Real Time Transformer Health Monitoring System using IOT Technology

V. Sanjeeya
UG Student
Department of Computer Science & Engineering
Valliammai Engineering College, Tamil Nadu, India

E. Ramyashankari
UG Student
Department of Computer Science & Engineering
Valliammai Engineering College, Tamil Nadu, India

M. Sakthi Kannan
UG Student
Department of Computer Science & Engineering
Valliammai Engineering College, Tamil Nadu, India

A. Vidhya
Associate Professor
Department of Computer Science & Engineering
Valliammai Engineering College, Tamil Nadu, India

Abstract

Here this document presents design and implementation of a mobile embedded system to measure load currents, over voltage, transformer oil level and oil temperature. This is implemented by using on-line measuring system using Internet of Things (IOT), with single chip Arduino microcontroller and sensors. It is installed at the distribution transformer site. The output values of sensors are processed and recorded in the system memory. System programmed with some predefined instructions to check abnormal conditions. If there is any abnormality on the system, details are automatically updated in the internet through serial communication. This Internet of Things (IOT) will help the utilities to optimally utilize transformers and identify problems before any catastrophic failure occurs. Thus online-measuring system is used to collect and analyze temperature data over time. So Transformer Health Measuring will help to identify or recognize unexpected situations before any serious failure which leads to a greater reliability and significant cost savings.

Keywords: Distributed Transformer, Arduino, Sensors, IOT, Microcontroller

I. INTRODUCTION

Electricity plays an important role in our life. Every moment of our life depends upon electricity. Electricity has several components and equipment helping human to transfer and regulate the distribution according to usage. The most crucial equipment of transmission and distribution of electric power is transformer. In Power system, an electrical component transformers directly distributes power to the low-voltage users and its operation condition is an criteria of the entire network operation...The majority of the devices have been in service for many years in different(electrical, mechanical, environmental)conditions. They are the main components and constitute the large portion of capital investment. Operation of distribution transformer under rated condition (as per specification in their name plate) guarantees their long service life. However their life is significantly reduced if they are subjected to overloading, heating low or high voltage current resulting in unexpected failure and loss of supply to a large number of customers thus is effecting system reliability. Overloading, oil temperature load current and ineffective cooling of transformer are the major cause of failure in distribution transformer. As a large number of transformers are distributed over a wide area in present electric systems, it's difficult to measure the condition manually of every single transformer. So we need a distribution transformer system to monitor all essential parameters operation, and send to the monitoring system in time. It provides the necessary information about the health of the transformer. This will help and guide the utilities to optimally use the transformer and keep this equipment in operation for a longer period.

II. MAJOR CAUSE OF THE TRANSFORMER

A. Oil Leakage:

Oil in addition to serving as insulating means serves to transfer the heat generated in the windings and the core toward the walls of the tank and the radiators. Due to this it has:

- High dielectric breakdown
- Low viscosity

If the oil leaks from the transformer tank due to some reason, the oil level in the tank will drop. In the worst case, the connections to bushings and parts of the winding will get exposed to air. This will increase the temperature of the windings. This in turn, would damage the insulation of the winding. Apart from this moisture can get in through the leak, and degrade the transformer oil – leading to an overheated transformer. In power transformer, the conservator tank is provided with an oil level indicator having an alarm facility. If the oil level drops below a predetermined level, the alarm will ring. It allows the operator to initiate necessary

actions. But in distribution transformer, oil level indicator with alarm facility is not provided. Only a small transparent window (gauge) placed conservator tank to see the oil level is provided. It shows the level of the oil directly, being able to see from the outside. When the crystal is dirty, you can wipe it off with a rag. Periodic checking of this window is not done in India. So, many of small transformers fail due to decrease in oil level.

B. Overloading:

This category pertains to those cases where actual Overloading could be established as the cause of the failure. It includes only those transformers that experienced a sustained load that exceeded the nameplate capacity.
Often, the overloading occurs when the plant or the utility slowly increases the load in small increments over time. The capacity of the transformer is eventually exceeded, resulting in excessive temperature that prematurely ages the insulation. As the transformer's paper insulation ages, the strength of the paper is reduced. Then, forces from an outside fault may cause a deterioration of the insulation, leading to failure.

