# IoT Based Transformer Monitoring System

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*Abstract*— Distribution transformers are one of the most important equipment in power network. Because of, the large amount of transformers distributed over a wide area in power electric systems, the data acquisition and condition monitoring is important issue. The main aim of this system is distribution transformer monitoring and controlling through IOT. Also, it sends SMS to a central database via the GSM modem for further processing. The idea of on-line monitoring system mixes a global service mobile (GSM) Modem, with chip micro controller and different sensors. It is installed at the distribution transformer site and the above parameters are recorded using the analog to digital converter (ADC) of the embedded system. The obtained parameters are processed and recorded in the system memory. If any deviation or an emergency situation occurs the system sends SMS (short message service) messages to the mobile phones containing information about the deviation according to some predefined instructions programmed in the micro controller.

***Key words:*** IoT (Internet of Things), GSM, Micro Controller, Sensors

## I. INTRODUCTION

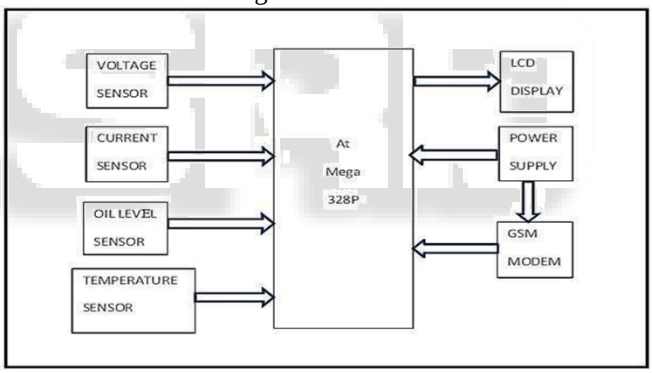
In power system network distribution transformer is electrical equipment which distributes power to the low-voltage users directly and its operating condition is a vital part of the operation of distribution network. Operation of distribution transformer under rated condition assurances their long life. However, their life is significantly reduced if they are subjected to overloading condition, resulting in sudden failures and loss of supply to a large number of customers thus affecting system reliability. Overloading and rise in oil & winding temperature of transformer are the major causes of failure in distribution transformers.

The GSM based monitoring of distribution transformer is rather useful as compared to the manual operating system. In case of manual monitoring system it is not possible to monitor the oil level, rise in oil temperature, rise in ambient temperature, load current frequently. After receiving the message of any deviation, it can easily take action immediately to check any failure of distribution transformers. In a distribution network system there are many distribution transformers and connecting each transformer with such system can easily figure out faulty transformer from the message sent to mobile, thereby no need of checking all transformers phase current and voltage and thus it can improve the system in less time. Our system is designed based upon online monitoring of key Operational parameters of distribution transformers can provide useful Information about the health of transformers which will help the utilities to Optimally use their transformers and keep the asset in operation for a longer Period.

## II. PROPOSED SYSTEM

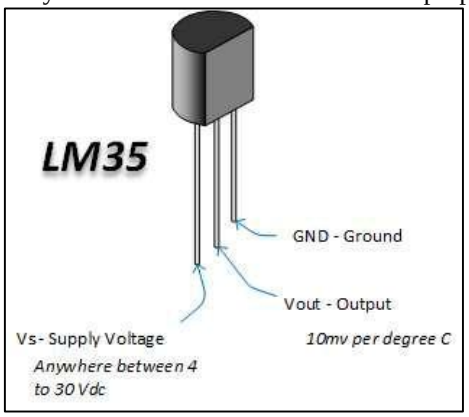
Smart grid, the next generation electric power system is actual way of digital transmission of electricity. It is digital technology that allows resourceful two way communications between utility and customers. It provides a system model that will monitor critical parameters such as current, voltage, power and temperature. A smart grid uses digital technology to improve reliability, security and efficiency of the electric system.

