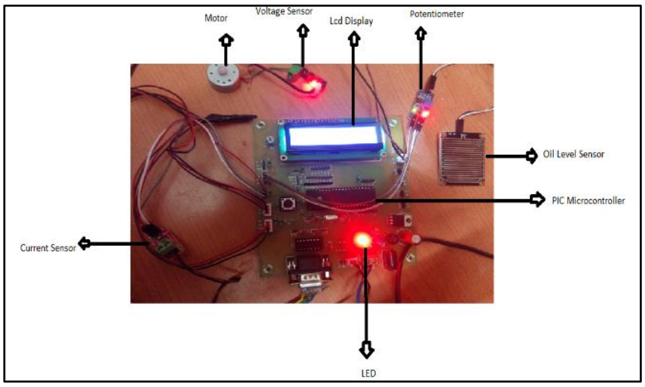
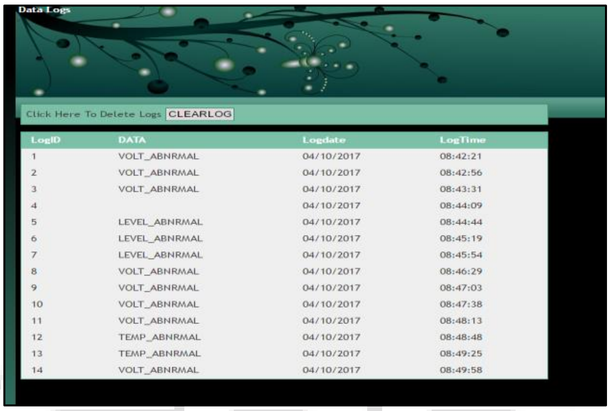


Fig. 13: Circuit Assembling

B. When abnormalities occur for various parameters



Data Logs

Click Here To Delete Logs CLEARLOG

LogID	DATA	Logdate	LogTime
1	VOLT_ABNRMAL	04/10/2017	08:42:21
2	VOLT_ABNRMAL	04/10/2017	08:42:56
3	VOLT_ABNRMAL	04/10/2017	08:43:31
4		04/10/2017	08:44:09
5	LEVEL_ABNRMAL	04/10/2017	08:44:44
6	LEVEL_ABNRMAL	04/10/2017	08:45:19
7	LEVEL_ABNRMAL	04/10/2017	08:45:54
8	VOLT_ABNRMAL	04/10/2017	08:46:29
9	VOLT_ABNRMAL	04/10/2017	08:47:03
10	VOLT_ABNRMAL	04/10/2017	08:47:38
11	VOLT_ABNRMAL	04/10/2017	08:48:13
12	TEMP_ABNRMAL	04/10/2017	08:48:48
13	TEMP_ABNRMAL	04/10/2017	08:49:25
14	VOLT_ABNRMAL	04/10/2017	08:49:58

Fig. 14: Screenshot of data logs on monitoring screen

C. Analysis Graph of various parameters

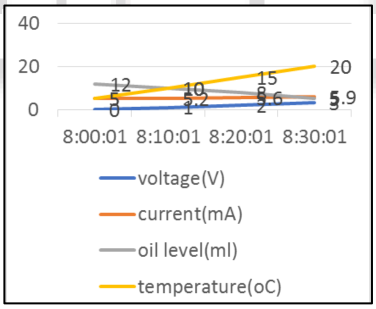


Fig. 15: Analysis Graph for data monitoring

X. CONCLUSION

The IoT-based monitoring of distribution transformer is quite useful as compared to manual observing and also it is reliable as it is not possible to monitor always the oil level, oil temperature rise, ambient temperature rise, load current manually. As abnormalities occur, it will automatically send data to the system in EB department, and they can take necessary action.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to my guide Dr. Diwakar R. Marur, his valuable guidance, consistent encouragement, personal caring, timely help and providing us with an excellent atmosphere for doing research.

REFERENCES

[1] E Kolyanga, ES Kajuba and R Okou "Distribution transformer monitoring and control system remote electric power grids through GSM," International Journal of Modern trends in engineering and research, vol. 03, no. 01, Jan 2016.
[2] Abel A. B. Gehm, Josemar O. Quevedo, Mário L., "A Low-Cost GPRS Based Communication System for a Smart Transformer," International Journal of Scientific and Engineering Research, vol. 4, no. 6, June 2013.
[3] Abdul-Rahman AI-Ali, Abdul Khaliq & Muhammad, “GSM-Based Distribution Transformer Monitoring System,” IEEE MELECON 2004, May 2004, Dubrovnik.
[4] Mohamed Ahmed, Eltayeb Ahmed & Elmustafa Hayati, “Design and implementation of Low-Cost SMS Based Monitoring System of Distribution Transformers,” Conference of Basic Sciences and Engineering Studies, 2016.
[5] Jouni K. Pylyanainent, Kirsi Nousiainen, “Studies to Utilize Loading Guides and ANN for Oil- Immersed Distribution Transformer Condition Monitoring, “IEEE Trans. Power Delivery, VOL. 22, no. 1, Jan 2007.