GSM BASED MONITORING AND PROTECTION OF DISTRIBUTION TRANSFORMER

Author
GC Sahil
GC Nad-eAli
GC M Ali
GC Farhat Hussain

Supervisor
Major Ajlaan Bin Mamoon

Submitted to the faculty of Department of Electrical Engineering,
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CERTIFICATE OF CORRECTIONS & APPROVAL

Certified that work contained in this thesis titled "GSM BASED MONITORING AND PROTECTION OF DISTRIBUTION TRANSFORMER**", carried out by GC Sahil GC Nad-eAli GC M Ali and GC Farhat Hussain under the supervision of Major Ajlaan Bin Mamoon for partial fulfillment of Degree of Bachelors of Electrical Engineering, in Military College of Signals, National University of Sciences and Technology, Islamabad during the academic year 2019-2020 is correct and approved. The material that has been used from other sources it has been properly acknowledged / referred.**

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00199953

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Acknowledgements

In the name of God, the most kind and most merciful.

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I am grateful to the God Almighty who provides all the resources of every kind to us, so that we make their proper use for the benefit of mankind. May He keep providing us with all the resources, and the guidance to keep helping the humanity.

Abstract

The traditional electricity grid system has proved to be incompetent with the growing energy needs. In order to provide reliable operations and uninterrupted electric power supply to consumers connected in the electricity grid system, there is a strong need to upgrade the traditional electricity grid with the modern generation of grids that are equipped with communication technologies and vast deployment of sensors. Since the distribution transformers have an essential role in delivering electricity to the consumers, distribution transformer must be operated under rated conditions. In this regard, the reliable operation and cost savings can be made by monitoring the distribution transformer before any fault occurrence. This project provides the design and implementation of hardware to monitor the useful parameters such as ambient temperature, load currents, over voltage and oil level of the distribution transformer. The monitored data obtained from the remotely located distribution transformers is send to the mobile operator using GSM technology. If any abnormalities are investigated in the received parameters of distribution transformers, then SMS and call is made to the mobile engineer to take necessary action so that uninterrupted power supply is ensured to electricity consumers.

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1 Introduction

In power systems, distribution transformer is essential electrical equipment which distributes power to the low-voltage users. Therefore, proper operation of distribution transformer is very important for efficient power distribution. The lifetime of distribution transformer can be increased by operating it under rated conditions. The performance of distribution transformer is severely affected if it is subjected to any abnormalities such as over loading, reduced oil-level etc. The electric power deficiency and various malpractices followed in Pakistan has led to frequent power failures among which distribution transformer over loading is main issue . Although several monitoring systems are used by electric utility companies, however, they are not efficient. Therefore, real time monitoring of distribution transformer is a crucial task for reliable operation of power system [The status of distribution transformer is then transmitted to control center for necessary actions.

1.1 Overview

Distribution transformer is the main equipment in the power system. The main purpose of this project is real time monitoring of distribution transformer. Real time monitoring of distribution transformer is performed by deploying sensors which continuously examine the parameters such as over voltage, oil-level etc. The monitored data from distribution transformer is processed by microcontroller module which further transmits this data to the GSM module located at control center. Based on received data, the abnormalities in voltage, current and temperature overcome by the central control system by performing necessary action against the abnormality.

1.2 Project Scope

The real time monitoring of the distribution transformer increases the reliability of power distribution network and save extra cost needed for changing and replacing distribution transformer. There are many other methods to monitor transformer, but these are inefficient as they do not provide timely information of distribution transformer.

1.3 Motivation

The traditional electric power system has proved to be incompetent. Therefore, it is necessary to improve the outdated electric power system using an appreciable

network. In this prospective sensors and communication infrastructure can enhance the efficiency of traditional power systems, by deployment of sensors at various stage of power system [1]. Since distribution transformer is an expensive part of the power system, effort is required to enhance the reliability and long-life operation of distribution transformer [2]. This project provides a solution to over loading and over voltage issues frequently countered in distribution transformer by utilizing temperature and voltage sensors. The acquired data from the sensors is forward to the central system where decisions are made to overcome abnormality [3], [4].

1.4 Problem statement

Distribution transformers are one of the major parts of electric power system. The main problem that Pakistan is facing now-a days and in past is that how to overcome with the issue of electricity over loading which causes fatal damage to distribution transformers [10]. GSM based monitoring of distribution transformers is a cheap and reliable source to overcome with these problems. It provides real-time monitoring and reliable solution to the inherent in distribution transformer operation. This gives in-time alert regarding any problem such as temperature abnormality, over voltage and oil level etc.

2 Literature Review

This chapter provides a literature review of different modules utilized in this project.

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2.1 Arduino Mega

The Arduino Mega 2560 is an exclusive board designed microcontroller, developed and engineered on the principles of ATmega2560 (datasheet).It is designed to have 54 digitalized input/output pin layout formation out of these 54 pins,14 pins are specifically being used for Pulse Width Modulation output (for the purpose of getting analog output with digital based means) . Separated 16 pins for Input of analog based Data entry ,4 pins designated for UARTs (serial ports of hardware nature),for oscillation(clock speed) a crystal Oscillator of 16 MHz is used , a USB port for connecting USB cable , an electric power supply jack , a header for In-circuit Serial Programming, and finally a button working as built-in reset for microcontroller. It is completely fuel-packed and provides optimal support to microcontroller; to get started user can either connect it to a computer by simply using a USB cable or power it by connecting AC to DC Adaptor, battery set up can also be used. This distinctively invented microcontroller is completely in harmony with almost all the shields that are designed for the Arduino Duemilanove or Diecimila.

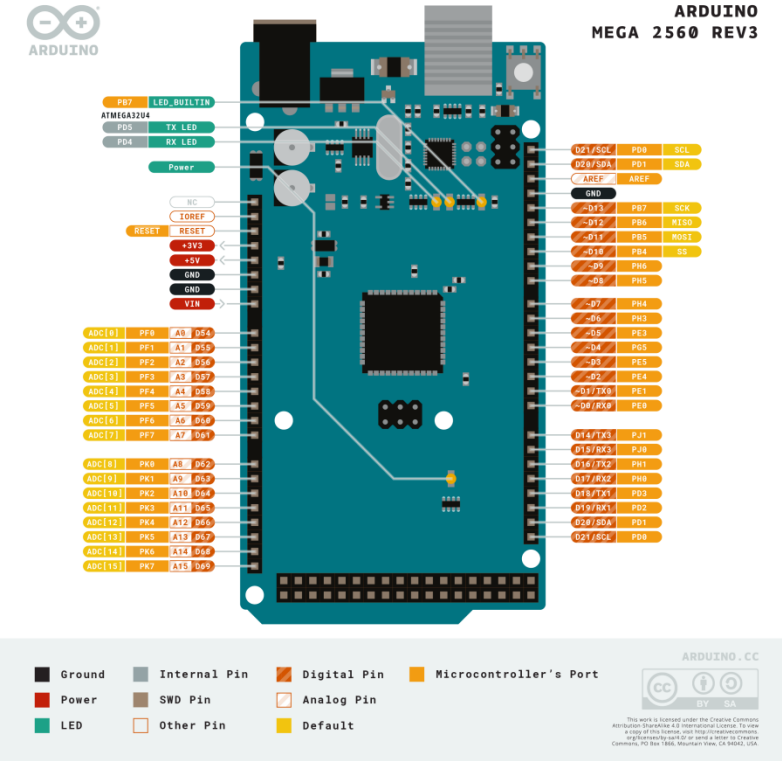

Figure 2.1

2.1.1 Working

Electric Power

The microcontroller board (Arduino Mega 2560) can be connected to electric power through diverse and numerous ways and methods. Some of the ways are mentioned below:

- Via linking the board to a system mainly computer through USB cable.
- Via attaching AC to DC adapter to power jack.
- Via using external energy source mainly battery set.

→ **External**

Through electric power adapter or battery powered energy we can provide external energy source to our microcontroller board. To connect our power adaptor with the board, we will need a 2.1mm center-positive header cable, which can be simply be attached and plugged into built-in power jack given on board's surface. A battery

can be easily connected by embedding the positive and negative wires in the Voltage Input and Ground pin headers of the board, respectively.

By providing/supplying an external source energy of 6 to 20 V our microcontroller board can function optimally. If the provided supply is less than 7V then the other 5V pin may cause the board to go unstable by supplying less than five volts. User should maintain the voltage because 12V or above can cause the voltage regulator of microcontroller to overheat. The optimal functional voltage is 7 to 12 volts.

The innovative Change in Mega2560 microcontroller board is that it is not functional with **F**uture **T**echnology **D**evices **I**nternational USB to Serial Driver chip Rather it astonishes user by providing work environment with ATmega8U2 as USB-to-Serial converter.

The power pins are as follows:

VIN	Primary source of Voltage Input while using external powering supply (rivaled to 5V the USB or the sync energy source). User can provide voltage through this pin, or powering up through the power jack, allowed through this pin.
5V	The synchronized energy source for powering up microcontroller and other built-in embedded components on the board. It can be from VIN or regulated external 5V supply.
3V	Generated by built on Regulator with a potential max current draw of 47.5~50mA.
GND	Pin used for ground.

Memory

Our microcontroller has been assigned a flash memory of 256Kbyte which is solely for the purpose of saving the coded data entry by the User. Out of this 256Kbyte, 64Kbits are made available to the bootloader working mechanism, another 64Kbits are designated for SRAM and 32Kbits are allocated for the use of EEPROM (which is simply readable/writable with library).