C. Failure Due to Bad Insulation of Conductor:

Various types of insulation are used as coverings of conductors. The type of covering depends upon the type of use and basic insulation of the transformer. It is very common to see a conductor with lost wrapping. Also, the conductors have single covering instead of double covering. The quality of paper is also one of the causes of failure. The workmen should be properly trained for proper insulation of winding – and identity bad material of insulation during the process of coil making…

III. REQUIREMENT SPECIFICATION

A. Software Requirements:

The software requirements document is the specification of the system. It should include both a definition and a specification of requirements. It is a set of what the system should do rather than how it should do it. The software requirements provide a basis for creating the software requirements specification. It is useful in estimating cost, planning team activities, performing tasks and tracking the teams and tracking the team's progress throughout the development activity.
Tool: ARDUINO IDE, PROTEUS
1)Arduino IDE:
The Arduino Integrated Development Environment or Arduino Software (IDE)contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.
2)Proteus:
Proteus is a software technology that allows creating clinical executable decision support guidelines with little effort. Once a guideline for a condition has been created, it can be executed to provide stepwise advice for any patient having that condition. This site is dedicated to the Proteus executable guidelines model, tools based on the Proteus approach and the automated guidelines created using those tools. A software tool that allows creating and executing clinical decision support guidelines using the Proteus approach is available. The tool called Protean may be downloaded from here. Protean allows creating new guidelines or editing existing ones very easily. Much of the editing is done by dragging and dropping. Proteus (Processes and Transactions Editable by Users) is a model that describes creation of clinical guidelines with Knowledge Components (KCs).Each KC represents a clinically identifiable activity and is available to the clinician as executable knowledge. Experts at disparate locations may manage the individual knowledge components, while the clinicians benefit from the state-of-the-art knowledge. Additionally, the KCs offer a template for capturing data pertaining to the clinical activity that they represent, to provide a basis for the EMR. Since the KCs represent discretely identifiable clinical activities they also allow attaching related elements from non-clinical processes. Each such non-clinical process can be assigned a separate layer, with components within it communicating with a logically related KC in the clinical guideline. This allows conceiving of an integrated healthcare information system with logically related parts and unlimited extensibility.

B. Hardware Requirements:

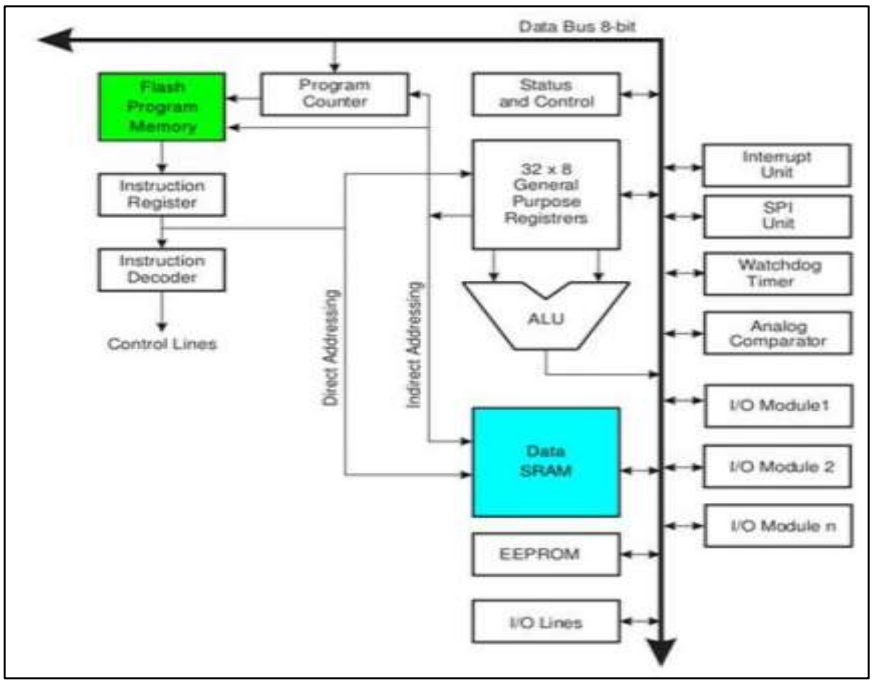
The hardware requirements may serve as the basis for a contract for the implementation of the system and should therefore be a complete and consistent specification of the whole system. They are used by software engineers as the starting point for the system design. It shows what the systems do and how it should be implemented.
The minimum hardware requirements are as listed below.

