Project Report

on

GSM BASED TRANSFORMER FAULT DETECTION SYSTEM

Submitted to the Department in partial fulfilment of the requirements for the award of the Degree of Bachelors of Technology in Electrical Engineering of Assam Science and Technology University

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ABSTRACT

Transformers are the main building blocks in a power system. Any damage in the transformer adversely affects the balance of a power system. The damages mainly occur due to overloading and inefficient cooling. The main objective of this project is real time monitoring of the health conditions of the distribution transformer using GSM technology. The parameters, such as temperature, oil level, voltage and current of a transformer are monitored and our system will provide alert message to the remote operator about the current status of the transformer around the clock.

For this purpose, we have used sensors interfaced with Arduino. The alert message can be sent using GSM module and as the danger level of the sensor data is noticed, operators can immediately take action to save the transformer from getting damaged. And after the fault is solved, the GSM will send another message to the mobile operator that the system has been recovered.

CERTIFICATE FROM THE SUPERVISOR

This is to certify that the project entitled "GSM BASED TRANSFORMER FAULT DETECTION SYSTEM" has been carried out and presented by

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Further, the report has not been submitted/reproduced in any form for the award of any other degree/diploma.

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CHAPTER I

INTRODUCTION

The efficient and reliable functioning of power distribution systems is crucial for the seamless delivery of electricity to consumers. Transformers play a pivotal role in this process by stepping up or down voltage levels to facilitate efficient power transmission. However, transformers are susceptible to various faults that can lead to system failures, downtime, and even pose safety hazards. Rapid detection and timely response to transformer faults are imperative to ensure the reliability and continuity of the power supply.

Traditional methods of transformer fault detection often rely on manual inspections, which are time-consuming, costly, and may not provide real-time information. In response to these challenges, modern technologies offer innovative solutions to enhance the monitoring and detection of transformer faults. This project focuses on leveraging GSM (Global System for Mobile Communications) technology to develop an intelligent and remote monitoring system for transformer fault detection.

The GSM module allows for real-time transmission of data from the transformer to a central monitoring system. This means that any changes or abnormalities in the transformer's parameters can be immediately communicated to a central control unit.

The real-time data provided by the GSM-enabled system allows for more efficient maintenance planning. Maintenance teams can prioritize tasks based on the actual condition of transformers, reducing the need for routine inspections and optimizing resources.

OBJECTIVE

The primary objective of the project is to develop low-cost solution for monitoring health condition of remotely located distribution transformers using GSM technology along with Arduino. By rescuing the transformer from high fault before its occurrence, the reliability of the services to the customer can be improved. Thus, reducing the discrepancy in the transmission and distribution of power to the consumers.

By innovatively fabricating and integrating smart features, we aspire to develop an economical solution for fault detection that can optimise the performance of the transformers.

SIGNIFICANCE

A GSM-based transformer fault detection system with features like oil level monitoring, temperature sensing, overload sensing, and moisture content sensing is significant for several reasons:

1. **Real-time Monitoring and Alerts**:
   - **GSM Communication**: Using GSM technology enables real-time communication and alerts. This means that any abnormal condition detected by the system can be immediately communicated to maintenance personnel, allowing for quick response and potentially preventing severe damage.
2. **Enhanced Transformer Protection**:
   - **Oil Level Monitoring**: Ensuring the transformer oil is at an appropriate level is crucial for effective cooling and insulation. Low oil levels can lead to overheating and insulation failure. Real-time monitoring helps in maintaining optimal oil levels.
   - **Temperature Sensing**: Overheating is a common issue in transformers, leading to insulation breakdown and reduced transformer lifespan. Temperature sensors can detect abnormal temperature rises, prompting preventive measures before critical damage occurs.
   - **Overload Sensing**: Transformers can be damaged by overloading, which leads to excessive heat generation. Overload sensing helps in detecting and managing overload conditions, thereby protecting the transformer from damage.
   - **Moisture Content Sensing**: As previously mentioned, high moisture content can degrade the insulation and reduce the dielectric strength of the oil. Continuous monitoring helps in maintaining the moisture content at safe levels, ensuring the longevity and reliability of the transformer.
3. **Preventive Maintenance**:
   - Regular maintenance is essential for the reliable operation of transformers. By continuously monitoring critical parameters, the system can help in planning maintenance activities proactively rather than reactively. This reduces downtime and maintenance costs.