A system is designed to improve the power quality and reliability of power supply. Using smart grid based sensors like current, voltage and temperature sensor along with IOT wireless communication protocol real time monitoring of Power line parameters like voltage, current, temperature etc. can be carried out. These sensors qualify the remote monitoring of equipment such as transformers and power lines. They are improving the performance and extending the life of grid components to ensure a safe and reliable operation of the electricity network. This system will help us to identify problems before any shattering Failure, thus resulting in a long life service for transformers. In transformer monitoring system we used four sensors for monitoring that is voltage sensor, current sensor, temperature sensor and oil level sensor. We used power supply to operate micro controller AT mega 328P and GSM module.




## III. VOLTAGE SENSOR

A voltage sensor is a device which detects the voltage in a wire, and generates 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 voltage in a voltmeter or can be stored for further analysis in a data acquisition system or can be utilized for control purpose.



## IV. 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.


## V. OIL LEVEL SENSOR

Oil level sensor is a device which is used to check the oil level in the transformer. Due to overheating the oil start to evaporate and the oil level decreases and thus this decrease in the oil level may be dangerous to the transformer.

Thus this sensor indicates the level and we get aware about the level. Thus we can look over the oil viscosity also.

## VI. TEMPERATURE SENSOR

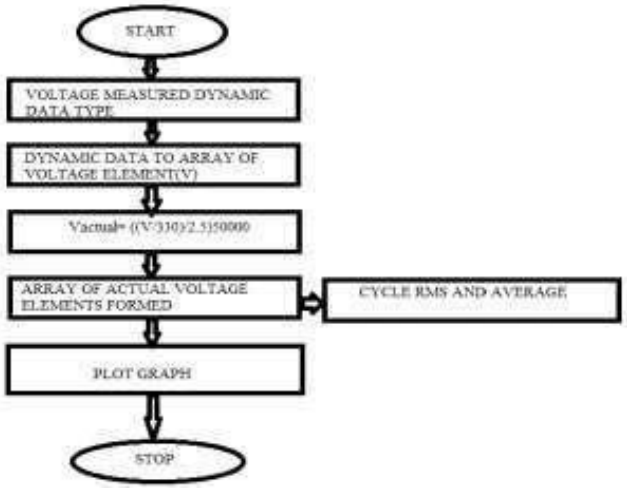
Temperature sensor vary from simple ON/OFF thermostatic devices which control a domestic hot water heating system to highly sensitive semiconductor types that can control complex process control furnace plants. We remember from our school science classes that the movement of molecules and atoms produces heat (kinetic energy) and the greater the movement, the more heat that is generated. Temperature Sensors measure the amount of heat energy or even coldness that is generated by an object or system, allowing us to "sense" or detect any physical change to that temperature producing either an analogue or digital output.

There are many different types of Temperature Sensor available and all have different characteristics depending upon their actual application.