Input and Output

“The 54 pins designed and engineered on board of ATmega2560 can be used as digitalized Input and Output source. They need a 5V energy supply to function optimally. Every pin on board is potentially able to transmit, sustain and

collect(receive) a maximum of 0.038~0.04A and has an interior draw up resistor (separated as a matter of course) of 20-47.5~50KΩ. Furthermore, some of specific pins have exclusive and unique functionalities:

- In order to achieve serial communication 2xSerial pins namely RXD and TXD, the specific pins that provide user with the ability to receive and transmit data of serial nature, where Rx indicates the receiving of information while on the other hand Tx indicates the transmission of information. These special serial pins use an exclusive four combination working methodology.

- To achieve External Interrupt, the user is given 6 pins to fulfill the functionality process.

There are numerous ways in which these pins function to generate interrupts for example supplying extreme (LOW) utility number, increasing/decreasing margin, altering the values to these pins.

The ATmega2560 has an onboard embedded LED which is digitally connected to pin 13. On adjusting the value high, it turns on and vice versa.

Serial Peripheral Interface (SPI) is utilized for the sending of information in between the controller and different segments (peripheral components). It consists of 4xpins.

Furthermore, to establish I2C Communication the user is given 2xpins namely pin #20 and #21. In the above-mentioned digital communication pins
The pin #20 indicates Serial Data Line which has a primary objective of holding information. On the other hand, pin #21 represents Serial Clock Line which has an effective function of supplying information integration between equipment and available devices.

Programming

The ATmega2560 is a microcontroller with a balanced blend of programming and hardware control. To program the user is given a platform with the help of which the user can program the microcontroller according to his\her requirements using C language to attain this job. The platform is called Arduino IDE. IDE enables user to cast out program and burn it on the microcontroller.

Automatic (Software) Reset

Arduino Mega 2560 is engineered and designed in such an innovative approach that in order to reset the software you don't have to physically press the reset button rather the IDE software allows you to automatically reset the microcontroller. It occurs because the reset line (ATmega2560) is linked with flow control line (hardware) of Atmega8U2 with the help of a 100 n ⊨ Capacitor. The reset line resets the controller chip when it is assigned asserted low value. The Arduino IDE software enables the user to upload code by a single click on the upload button due to this innovative capability. This enables the bootloader to have a short duration of timeout , as the start of program upload is in optimal coordination with lower asserted value of the DTR. This startup has entanglement.

When we connect a Computer system running on MAC OS or The Linux, with Atmega2560, it makes connection with software each time it resets via USB. The bootloader keeps processing on the controller chip until the very next second or may be less. However, the contorted information is automatically ignored (i.e. everything except an upload of recently developed programming code), when the link is Established first few bytes of information sent to the board will be under interception. If a code undergoes processing by the microcontroller gets recent design(configuration) or different information when it first beginning, ensure that the product with which it imparts holds up a fraction of time mainly a second subsequent to establish communication and before sending information. The automatic reset feature can be disabled by cutting trace on the board. It can be enabled again by soldering the pads on any side. It is represented as "RESET-EN". User can connect a 110 Ω resistor on the reset line to remove automatic reset feature.

USB Overcurrent Protection

The ATmega2560 has a safety feature mainly to protect USB ports from short or over current of the user's computer system with the help of resettable polyfuse. This resettable polyfuse provides extra protection to the computer systems. If the applied current exceeds 0.5A connected to USB port, the connection will be broken automatically by the fuse.

2.1.2 Crystal Oscillator

Crystal oscillators are also called ceramic resonator. They are used to generate desired frequency by varying the capacitance of the oscillator [5]. By increasing the capacitance stability will also increase, however, startup time will also increase. In this project, a crystal oscillator of 20 MHz with two capacitors of 33 pF used which provide stable operation [15].

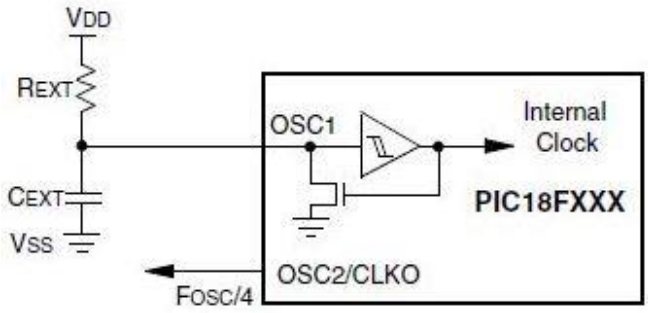

Figure 2.1 Crystal Oscillator

2.2 Global system for mobile (GSM)

The most used mobile communication network is GSM(Global system for mobile communication). This standard was developed by ETSI (European Telecommunication standards institute) for 2G leading digital cellular system used by cell phones. We use this technology to transmit cellular voice and data services. The speed of GSM used in voice calls and data transfer is 9.6 kbps along with transference of SMS.
The important qualities of GSM are mentioned below:

1. Short message service(SMS)
2. Lesser interference
3. It provides transfer without damaging voice quality of services.
4. Emergency calls
5. The encryption methods used in GSM provides us high level of security as part of air interference.

2.3 Communication Modules

Like a mobile phone a GSM module is same type of modem which mostly accepts any sim card. Mobile phone and GSM modem have exactly same functions. Different parts of GSM module are high-lighted in Figure 2.4

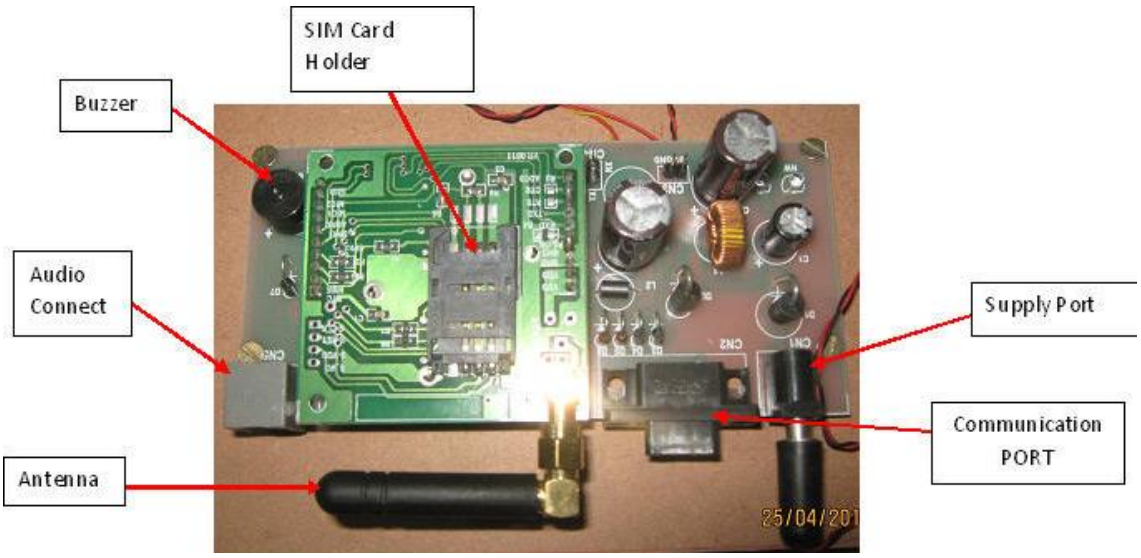

Figure 2.3 GSM Module

2.3.1 SIM900D

This module is a single chip micro-controller which helps the user to get through little measurements and cheap solutions. This is a full Quad-band GSM/GPRS module. It submits GSM/GPRS space 850/900/1800/1900 MHZ frequencies for voice data. Qualities of SIM900D are listed below:

1. It can function at low power almost 1 mA.
2. AT commands control SIM900D.
3. Functioning temperature ranges from -40 to 85 degree Celsius.
4. Weight of SIM900D is 6.2 grams.
5. Provides a voltage range of 3.2-4.8 V.

2.3.2 GSM Modem Instructions

AT commands control GSM module. A command line starts with AT/at e.g. To make a call AT dial is utilized as a command. GSM/GPRS and cell phone also assists AT command.

2.3.4 Website/Domain

In this project we have created a database on a domain which will be showing all the values of the sensors on a graph by using Django framework. By the help of Django framework, we will display all the database values of a sensor in a domain which will be displayed on a graph. We use Django framework as a midway between the values of sensor and user-friendly display. We can make any website in any language in Django framework. The display of website will help us to gather data of sensor which were being displayed in shape of graph or table. This thing helps us to make a presentable form on screen of the database. We can create difficult , different and database dependent websites using python-based frame which is Django. We have used similar framework to make the website of our project which will display our data in variable graphs.

Django is A Python Based Frame work That Allows user to Create and Develop Complex , Variable And Data Based Driven Websites and We have used this method to make a website of our own Which will be showing our values on different graphs.