4. **Cost Efficiency**:
   - Early detection of faults can prevent catastrophic failures, which are expensive to repair and may result in significant operational losses. The GSM-based system ensures that minor issues are addressed before they escalate into major problems, leading to overall cost savings.
5. **Data Logging and Analysis**:
   - The system can log data over time, providing valuable insights into the transformer's operating conditions. This historical data can be used for trend analysis, helping in predictive maintenance and improving the overall asset management strategy.
6. **Improved Reliability and Safety**:
   - Reliable transformer operation is critical for the stability of the electrical power supply. By ensuring that transformers operate within safe parameters, the system enhances the reliability and safety of the power distribution network.
7. **Remote Monitoring**:
   - For transformers located in remote or hard-to-access areas, GSM-based systems allow for remote monitoring without the need for frequent on-site inspections. This is especially useful for utilities managing large and geographically dispersed networks.

In summary, a GSM-based transformer fault detection system with comprehensive monitoring capabilities is essential for maintaining the health, efficiency, and reliability of transformers, ultimately leading to better service delivery and reduced operational costs.

CHAPTER II

PROPOSED SYSTEM

Distributed transformers are prone to damages because of the raise in oil temperature when there is an overload or huge current flows through the internal winding of the transformer. When the oil temperature rises, accordingly that increases the probability of getting damages in the transformers. The transformers are to be monitored very cautiously during these situations. The proposed system includes monitoring system which is connected to the distribution transformer for observing purpose. This control system-controlled Arduino consists of sensing unit that gathers the essential readings like current, voltage, and the oil temperature, level, moisture within the distribution transformer. The digital LED display connected to the processing unit that displays the respective parameter values at the substation. The controller also senses the overload and high current flow process in the internal windings which may lead to breakdown of respective unit. An Arduino controller is programmed in such a manner so for the scanning of the transformer continuously. It will update observation readings at particular time period. The AVR microcontroller is transmitted through the ADC (Analog to Digital Converter) transmitter connected to the ARM controller unit.

This project includes GSM (Sim800C) module, which is connected to Arduino through UART. Temperature sensor (DHT11) connected to Arduino analog pin. Buzzer interfaced with Arduino digital pin. Relay connected to Arduino digital pin to control transformer input power.

DIFFERENT PROCESSES

Our project aims to perform the following processes:

Over Load: Over current is the current flowing through the transformer resulting from faults on the power system. Fault currents that do not include ground are generally in excess of four times full-load current; fault currents that include ground can be below the full-load current depending on the system grounding method. Over current conditions are typically short in duration (less than two seconds) because protection relays usually operate to isolate the faults from the power system. Overload, by contrast, is current drawn by load, a load current in excess of the transformer name-plate rating.

Our system will monitor the excess level of the load current and voltage according to the transformer ratings that we have set through coding in Arduino and it will display the values in the LCD monitor.

Over Temperature: Over temperature excessive load current alone may not result in damage to the transformer if the absolute temperature of the windings and transformer oil remains within specified limits. Transformer ratings are based on a 24-hour average ambient temperature of 30°C (86°F). Due to overload and under voltage, temperature of oil increases which causes failure of insulation of transformer winding.

Due to overload voltage and current, the transformer oil temperature increases. The system will monitor the excess temperature level and send a message to the remote operator.

Oil Level: Oil mainly used in transformer for two purposes, one is for cooling of transformer and another use is for insulation purpose. When temperature of transformer goes high, oil level in transformer tank decreases due to heating effect. For normal operation of transformer oil level should maintain at required level. If oil level decreases beyond required level, it affect cooling and insulation of the transformer.

Similarly, for better regulation of temperature, we should maintain the oil level of the transformer continuously. The oil level sensor will provide this information and display in the monitor.

Moisture content: Maintaining low moisture content in transformer oil is essential to ensure the longevity, efficiency, and safe operation of transformers. In transformer oil moisture content is a critical factor for several reasons such as Dielectric Strength, Insulation Degradation, Corrosion, Sludge Formation etc.

Therefore, Moisture sensor is used so as to indicate if there's any presence of moisture in transformer oil.

If any of the above parameters passes the threshold value that we have set through coding, then the GSM module will send the notification to the remote operator. The remote operator will then go to the location or send the information to the attendant physically present at the location. After the removal of fault, the GSM module will again send a notification stating that the fault has been solved.

TECHNOLOGY USED

GSM Technology: GSM (Global System for Mobile communication) is a digital mobile network that is widely used by mobile phone users in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies: TDMA, GSM and code-division multiple access (CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 megahertz (MHz) or 1,800 MHz frequency band.

GSM, together with other technologies, is part of the evolution of wireless mobile telecommunications that includes High-Speed Circuit-Switched Data (HSCSD), General Packet Radio Service (GPRS), Enhanced Data GSM Environment (EDGE) and Universal Mobile Telecommunications Service (UMTS). The GSM network has four separate parts that work together to function as a whole: the mobile device itself, the base station subsystem (BSS), the network switching subsystem (NSS) and the operation and support subsystem (OSS). The mobile device connects to the network via hardware. The subscriber identity module (SIM) card provides the network with identifying information about the mobile user.