1) Arduino uno
2) Voltage Sensor
3) Temperature Sensor
4) Current Sensor
5) Ethernet shield
6) Ultrasonic Sensor

7) Relay
8) Power supply

1) Arduino Uno:

An Arduino is actually a microcontroller based kit which can be either used directly by purchasing from the vendor or can be made at home using the components, owing to its open source hardware feature. It is basically used in communications and in controlling or operating many devices. The Arduino Uno is a microcontroller board based on the

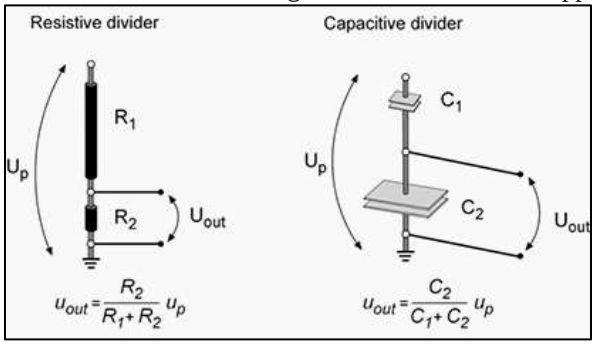


.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions.

2) Voltage Sensor

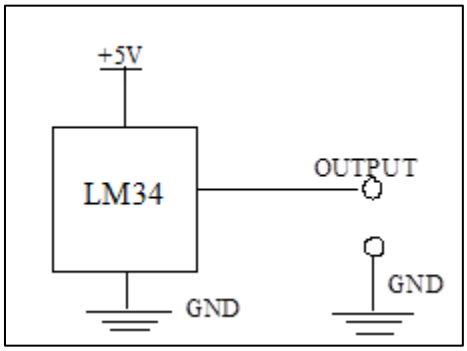
The voltage Sensor uses only electronic components. The voltage to be measured is directly applied to the sensor terminals: +HT (positive high voltage),-HT (negative high voltage or ground) the primary voltage going through an insulated Amplifier, is converted into the output current Is proportionally to the input signal. The power supply of the primary section of this sensor is galvanicly insulated. This principle is called static voltage sensing. The measurement of voltage is based on voltage divider. Two main types are available, namely the capacitive one and the resistive one. The output in both cases is a low-level voltage signal. The output is linear throughout the whole rated measurement range. The considerations and protection methods against the ferroresonance phenomena, discussed with traditional voltage transformers, are not applicable with voltage sensors.



3) Temperature Sensor

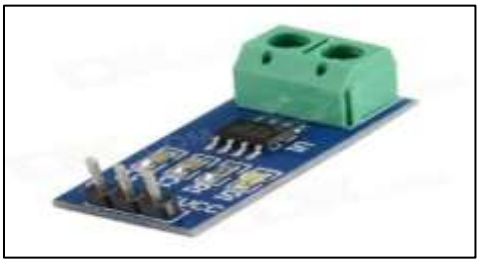
Temperature is the most-measured process variable in industrial automation. Most commonly, a temperature sensor is used to convert temperature value to an electrical value. Temperature Sensors are the key to read temperatures correctly and to control temperature in industrials applications. A large distinction can be made between temperature sensor types. Sensors differ a lot in properties such as contact-way, temperature range, calibrating method and sensing element. The temperature sensors contain a sensing element enclosed in housings of plastic or metal. With the help of conditioning circuits, the sensor will reflect the change

of environmental temperature. In the temperature functional module we developed, we use the LM34 series of temperature sensors. The LM34 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Fahrenheit temperature. The LM34 thus has an advantage over linear temperature sensors calibrated in degrees Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Fahrenheit scaling. The LM34 does not require any external calibration.



It is easy to include the LM34 series in a temperature measuring application. The LM34 series is available packaged in hermetic TO-46 transistor packages, while the LM34C, LM34CA and LM34D are also available in the plastic TO-92 transistor package

4) Current Sensor



A current sensor is a device that detects electric current (AC or DC) in a wire, and generates a signal proportional to it. The generated signal could be analog voltage or current or even digital output. It can be then utilized to display the measured current in an ammeter or can be stored for further analysis in a data acquisition system or can be utilized for control purpose.