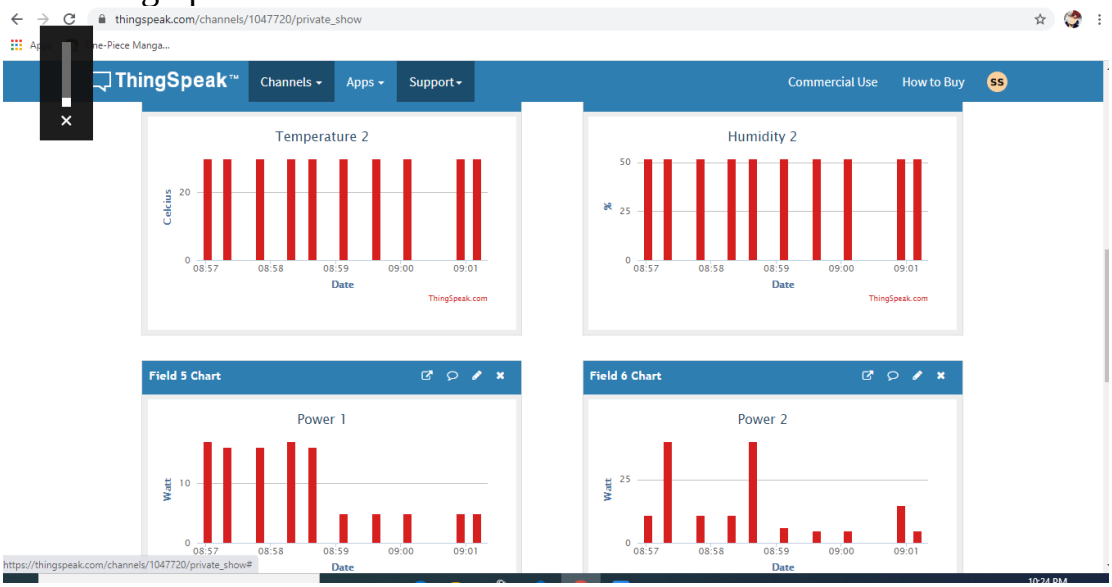

Figure 2.4

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2.3.5 Wi-Fi Module

The Wi-Fi module which we used in our project is ESP8266. It is an independent SOC that contains united TCP protocol which helps your microcontroller gain access to Wi-Fi network. Every ESP8266 Wi-Fi module is a self-driven module which comes with an AT command set. The advantage of this is that you can easily connect this module to your Arduino device which gives us same Wi-Fi ability as any other Wi-Fi device. The ESP8266 can host an application as well as off load all Wi-Fi network function. The process of connecting esp. to a Wi-Fi module is surprisingly practical board along with an enormous and always changing community. The ESP8266 is unable to convert 5-3 V logic and requires external logic level converter.

›

Figure 2.5

2.4 Transformer

In early 1880's, the history of transformer was commenced. First constant potential transformer was invented in 1885, in 1950, first electrical power transformer was introduced in high voltage electrical power system [10]. In the early 1970s, produced largest unit rating was 1100 MVA. In 1980, 800 KV and even higher KV class transformers were contrived. Transformers are utilized for the AC transmission, distribution, and utilization of electrical energy.

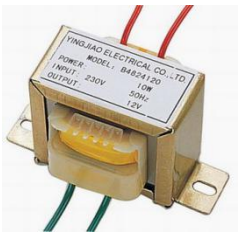


Figure 2.6

2.4.1 Definition of Transformer

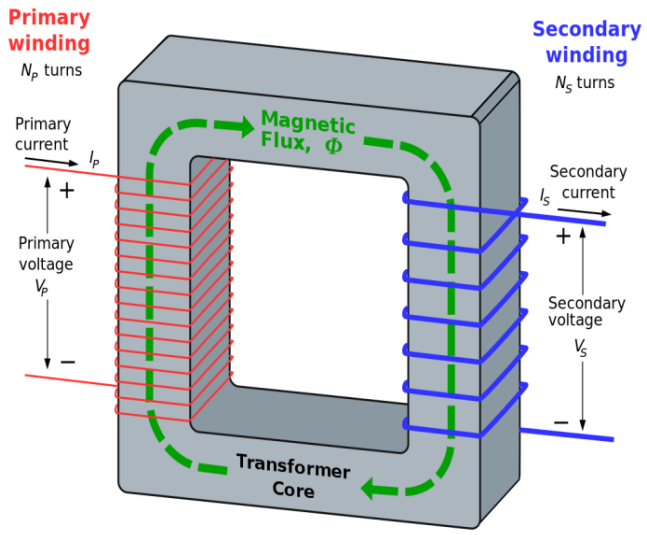
Any transformer is definitely an electro mechanical product of which transactions energy between some circuits by means of electromagnetic induction Electric power transformer can be a static device which converts electric power from one circuit to another without any direct connection but using mutual induction between two windings. [10].

2.4.2 Working Principle

In a transformer, two coils are arranged in that manner so that the magnetic field generated by the current in one coil induces a voltage in the other. This physical principle can only be applicable in AC systems; voltage can only induce in the presence of time-varying magnetic field [24]. Higher or lower voltage can be obtained by changing the windings of two coils.

Faraday's Law of electromagnetic induction describe the working principle of transformer. By varying the current in primary coil a magnetic flux induce in the core [10].A varying o electromotive force (emf) or voltage in the secondary winding by varying the magnetic field.

Figure 2.2 Transformer Working Principal



2.4.3Types of Transformer

Transformer has two types which are discussed below [10]:

- Step-Up Transformer:

Number of turns in secondary winding is greater than the primary [24]. Therefore, the output voltage is greater than input voltage.

- Step Down Transformer:

Step-down transformer basically steps down the voltage because it has less numbers of turns in secondary winding. Consequently, output voltage at secondary winding (VS) is given by:

$$Np/Ns=Vp/Vs \qquad (2.1)$$

Where:

NP = Turns on primary coil

NS = Turns on secondary coil

VP = Primary voltage

VS = Secondary voltage

2.4.4 Faraday's Law of electromagnetic induction

Faraday's law of induction is a basic law of electromagnetism. Transformer's working based on this law. An EMF gets induced across the conductor when it situated in the varying magnetic field, and induced current will be flows through it if the conductor is closed circuit [24]. Magnetic field can be change by following:

- By stirring magnet
- By affecting(moving) the coil
- By rotating the coil relative to magnetic field

Induced EMF is directly proportion to the change of magnetic flux linkage. The flux linkages get by multiplying the number of turns and the flux associated with the coil.

Let suppose the conductor is stirring in magnetic field. The flux at initial ($\Phi 1$) and final ($\Phi 2$) position is given by following relation:

$$\Phi 1 = N\Phi 1 \qquad (2.2)$$

$$\Phi 2 = N\Phi 2 \qquad (2.3)$$

where N denotes speed of the motor and Φ flux.

Change in flux ($\Delta\Phi$) is calculated by:

$$\Delta\Phi = N (\Phi 1 - \Phi 2) \qquad (2.4)$$

$$\text{let } \Phi 1 - \Phi 2 = \Phi \qquad (2.5)$$

Therefore, change in the flux linkage = $N\Phi$

and, rate of change in the flux linkage = $N\Phi/t$ so rate of change of flux linkages = $N (d\Phi/dt)$

According to Faraday's law of electromagnetic induction, rate of change of flux linkages is equal to the induced emf so,

$$E = N (d\Phi/dt) \quad \text{(volts)} \qquad (2.6)$$

Faraday's law states that a changing magnetic flux will induce an emf in a coil. The induced

emf for a coil with N loops is:

$$E = -N (d\Phi/dt) \text{ volts} \qquad (2.7)$$

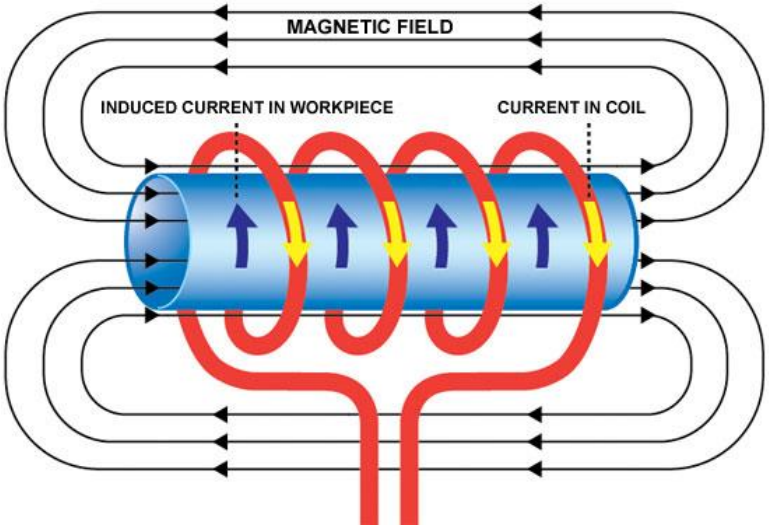


Figure 2.3 Faraday law

2.5 Sensors

Sensors are attached with the transformer which are reading and measuring the physical values from the distribution transformers and they are converting the values into analogue signals. Sensors are for measuring current , voltage , temperature both i.e. ambient and winding, oil level and humidity. A sensor is a component which receives and sends back to a signal when its touched
A magnitude of diverse measurable variables can be gathered for on-line observing. In any case, it is infrequently helpful to utilize the whole spectrum. Accordingly, sensor technology must be acclimated to the prerequisites of a specific transformer relying upon their lifetime and condition. In this project following set-up of sensors is proposed for the utilization on the transformers.