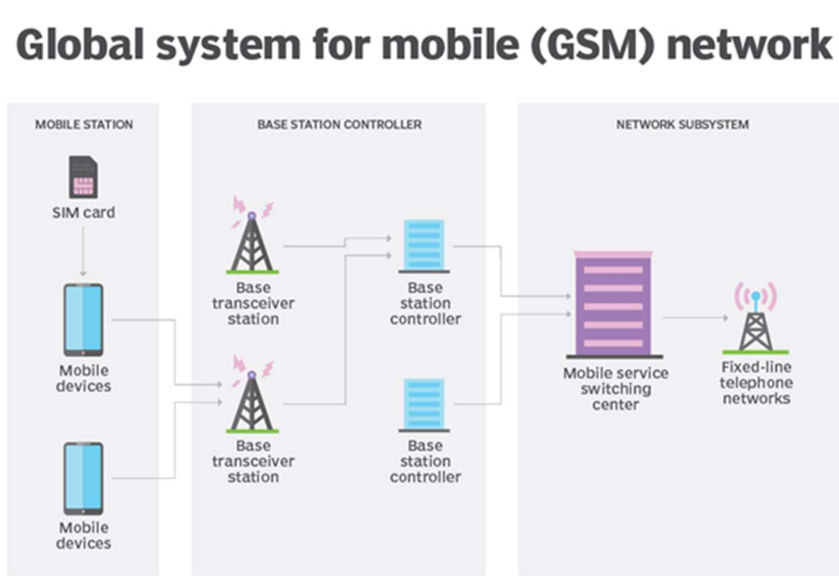


Fig II (1): GSM SYSTEM FOR MOBILE

The BSS handles traffic between the cell phone and the NSS. It consists of two main components: the base transceiver station (BTS) and the base station controller (BSC). The BTS contains the equipment that communicates with the mobile phones, largely the radio transmitter receivers and antennas, while the BSC is the intelligence behind it. The BSC communicates with and controls a group of base transceiver stations.

The NSS portion of the GSM network architecture, often called the core network, tracks the location of callers to enable the delivery of cellular services. Mobile carriers own the NSS. The NSS has a variety of parts, including mobile switching centre (MSC) and home location register (HLR). These components perform different functions, such as routing calls and Short Message Service (SMS) and authenticating and storing caller account information via SIM cards.

Because many GSM network operators have roaming agreements with foreign operators, users can often continue to use their phones when they travel to other countries. SIM cards that hold home network access configurations may be switched to those with metered local access, significantly reducing roaming costs, while experiencing no reductions in service.

SOFTWARE USED

Proteus

Proteus is a software suite for electronic circuit simulation, schematic capture, and PCB (Printed Circuit Board) design. It is developed by Lab centre Electronics and is widely used by electronics engineers and hobbyists for designing and testing electronic circuits.

The Proteus software suite consists of several components, including:

- Proteus ISIS, a simulation tool for analog, digital, and mixed-signal circuits. It allows users to simulate and test circuits before building them in real-life.
- Proteus ARES, a PCB design tool that allows users to create and design printed circuit boards. It includes features such as auto-routing, design rule checking, and 3D visualization.
- Proteus VSM (Virtual System Modelling), a co-simulation tool that allows users to combine microcontroller simulation with their own circuit simulation.

Proteus is known for its ease of use and user-friendly interface, making it accessible for both beginners and experienced users. The software supports a wide range of microcontrollers, including popular microcontrollers from Atmel, PIC, and ARM.

Proteus is a valuable tool for designing and testing electronic circuits, as it provides a comprehensive simulation environment that allows users to test and debug their circuits before building them. The software also includes a large library of components and footprints, making it easy to find the components needed for a specific design.

Arduino IDE

Arduino Integrated Development Environment (IDE) is a free and open-source software application used for programming and developing applications for the Arduino platform. The Arduino IDE is the main tool used to write, upload, and debug code on Arduino boards.

The Arduino IDE provides a simple and user-friendly interface for writing and uploading code to the board. It supports a variety of programming languages, including the Arduino programming language, a simplified version of C++. The IDE also includes a code editor with syntax highlighting, auto-indentation, and code completion, making it easier to write and edit code.

In addition to its coding features, the Arduino IDE also includes a built-in serial monitor for debugging and testing code. The serial monitor allows users to send and receive data between the computer and the board, and to view debugging information from the board.

The Arduino IDE also includes a library manager that makes it easy to find, install, and manage libraries. Libraries are pre-written code that can be easily imported into a project, making it easier to add functionality to a project without having to write all the code from scratch.