5) Ultrasonic Sensor

Ultrasonic sensors work on a principle similar to sonar which evaluates distance of a target by interpreting the echoes from ultrasonic sound waves. This ultrasonic module measures the distance accurately which provides 0cm - 400cm with a gross error of 3cm. Its compact size, higher range and easy usability make it a handy sensor for distance measurement and mapping. The module can easily be interfaced to micro controllers where the triggering and measurement can be done using two pin. The sensor transmits an ultrasonic wave and produces an output pulse that corresponds to the time required for the burst echo to return to the sensor. By measuring the echo pulse width, the distance to target can easily be calculated.

a) Male Connector Side:

Pin No.	*Signal*
1	*VCC (5V supply)*
2	*Trigger Pulse Input*
3	*Echo Pulse Output*
4	*GND (0V)*

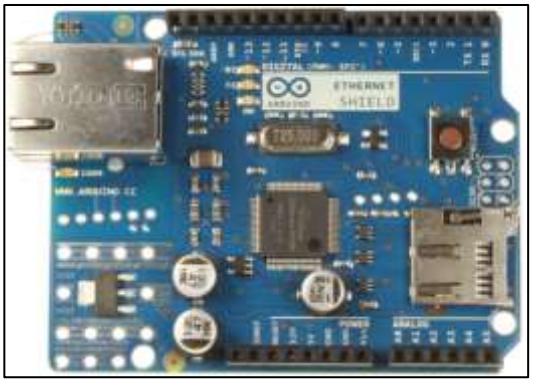
b) Specifications:

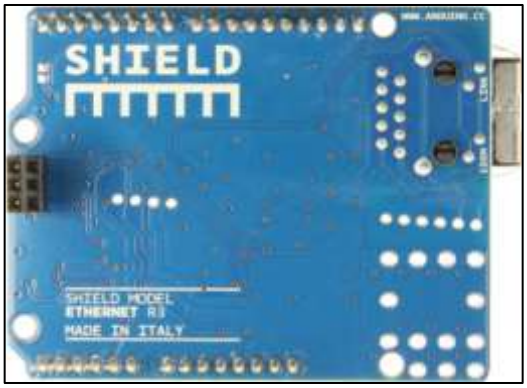
Parameter	Specification
Dimensions	45 x 20 x 15 mm
Pin-out Pitch	2.54mm male berg
Interface	VCC, GND, SDA,SCL

6) Ethernet Shield

The Arduino Ethernet Shield R3 (assembled) allows an Arduino board to connect to the internet. It is based on the Wiz net W5100 Ethernet chip (datasheet). The Wiz net W5100 provides a network (IP) stack capable of both TCP and UDP. It supports up to four

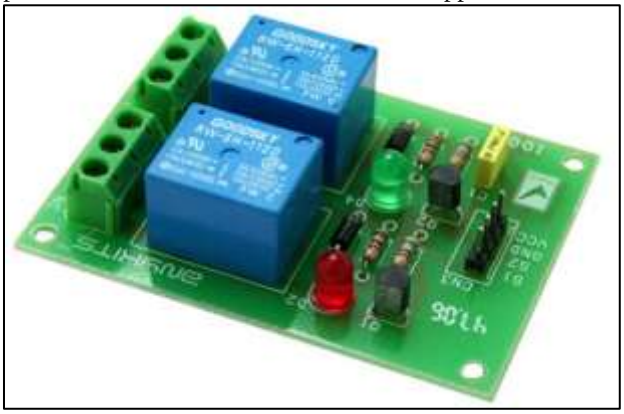
simultaneous socket connections. Use the Ethernet library to write sketches which connect to the internet using the shield. Ad fruit started shipping the R3 version on Feb. 3, 2012 at 3:30pm ET. The Arduino Ethernet Shield connects your Arduino to the internet in mere minutes. Just plug this module onto your Arduino board, connect it to your network with an RJ45 cable (not included) and follow a few simple instructions to start controlling your world through the internet. As always with Arduino, every element of the platform – hardware, software and documentation – is freely available and open-source. This means you can learn exactly how it's made and use its design as the starting point for your own circuits. Hundreds of thousands of Arduino boards are already fuelling people's creativity all over the world, everyday.





7) Relay

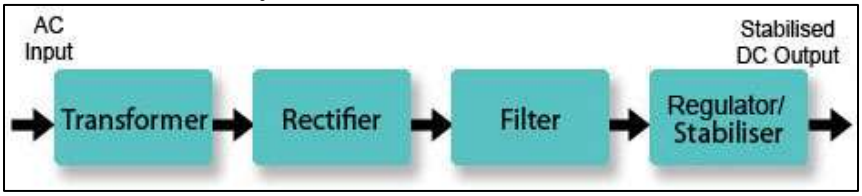
We know that most of the high end industrial application devices have relays for their effective working. Relays are simple switches which are operated both electrically and mechanically. Relays consist of an n electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. There are also other operating principles for its working. But they differ according to their applications. Most of the devices have the application of relays.