2.5.1 Potential Transformer (PT)

Voltage and potential transformers are utilized to quantify voltage (potential). The secondary voltage is significantly corresponding to the primary voltage and contrasts from it in phase by an angle that Is roughly zero. Voltage and potential transformers that are intended for checking single-phase and three-phase line voltages in power metering applications are utilized primarily as venture down gadgets. They are intended for interfacing line-to-line or line-to-neutral in the same path as standard voltmeters [24]. The secondary voltage has an altered relationship to the primary voltage with the goal that a change in potential inside the primary circuit is checked precisely by meters associated over the secondary terminals [10]. Voltage and potential transformers can be utilized with voltmeters for voltage estimations, or with current transformers for wattmeter or watt-hour meter estimations. Voltage transformers and potential transformers are likewise used to work defensive transfers and gadgets and in numerous different applications. Since they are utilized basically as a part of an observing limit, not withstanding, voltage or potential transformers by and large oblige more prominent precision. For illustrations, items utilized by open utilities for deciding power use must be exact since these voltage or potential transformers are utilized for charging clients.

2.5.2 Current Transformer (CT)

The “Instrument Transformer” often called CT, is arranged to make a subbing potential-current in its auxiliary winding that is resultant to the charge being estimated in its essential .

CT ignores exceeding values of operational-voltage ebbs, flows and affiliate to very low regarded value and provide user with a profitable technique to safely view the actual flow of chargers spilling in an Alternate-Current transmission line using a globally accepted ammeter. The principle working methodology of CT is equivalent to that of a regular transformer.

This well-balanced designed component comprises of stand out or very few loops on its essential winding. This essential twisting is of either a single level turn, a circle of generous commitment wire folded over the middle basically a transport or transport bar put through a central gas as illustrated.

In light of this sort of course of action, the CT is consistently insinuated just as an "arrangement transformer" as the essential twisting, never has in excess of these many turns, is in plan with the current pass on conductor [24].

The secondary winding has greater quantity of circular windings upon an overlaid center of small set back exclusive substance which has an extensive well define region so that the exclusive flux thickness is low using a lot less definite range wire, unforeseen on how much the current must be ventured down. This auxiliary slowing down normally evaluated at a standard 1 A or 5 A.

In CT, the flow of charges along both ends are communicated as a proportion, for example, 80/4. It is an implication that with 99.2~100 A streaming in the initial wire wounds will bring about 5 A streaming in the second wire wounding. On expanding\increasing the quantity of turns on second coil N2, the primary flow of charge can be greatly reduced than the flow of charge measured on initial coil side. As it were, as N2 builds, I2 goes around a relative sum.

$$\text{Turns Ratio} = n = Np/NS = Is/IP \quad (2.8)$$

$$\text{Secondary Current, } Is = IP\,(NP/NS) \quad (2.9)$$

2.5.3 Temperature Sensor (DHT11)

The dampness holding substance with ends applied to surface is the moistness detecting part of DHT11.the conductivity between ends is produced due to water particles being consumed by substrate .The relative dampness is opposition in adjustment between two terminals. Relatively lower dampness increases the distance between the nodes while higher moistness decreases the distance between terminals.

CRETITUDE:

- VCC, DATA and GND are the three pins of this four-pin sensor while he fourth pin is not used .
- Only one line is used for correspondence between dht11 and microcontroller.
- Rational one or Rational zero voltage levels are considered according to certain time regard .

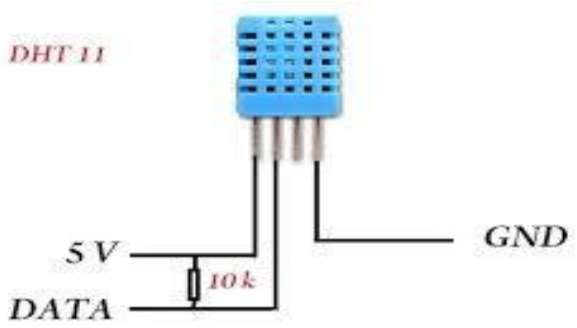


Figure 2.9

2.6 Liquid Crystal Display (LCD)

To visually representing our data, LCD is being embedded with the circuitry of the Project. The LCD being used is configured in such a way that it displays 4 lines with 20 set of characters each. Hence it is called a 20x4 display screen. LCD model JHD204A is put up to task to meet the requirements of our project and suggest to microcontroller which receives data/information from an outer origin (Arduino mega) and shares\communicate it with the LCD [23].

- There are 3 control lines.

In order to communicate the LCD that the user is transmitting data\information, Enable[EN] control line is used .When the user transmit information to LCD, the code should give confirmation that the line is set to Low(0) and select data for the

information transport[23]. After this when the alternate lines become totally ready, bring Enable[EN] High(1) and should hold up for the base duration needed by the display framework datasheet and terminate by converting it Low(0) once more.

The RS represents "Register-Select" line. Right when Register-Select[RS] is Low(0), the data\information is rewarded with a charge or uncommon exclusive set of working rules(guidelines) for instance “clear screen” or “position cursor”. The moment when RS is set to High(1), the data sent is textual information which then appears on the display screen, i.e. to show any letter say "ABC" on the screen you would set RS High(1).

The RW represents "Read/Write" line. Right when Read\Write[RW] is Low(0), the processed data on the information transport is composed or created to the LCD [23]. Exactly when Read\Write[RW] is High(1), the program is adequately tending (perusing) to the LCD. On guidance “Get LCD status” in understood order. Rest all are composed orders, Read\Write[RW] will constantly be Low(0).

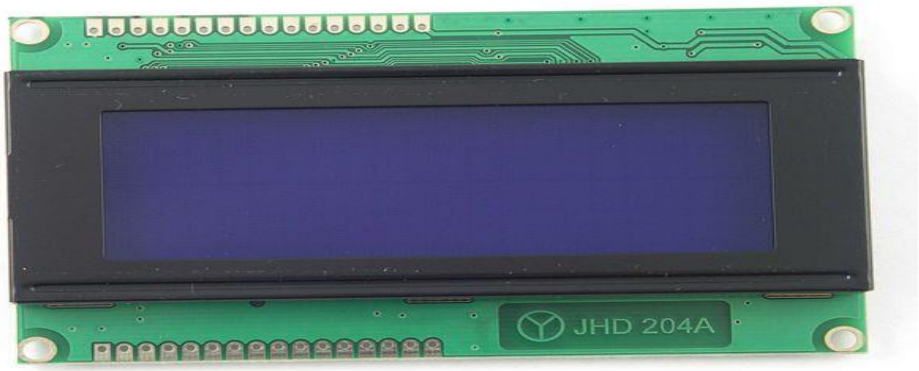


Figure 2.4 LCD

The pin details of LCD are given in Table 2.1.

Table 2.1 Pin Description of LCD

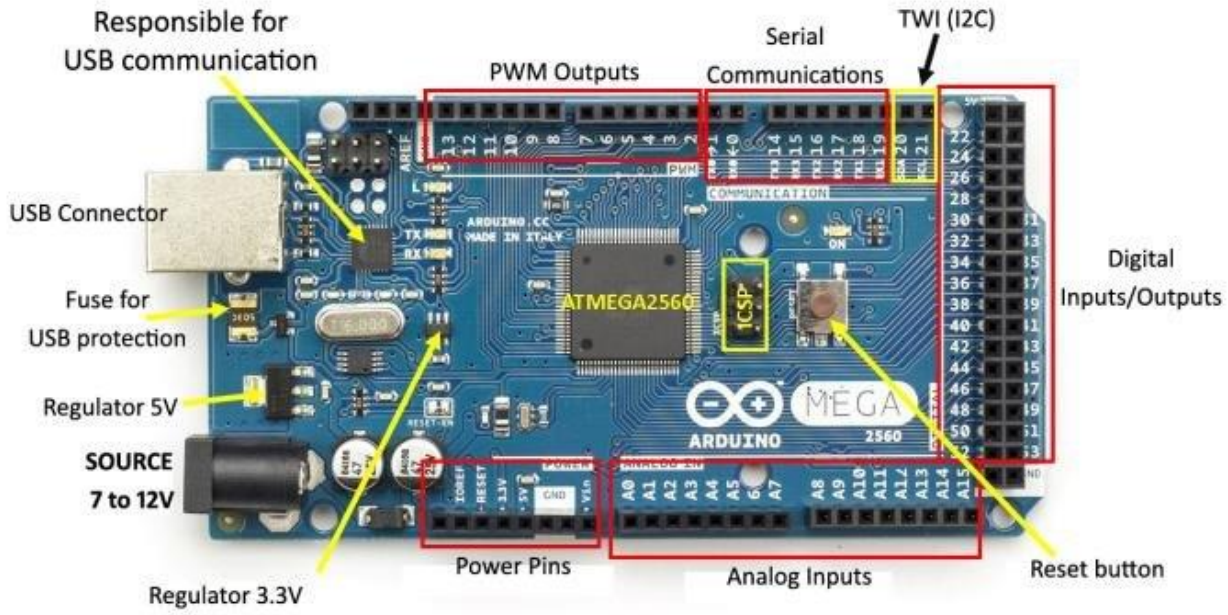
Pin Number	Pin Label	Descriptions
1	VCC	Ground(GND)
2	VSS	Power supply (+5)
3	VEE	Display(contrast)
4	RS	Control pin
5	R/W	Control pin
6	EN	Control pin
7	D-B0	Not required
8	D-B1	Not required
9	D-B2	Not required
10	D-B3	Not required
11	D-B4	Data or address pin
12	D-B5	Data or address pin
13	D-B6	Data or address pin
14	D-B7	Data or address pin
15	LED (+)	LED Back light Anode(+)
16	LED (-)	LED Back light Cathode(-)

3 Hardware Description

This chapter provides detailed description of different hardware modules used in this project. The hardware component consists of transformer, various types of sensors, GSM module and microcontroller.

3.1 Microcontroller Interfacing

The interfacing of microcontroller with GSM SIM900D, sensors and transformer etc. is shown in the Figure 3.1.