***Thermistor***

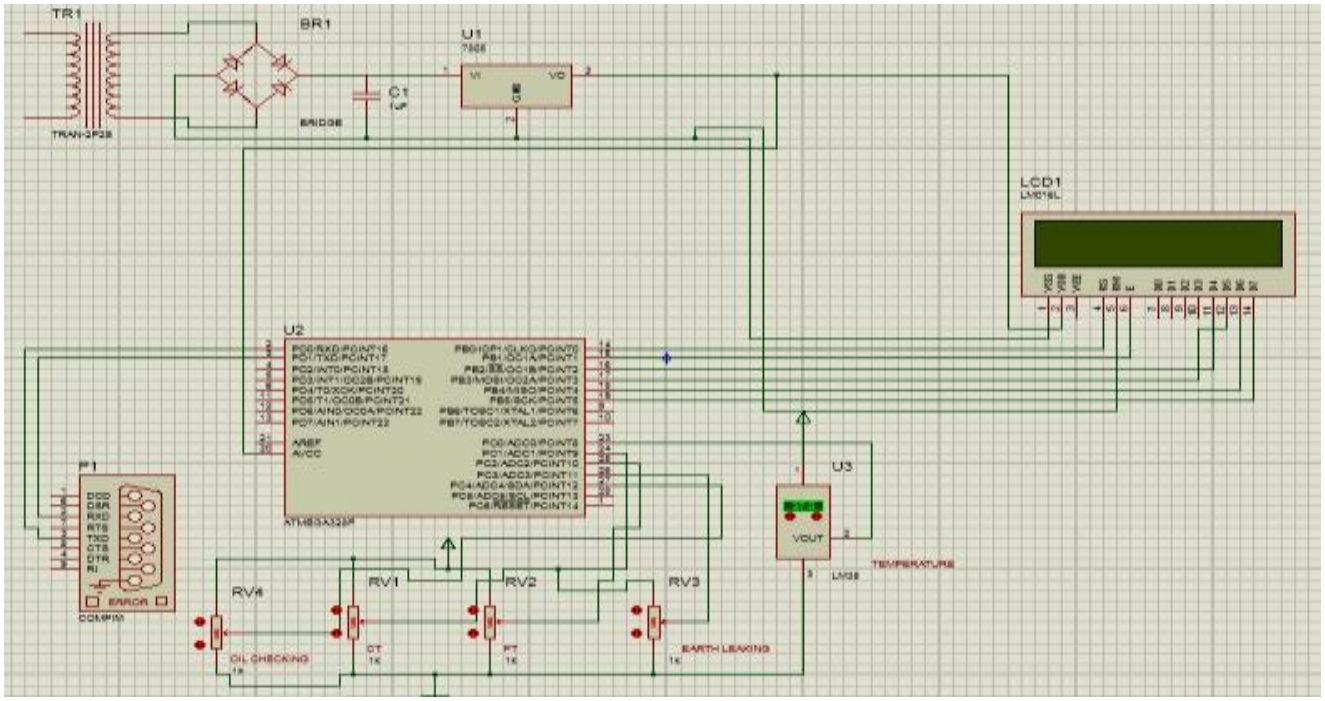


The display used is 16x2 LCD (Liquid Crystal Display); which means 16 appeals per line by 2 lines. The standard is referred as HD44780U, which refers to the controller chip which receives data from an external source (Here Atmega328) and transfers directly with the LCD. Here 8-bit mode of LCD is used, i.e., using 8-bit data bus. i.e., using 8-bit data bus. The LCD's used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCD's being extensively used in telecommunications and entertainment electronics.



## VII. CIRCUIT DIAGRAM OF THE MODEL




The programming is done in embedded C language then with the help of MPLAB software compilation of the C program converts into machine language file (.hex) which is required for micro controller. This is the only language the micro controller will understand and then design micro controller based circuit diagram on PROTEUS software. The voltage we get from the main supply is 230V AC but the other components of the circuit require 5V DC. Hence we get 12V AC by using step-down transformer which is later converted to 12V DC using a rectifier but output of rectifier still contains some ripples due to Pulsating DC. To remove the ripples and obtain smoothed DC power filter circuits are used. The 12V DC is rated down to 5V using a positive voltage regulator (chip 7805). Thus a fixed DC voltage of 5V is obtained.

The system hardware has four hardware modules like iot system, GSM modem, mobile users & GSM networks and PC-based server. The module is located at the site of transformer. It is utilized to acquire process and display as well as transmit and receive the parameters from the GSM modem. The second is the GSM module is the link between the embedded system and the public GSM network. Then third is utility module that has a PC-based -server located at the utility control center. Then server is attached to GSM modem and received SMS from the transformer site via the GSM module.