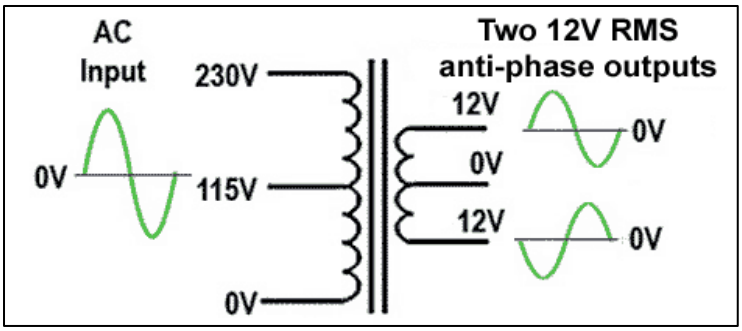
The main operation of a relay comes in places where only a low-power signal can be used to control a circuit. It is also used in places where only one signal can be used to control a lot of circuits. The application of relays started during the invention of telephones. They played an important role in switching calls in telephone exchanges. They were also used in long distance telegraphy. They were used to switch the signal coming from one source to another destination. After the invention of computers they were also used to perform Boolean and other logical operations. The high end applications of relays require high power to be driven by electric motors and so on. Such relays are called contactors.

8) Power Supply

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

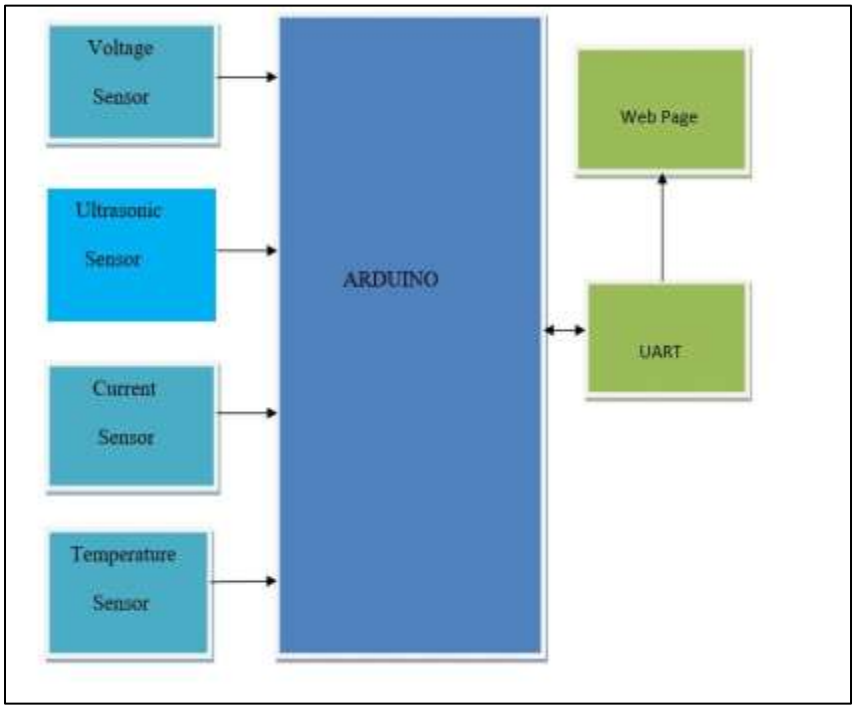


C. Transformers



Basic power supply the input power transformer has its primary winding connected to the mains (line) supply. A secondary winding, electro-magnetically coupled but electrically isolated from the primary is used to obtain an AC voltage of suitable amplitude, and after further processing by the PSU, to drive the electronics circuit it is to supply. The transformer stage must be able to supply the current needed. If too small a transformer is used, it is likely that the power supply's ability to maintain full output voltage at full output current will be impaired. With too small a transformer, the losses will increase dramatically as full load is placed on the transformer. As the transformer is likely to be the most costly item in the power supply unit, careful consideration must be given to balancing cost with likely current requirement. There may also be a need for safety devices such as thermal fuses to disconnect the transformer if overheating occurs, and electrical isolation between primary and secondary windings, for electrical safety.