The Arduino Mega 2560 is an exclusive board designed microcontroller, developed and engineered on the principles of ATmega2560 (datasheet).It is designed to have 54 digitalized input/output pin layout formation the pins used in project are shown in the table in Table 3.1

Table 3.1

Pin #	Interfaced device
Pin-30-31	GSM module
Pin-28	Relay of transformer 1
Pin-26	Relay of transformer 2
Pin-12	CT sensor 1
Pin-13	PT sensor 1
Pin-10	CT sensor 2
Pin-11	PT sensor 2
Pin-2	DHT-11 1
Pin-3	DHT-11 2
Pin-4,5	Sonar 1
Pin-6,7	Sonar 2
Serial Com 1	Serial communication

3.2 Transformer

The transformer used in this project is critical isolation transformer [24]. In this project the parameters of isolation transformer are monitored which is 200 W or 0.25 KVA transformer. However, in actual electric power network using 11 KVA transformers. The current, voltage, temperature and oil level sensors are installed on the transformer to measure conditions and abnormality. The different types of sensors installed at transformer site are discuss in the following section.

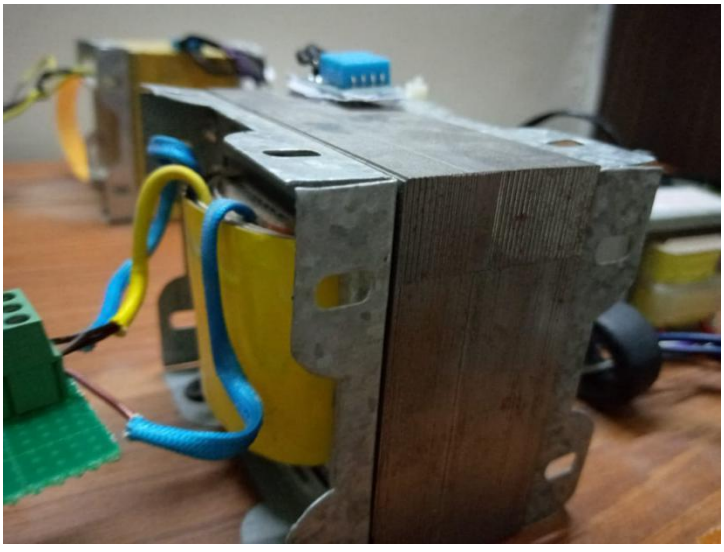


Figure 3.1 Isolation Transformer

3.3 PT Sensor

To quantify various boundaries of the transformer sensors are deployed with transformer. To measure the voltage of the transformer we have installed a sensor named pzem-004t This sensor has higher precision and faster refresh speed and integrated to have both CT and PT functions its voltage port is connected parallel to the transformer's input voltage and as the transformer draws voltage PT will measure the voltage and send the values to microcontroller.

Figure 3.2 pzem-004

3.4 CT Sensor

CT sensor is also installed at the transformer side. CT sensors monitor current of the transformer and provide response when the current exceeds from the threshold value. CT sensor is integrated in pzem which is connected to a inductor which is wound across the transformer more current it draws more magnetic field is induced in inductor which is detected by CT and values are then send to microcontroller.

Figure 3.3 Integrated CT PT hardware

3.5 Temperature and humidity Sensor

Temperature sensor is used to measure the temperature of the transformer [25]. This sensor provides response when temperature f the transformer will go beyond the threshold value. In this project DHT11 sensor is used as temperature sensor. DHT11 consists of 3-pins and it operates at +5 V DC. It converts 10 mV to 10C. The pin description of dht11 is given as:

Pin-1: It is an input voltage pin.

Pin-2: It is an analog output voltage pin.

Pin-3: It is grounded pin

Figure 3.4 dht11

3.6 Oil Level Measuring Sensor

Oil level measuring sensor is also installed at transformer side. It measures the oil level of the transformer because many transformers are damaged or spoiled due to the oil level decreasing. Therefore, proper operation of distribution transformer can be established by ensuring appropriate oil level. For this purpose, three oil levels (low, medium, and high) has been monitored for this transformer transmits received data to the control center, where decision are made to avoid system failure. The circuit configuration of oil level sensor depicted in Figure 3.6, in which F is the common pin, A is the low pin, B is the medium pin and C is the high pin for detecting the oil level of the transformer.

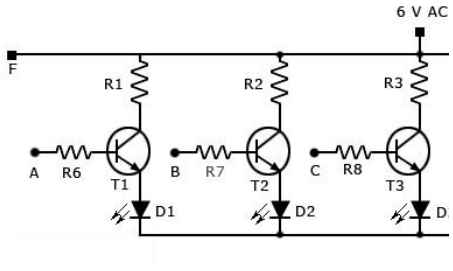


Figure 3.5 Oil level sensor

3.7 Power Supply

Power supply is the source from which the ideal dc voltage is acquired to run different circuits. The voltage from the rule line is 230 V AC yet interchange portions of our circuit require 5 V DC. Thus, a stage down transformer is required to get 12 V AC which is later changed over to 12 V DC through a rectifier as appeared in Figure 3.7. The purpose of a power supply is to supply proper DC voltage to each circuit and component. To remove the ripples and get smoothed DC power filter circuits are utilized. Alternatively, capacitor can also provide this function. The 12 V DC is rated down to 5 V DC utilizing a positive voltage controller chip 7805. Therefore, an altered DC voltage of 5 V is acquired. The block diagram of power supply is captured in Figure 3.7.

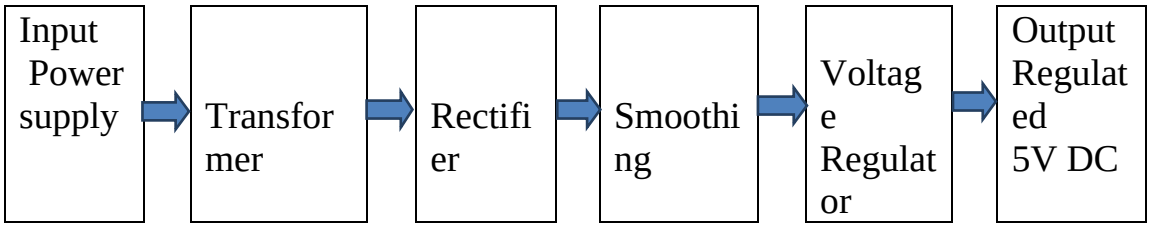


Figure 3.6 Power supply

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3.7.1 Voltage Regulator (7805)

Voltage regulator is electric circuit and its purpose is to maintain the voltage of a power supply automatically within in working range. Voltage controllers likewise are utilized as a part of electronic and are one of common devices used in electric circuits since a power source produces raw current frequently that can damage the system that's why voltage regulators are used. The circuit of voltage regulator is shown in the Figure 3.8.

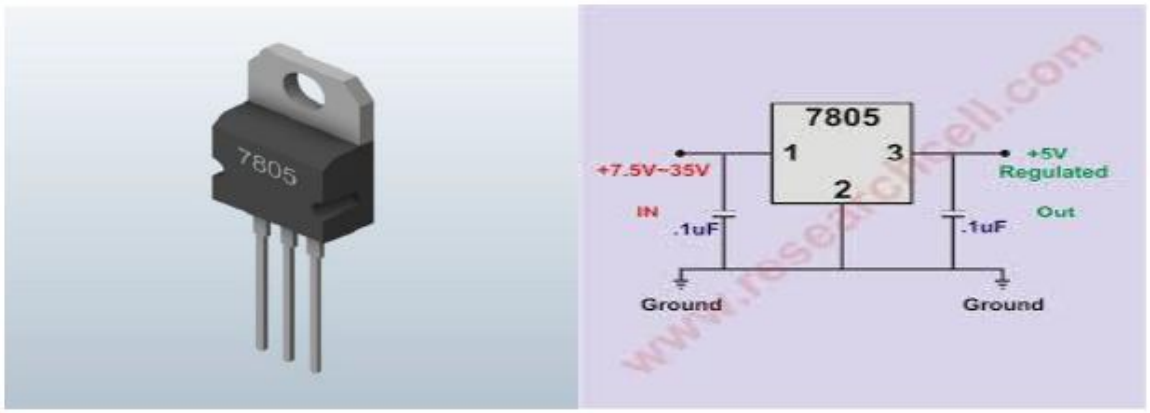


Figure 3.7 Voltage regulator

3.8 ESP8266

The Wi-Fi module which we used in our project is ESP8266. It is an independent SOC that contains united TCP protocol which helps your microcontroller gain access to Wi-Fi network. It is sending values on website after every 15 seconds.

Figure 3.9 Wi-Fi module

3.9 Relay

It is an electrically operated switch that utilizes an electromagnet to transform from the OFF to ON position instead of just beeping and alarming us it automatically changes from OFF to ON. It is used to control high voltage system with the help of low voltage signals. Using this all the issues in the circuit can be identified and isolated to resolve later or now.