Detailed specifications & functions of each module are described as follows: The system module has two blocks: Signal Conditioning Circuit block and Controller block. The SCC block reads the currents, voltages, temperatures from sensors. Then it converts each reading to a compatible signals that can be read by the embedded system built-in ADC (0-5 volts DC). Each circuit has two Op-amps & set of resistors to adjust the gain and the offset. The current & voltage SCC have small transformers and rectifier circuits that convert and scale the current and voltage values to be compatible levels with the Op Amps circuits. The controller block consists of an 8-bit micro controller that has 8-channel analog to digital converter (ADC) & several digital input/output ports. The ADC is used to read the parameters, which are built-in EPROM is used to host the embedded software algorithm that takes care of the parameters acquisition, processing, displaying, transmitting & receiving. The built-in EEPROM is used to save the online measured parameters along with their hourly& daily averages

## VIII. WIRELESS MODEM

Modems which use a mobile telephone system (GSM, GPRS or UMTS etc.), are known as mobile broadband modems (sometimes also called wireless modems). USB wireless modems use a USB port on the laptop instead of a PC card or Express Card slot. Most of GSM wireless modems come with an integrated SIM cardholder and some models are also provided with a micro SD memory . In this paper the wireless modem has used with RTU as well as the monitoring node. wireless modem is connected with simulated RTU circuit using RS232 cable and virtual serial port software to act as a GSM module. Also Monitoring node used wireless modem to send and receive SMS from RTUs.

## IX. MONITORING NODE OPERATIONS:

### *A. User access and authentication subsystem:*

User authentication system handles the process of allowing users to access the system and it deals with login table. Also administrator also uses this subsystem to add or delete users.

### *B. Communication:*

This part is responsible for establishing a connection with the communication media (USB wireless modem). Therefore, a port should be chosen in which the modem is connected. Then the baud rate, data bits, stop bit and other parameters of serial communication should be defined. The connection can then be established.

*C. Database manipulations:*

Addition, removal and updating of records are very important operations for system administrator in order to face the changes of RTUs. This part is responsible for query database to show its data, insert new RTU, delete or remove stations, update station name or address and add new user or changing the password or user name.

*D. Receiving data from RTUs:*

This is the main part of the monitoring node. It handles the received data, filters it and saves to the database. The idea behind this is: the system always listening and waiting for SMS messages come from the stations and when new message comes, the system will match the station name with station names listed in station database, and if it matches the system will filter and save data to the database inside the incoming data table

*E. Other features:*

There are other features of monitoring node system such as interrogate data from particular RTU anytime, show data in graphs, display the status of RTUs and saving important events in a log file for more security.

## X. MONITORING NODE TEST:

Testing is done through two stages. Firstly, the modem was connected to a computer and tested using Microsoft hyper terminal software to check the ability of modem to send and receive SMS messages using AT commands. Secondly, the modem and the monitoring node software were connected together via the USB port and few SMS messages were sent form mobile phone to the system to test the system.

*1) Modem Test*

SMS is sent / received from a computer using a USB wireless modem. For sending / receiving SMS messages, a valid SIM card was used for the modem, which is then connected to a computer. There are certain AT commands that can be used through Hyper Terminal software to send and receive SMS messages. The commands sent from hyper terminal to show the messages stored inside the wireless modem.

*Graphical User Interface Software Test* In this part, the GUI software is connected to wireless modem via USB port. Then few SMS messages were send and receive to check the response of the system. The format of the messages came from RTUs are following this format "Voltage; Current; Power; Temperature; hours ; minutes ;seconds; month; day; year". All other GUI functions were tested one by one. the GUI software at monitoring node.

## XI. CONCLUSION

The IOT wireless open typical technology is being designated in this project as the energy management and efficiency technology of choice. Employing the system for real time monitoring of power line with an open standard such as iot helps to keep costs down and condensed power consumption. It is clear from the experimentation's that the wireless sensor networks may be successfully employed to smart grids for monitoring resolve. For large scale deployment, cost effective power monitoring system is essential, which requires are liable and low cost WSN mote design.

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