D. Architecture Design:



IV. LANGUAGE SPECIFICATION

A. Embedded C

As assembly language programs are specific to a processor, assembly language didn't offer portability across systems. To overcome this disadvantage, several high level languages, including C, came up. Some other languages like PLM, Modula-2, Pascal, etc. also came but couldn't find wide acceptance. Amongst those, C got wide acceptance for not only embedded systems, but also for desktop applications. Even though C might have lost its sheen as mainstream language for general purpose applications, it still is having a strong-hold in embedded programming. Due to the wide acceptance of C in the embedded systems, various kinds of support tools like compilers & cross-compilers, ICE, etc. came up and all this facilitated development of embedded systems using C. Embedded C is a set of language extensions for the C programming language by the C Standards Committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming

requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations. In 2008, the C Standards Committee extended the C language to address these issues by providing a common standard for all implementations to adhere to. It includes a number of features not available in normal C, such as, fixed-point arithmetic, named address spaces, and basic I/O hardware addressing. Embedded C uses most of the syntax and semantics of standard C, e.g., main() function, variable definition, data type declaration, conditional statements (if, switch case), loops (while, for), functions, arrays and strings, structures and union, bit operations, macros, etc. Embedded C Programming is the soul of the processor functioning inside each and every embedded system we come across in our daily life, such as mobile phone, washing machine, and digital camera. Each processor is associated with an embedded software. The first and foremost thing is the embedded software that decides functioning of the embedded system. Embedded C language is most frequently used to program the microcontroller.

V. CONCLUSION

The proposed technique with results has shown that the protection scheme works properly with accuracy, sensitivity of this scheme is very high for the abnormal and faulty conditions. Transformer Health Monitoring will help to identify or recognize unexpected situations before any serious failure which leads to greater reliability and significant cost savings. If transformer is in abnormal condition we can know from anywhere. No human power need to monitor the transformer. Details about the transformer are automatically updated in webpage when the transformer is in abnormal condition.

REFERENCES

[1] Ravishankar Tularam Zanzad, Prof. Nikita Umare and Prof Gajanan Patle ,"ZIGBEE Wireless Transformer Monitoring, Protection and Control System",International Journal of Innovative Research in Computer and CommunicationEngineering (An ISO 3297: 2007 Certified Organization), Vol. 4, Issue 2,February 2016.
[2] Monika Agarwal and Akshaypandya, "GSM Based Condition Monitoringof Transformer", IJSRD - International Journal for Scientific Research &Development| Vol. 1, Issue 12, 2014 | ISSN (online): 2321-0613
[3] Hongyan Mao, "Research of Wireless Monitoring System in PowerDistribution Transformer Station Based on GPRS", Volume 5, C 2010 IEEE,978-1-4244-5586-7/10/$26.00
[4] Drasko Furundzic, Zeljko Djurovic, Vladimir Celebic, and Iva Salom,"Neural Network Ensemble for Power Transformers Fault Detection",11thsymposium on Neural Network Applications in electrical EngineeringNEUREL-2012
[5] Kalyani More, Ashwini Khaire, Sudhir Khalkar and P.G Salunke, "XBEEBased Transformer Protection and Oil Testing", International Journal ofScientific Research Engineering & Technology (IJSRET), ISSN 2278 – 0882 Volume 4, Issue 3, March 2015.
[6] Satya Kumar Behera,Ravi Masand and Dr. S. P. Shukla, "A Review ofTransformer Protection by Using PLC System", International Journal ofDigital Application & Contemporary research, (Volume 3, Issue 2, September2014)
[7] Pathak A.K, Kolhe A.N, Gagare J.T and Khemnar SM, "GSM BasedDistribution Transformer Monitoring And Controlling System" , Vol-2 Issue-2 2016, IJARIIE-ISSN (O)-2395-4396.
[8] Xiao-hui Cheng and Yang Wang, "The remote monitoring system oftransformer fault based on The internet of Things", 2011 InternationalConference on Computer Science and Network Technology
[9] D S Suresh, Prathibha T and Kouser Taj, "Oil Based Transformer HealthMonitoring System", International Journal of Science and Research (IJSR)ISSN (Online): 2319-7064 Impact Factor (2012): 3.358 Volume.
[10] Vishwanath R, Akshatha V Shetty, Poonam, Shamilli and M Thanuja ,"A New Approach to monitor Condition of Transformers incipient fault