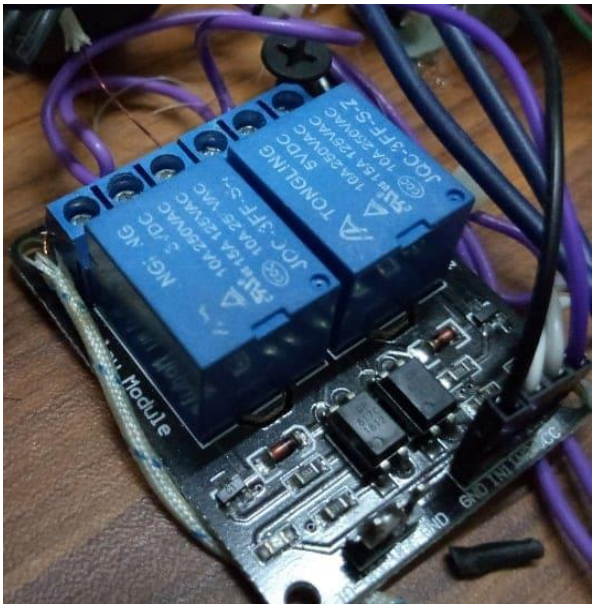


Figure 3.8 Relay

3.10 Buzzer

A buzzer is a sound gadget, it could be electro-mechanical or mechanical. The use of buzzer includes alarm devices and conformation of user input. These buzzers or beeper are applicable to automobile equipment's and its pin type terminal construction enables direct mounting on to printed circuit boards. The circuit of buzzer is shown in the Figure 3.11:

Figure 3.9 Buzzer hardware

Electronic symbol of buzzer is shown by Figure 3.13:

Figure 3.13 Buzzer symbol

4 Methodology

Methodology of the venture is that sensors are introduced at the transformer site which inspect the various boundaries like voltage, current, temperature and oil level then this information stored in microcontroller and send to the control center through GSM module. According to the received data control center made the suitable decisions to avoid any failure in electronic network. The methodology for this project is briefly described in the Figure 4.2

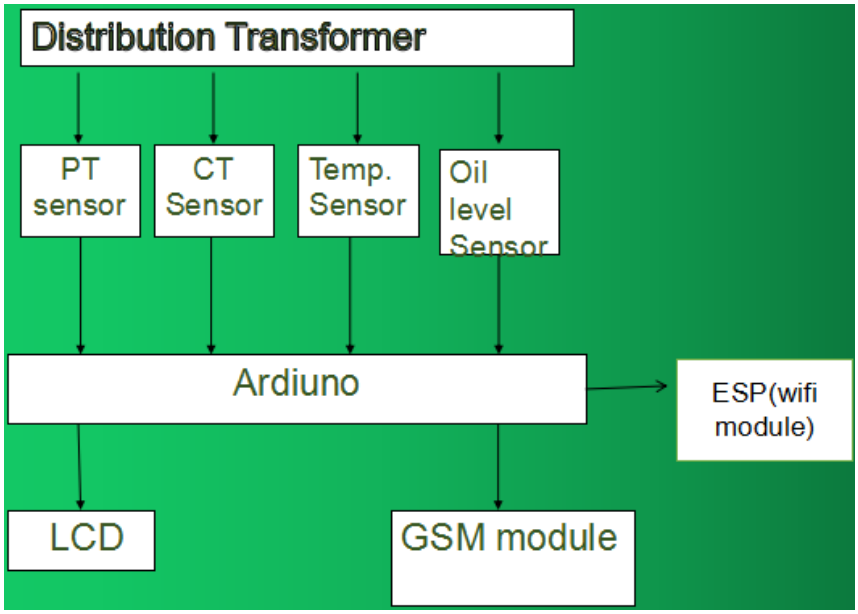


Figure 4. 1: Methodology

5 Results

This project has been evaluated through monitoring of several parameters of transformer for the system reliability. The design model of this project consists of two distribution transformers for which voltage, current and temperature are checked, and the measured data is forward to the control center.

Figure 5.1 shows voltage, current and temperature measurements for these two transformers. The voltage, current and temperature reading for transformer 1 are T1_V, T1_A and Temp1 and for transformer 2 are T2_V, T2_A and Temp2. The system first initializes, measure parameters of deployed transformers and then send these measured values to the control center. The normal operation conditions for these transformers for voltage 220 V, respectively. Figure 5.1 clearly shows that transformer 2 is in the condition of over voltage as its voltage go beyond the rated limit. This over voltage condition of transformer 2 leads to over current and temperature abnormalities.

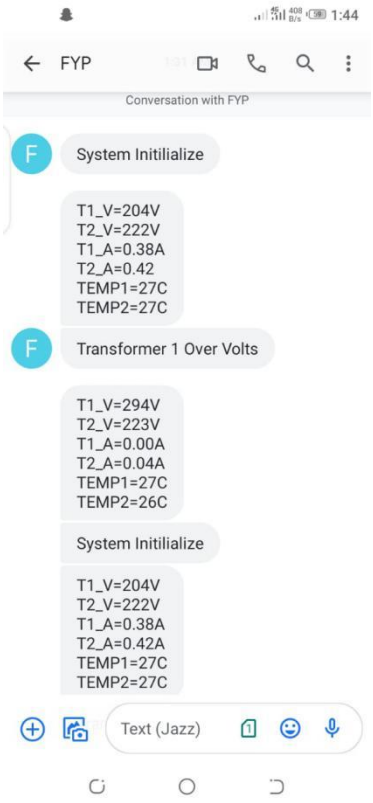


Figure 5.1 Measured readings of two transformers

Figure 5.2 tells the different parameters of the transformers on LCD

Figure 5. 2 Transformer readings on LCD

In figure 5.3 T2 over volts because its voltage goes beyond the rated values.

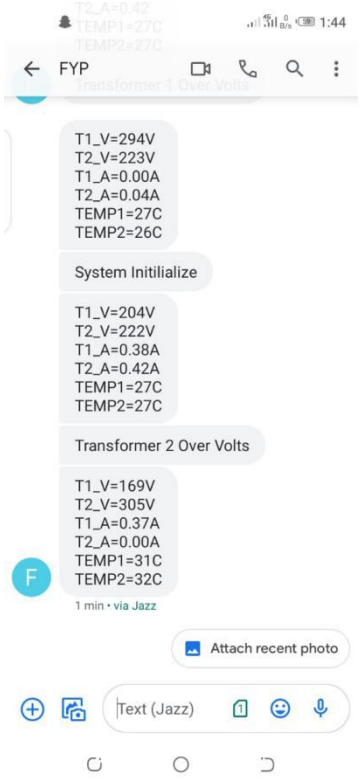


Figure 5. 3 Transformer 2 over volts condition

Different parameters of the transformers also shown in the Figure 5.4. Where T2 over volts.

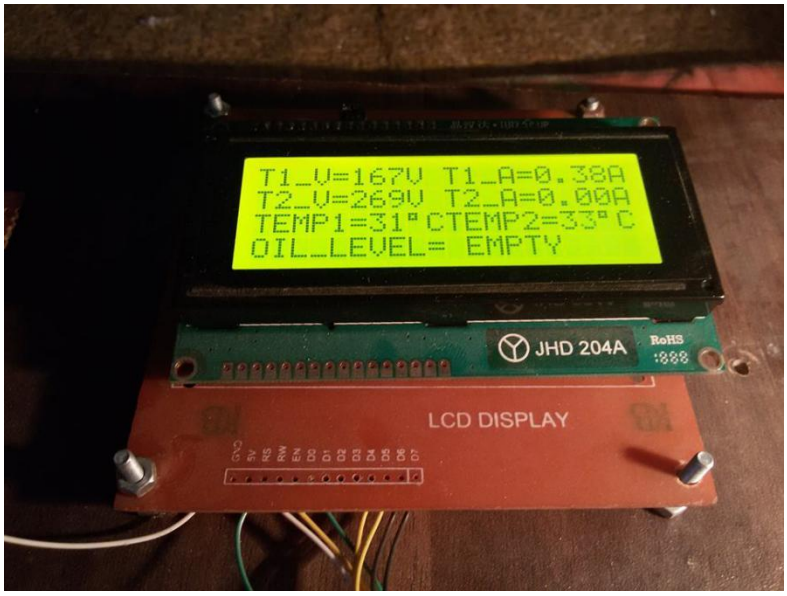


Figure 5. 4 Transformer 2 over volts condition on LCD

When transformer in the condition of overload then it dial a call, which is in the Figure 5.5.

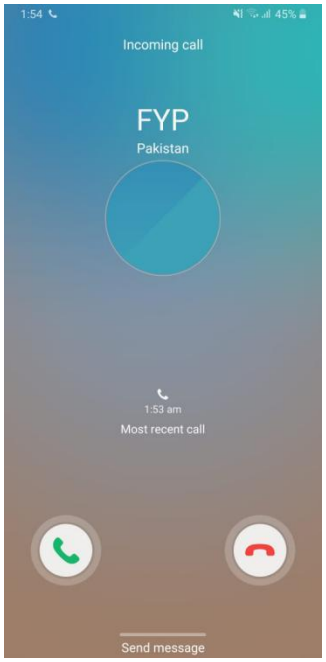
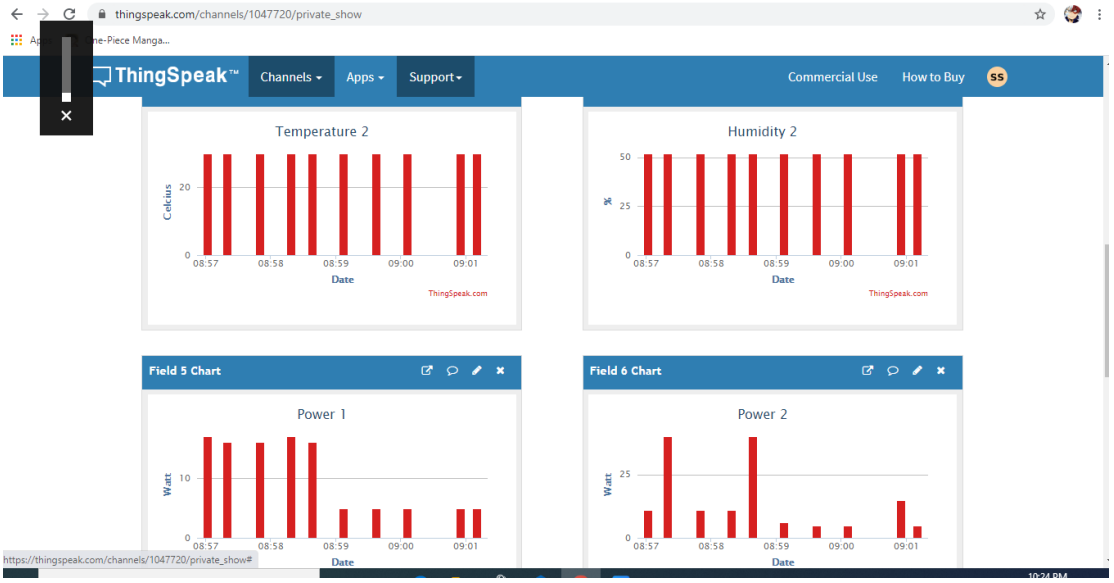


Figure 5. 5 Transformer make call for over current condition



Arduino sending values after every 15 sec on website via Wi-Fi module.

The schematic , circuit and commented diagram of the project are shown in Figures 5.6.1, 5.6.2, 5.6.3.

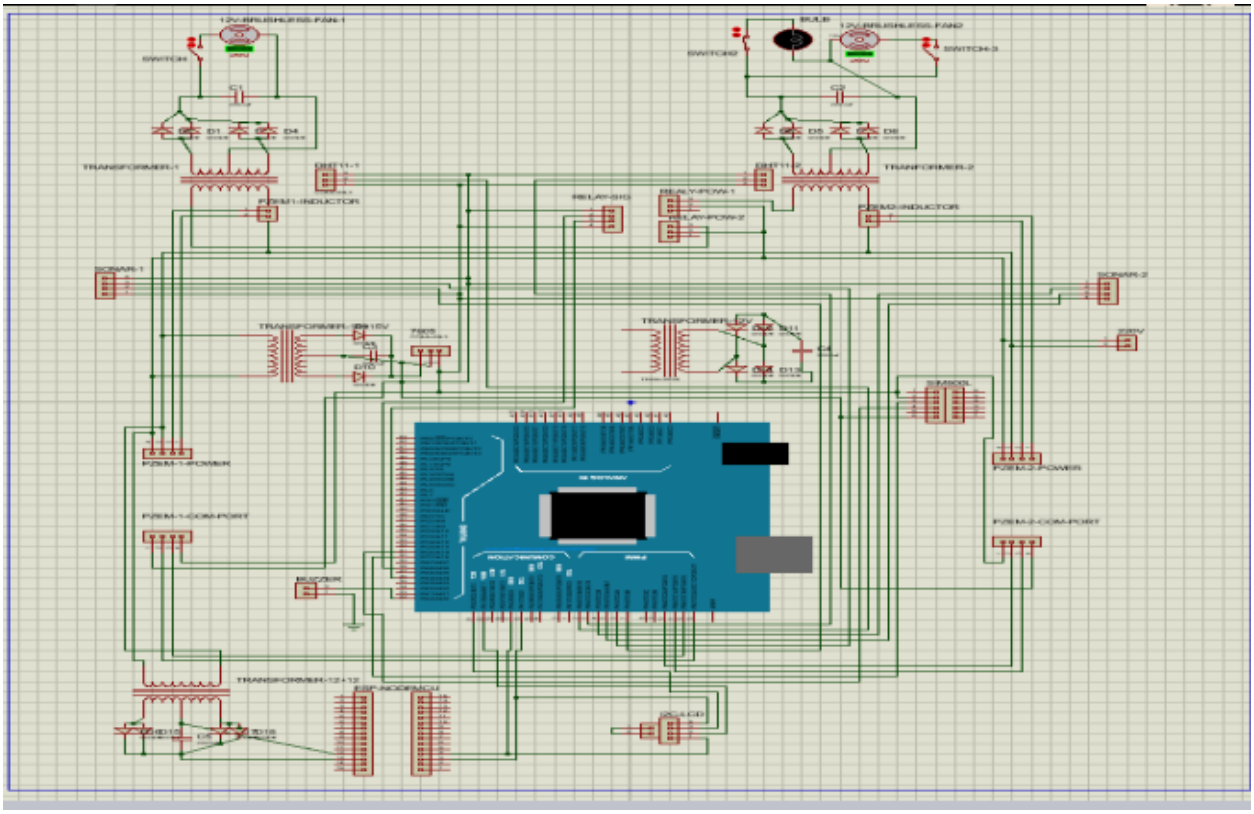


Figure 5.6.1

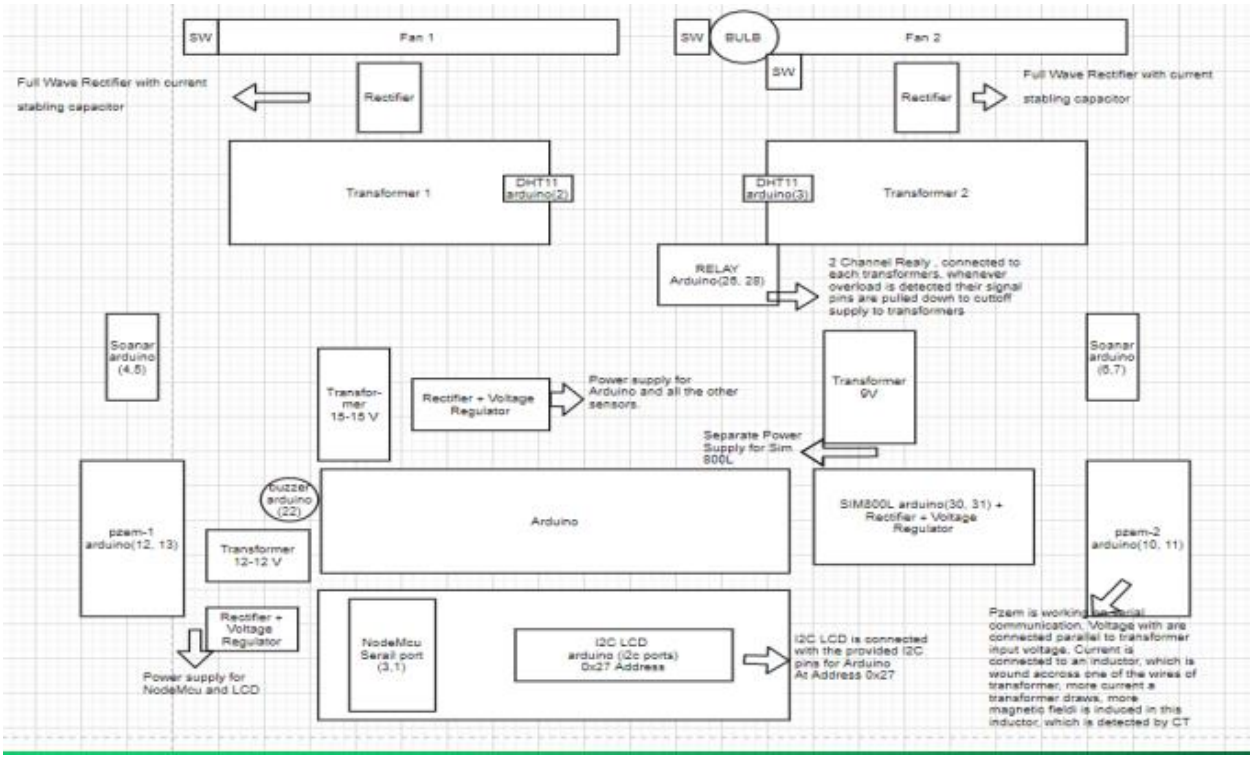

SW
Fan 1
SW
BULB
Fan 2
SW
Full Wave Rectifier with current stabling capacitor
Rectifier
Rectifier
Full Wave Rectifier with current stabling capacitor
Transformer 1
DHT11 arduino(2)
DHT11 arduino(3)
Transformer 2
RELAY Arduino(26, 28)
2 Channel Realy , connected to each transformers, whenever overload is detected their signal pins are pulled down to cutoff supply to transformers
Soanar arduino (4,5)
Transfor-mer 15-15 V
Rectifier + Voltage Regulator
Power supply for Arduino and all the other sensors.
Transformer 9V
Soanar arduino (6,7)
Separate Power Supply for Sim 800L
pzem-1 arduino(12, 13)
buzzer arduino (22)
Arduino
SIM800L arduino(30, 31) + Rectifier + Voltage Regulator
pzem-2 arduino(10, 11)
Transformer 12-12 V
Rectifier + Voltage Regulator
NodeMcu Serail port (3,1)
I2C LCD arduino (i2c ports) 0x27 Address
I2C LCD is connected with the provided I2C pins for Arduino At Address 0x27
Power supply for NodeMcu and LCD
Pzem is working on serial communication. Voltage with are connected parallel to transformer input voltage. Current is connected to an inductor, which is wound accross one of the wires of transformer, more current a transformer draws, more magnetic fieldi is induced in this inductor, which is detected by CT

Figure 5.6.2

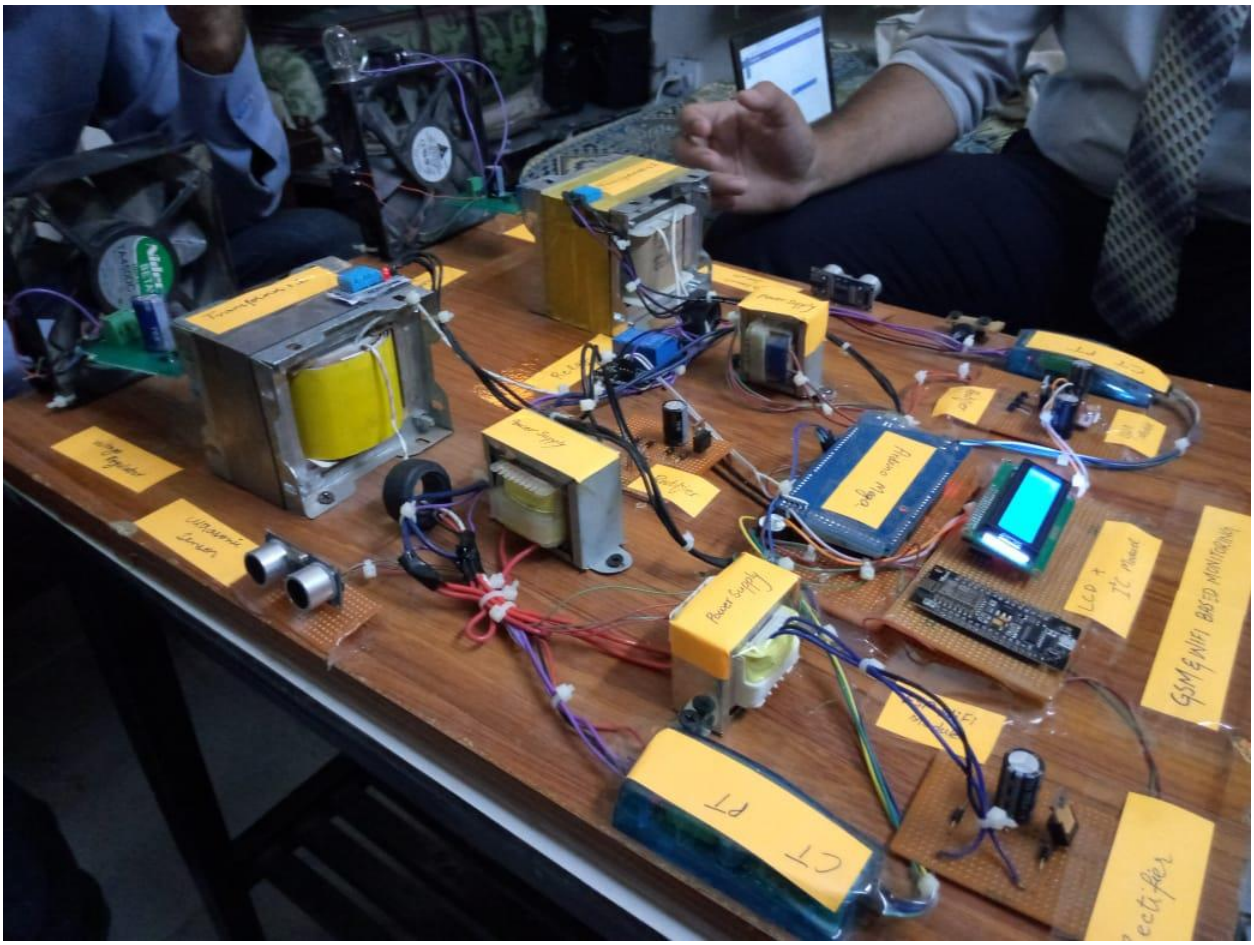


Figure 5. 6.3 Hardware of the project

6 Conclusion

This monitoring system is a lot useful than manual monitoring which has a lot of errors and does not allows reliable monitoring of oil level overloading etc. After receiving message of any issue electric utility company can draw out the measures to act regarding any failure occurrence in the transformers.

In power distribution network there are several distribution transformers and connecting each transformer with such system one can easily figure out that which transformer is giving abnormality readings with the help of received messages.

By the help of website where we can check their readings continuously.

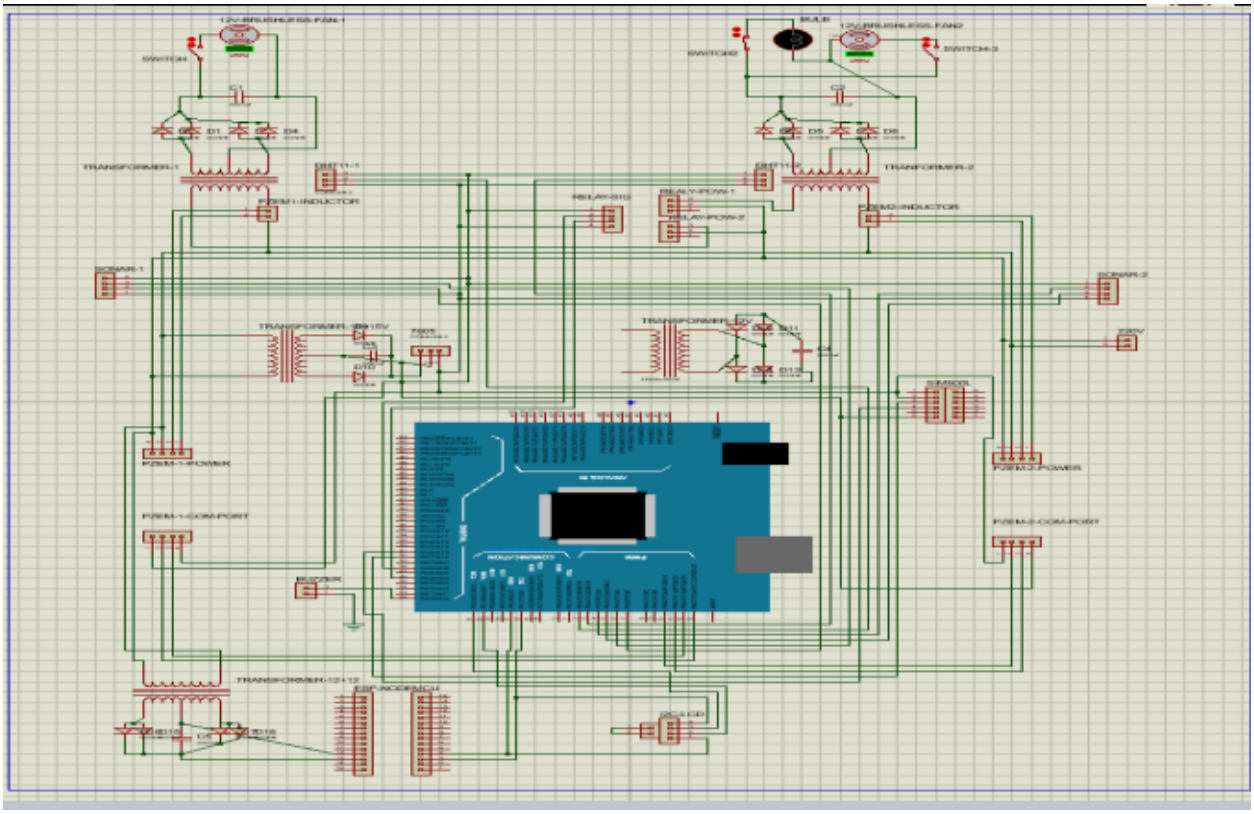
Therefore, there is no need for checking all transformers. The time for getting messages may vary because of network(GSM) traffic but still it is better than manual monitoring.

6.1 Future work

By receiving and storing readings of transformer's parameters periodically about all the transformers in a database i.e. cloud server. This database will be a useful source of information on the utility transformers. The analysis of the stored data can be performed which can help the electric utility to monitor the behavior of distribution transformer and identify system faults so that power network failure can be avoided. Consequently, it will provide cost saving and increases system reliability and we will be able to keep tabs on different transformers by analyzing how it has worked in different conditions. Thus, it will be cost saving as well as improves system reliability.

Overloading can be avoided by appropriate load management. This can be performed by deploying sensors and communication devices between user and grid station so that in case of overloading user can be pre informed.

Appendix B:
Hardware Schematics



Appendix C:
List of Hardware

Power supply:

Power supply	230VAC
Transformer	200 W or 0.25 KVA
Voltage regulator	IC7805
LED	1.63V to 4.8V
Capacitor	Different types

Embedded system:

Microcontroller	Arduino Mega
Crystal oscillator	20 MHz
LCD	20*4

Wi-fi module:

Wi-fi module	esp8266

GSM module:

GSM module	SIM900D

Sensors:

Sensors	CT, PT, Dht11 and oil level sensor

Appendix D: Project Timeline

TITLE	GSM Based Monitoring and Protection of Distribution Transformer

No.	STARTING WEEK	Details of Project timeline	DURATION
1	1	Work on GSM System & Working	3 weeks
2	4	Study of transformer overload and power loss issues	3 weeks
3	7	Study for Database development/Programming	4 weeks
4	11	Familiarity with Complete System & Put it all together	4 weeks
5	15	Study for website and domain making	4 weeks
6	19	Hardware Implementation	6 weeks
7	25	Testing and Results Analysis	6 weeks
8	31	Documentation/Thesis Writing	6 weeks