Overall, the Arduino IDE is a powerful and accessible tool that makes it easy for beginners and experienced users alike to develop applications for the Arduino platform. It provides a simple and user-friendly interface, a variety of programming languages, and a range of debugging and testing tools, making it a valuable tool for anyone interested in developing projects with the Arduino platform.

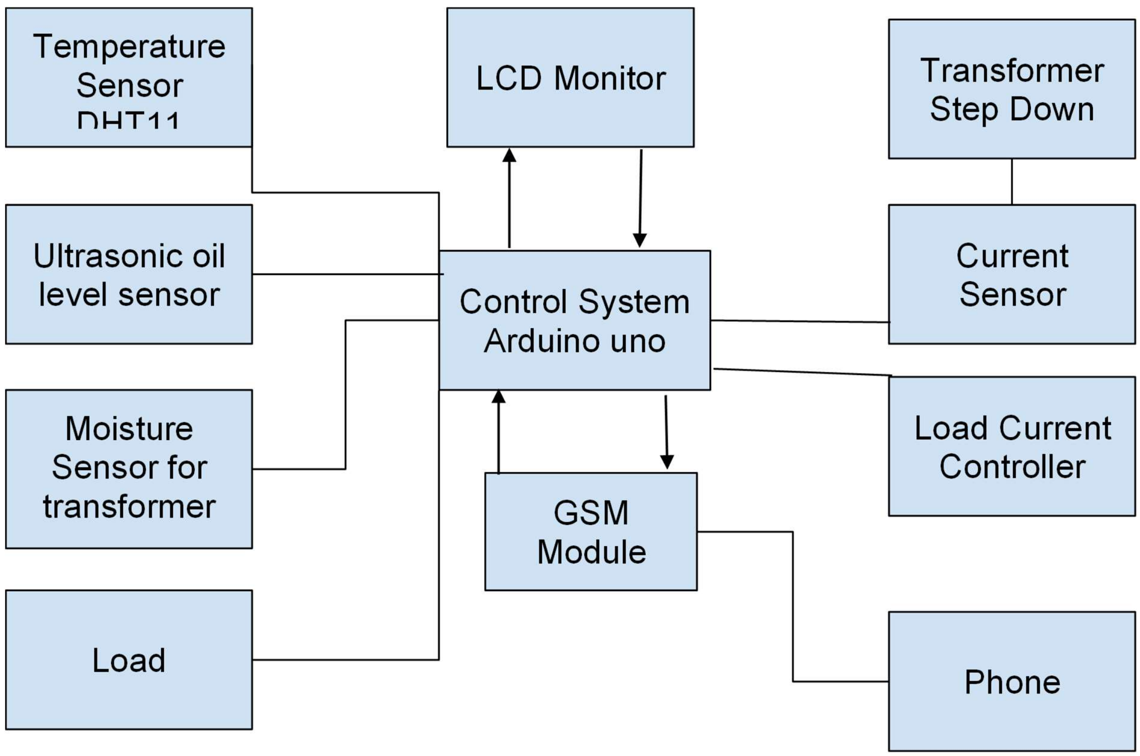
CHAPTER III

METHODOLOGY

To achieve the above stated objectives, the following methodologies are to be used:

1. Firstly, defining the types of faults, we aim to detect in transformers and the specific parameters to monitor. Considering common transformer faults such as overheating, overloading and reduction in oil level.
2. Choosing appropriate sensors to measure key parameters such as temperature, oil level, and electrical parameters.
3. Before the development of physical model, a proteus simulation will be carried out to design and implement all the sensors and components as per requirement.
4. Developing algorithms for fault detection based on the sensor data.
5. Proper Coding work is to be done in proteus simulation software so that the GSM module, Arduino and the other sensors are properly integrated.
6. After the complete simulation, a hardware model has to be designed incorporating all the designed components.
7. Testing of the hardware model in a controlled environment should be done to validate its functionality.
8. Based on the performance evaluation, necessary refinements to improve its effectiveness and efficiency should be carried out for better optimisation of the system.

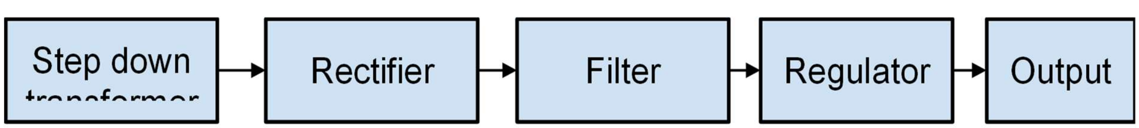
BLOCK DIAGRAM



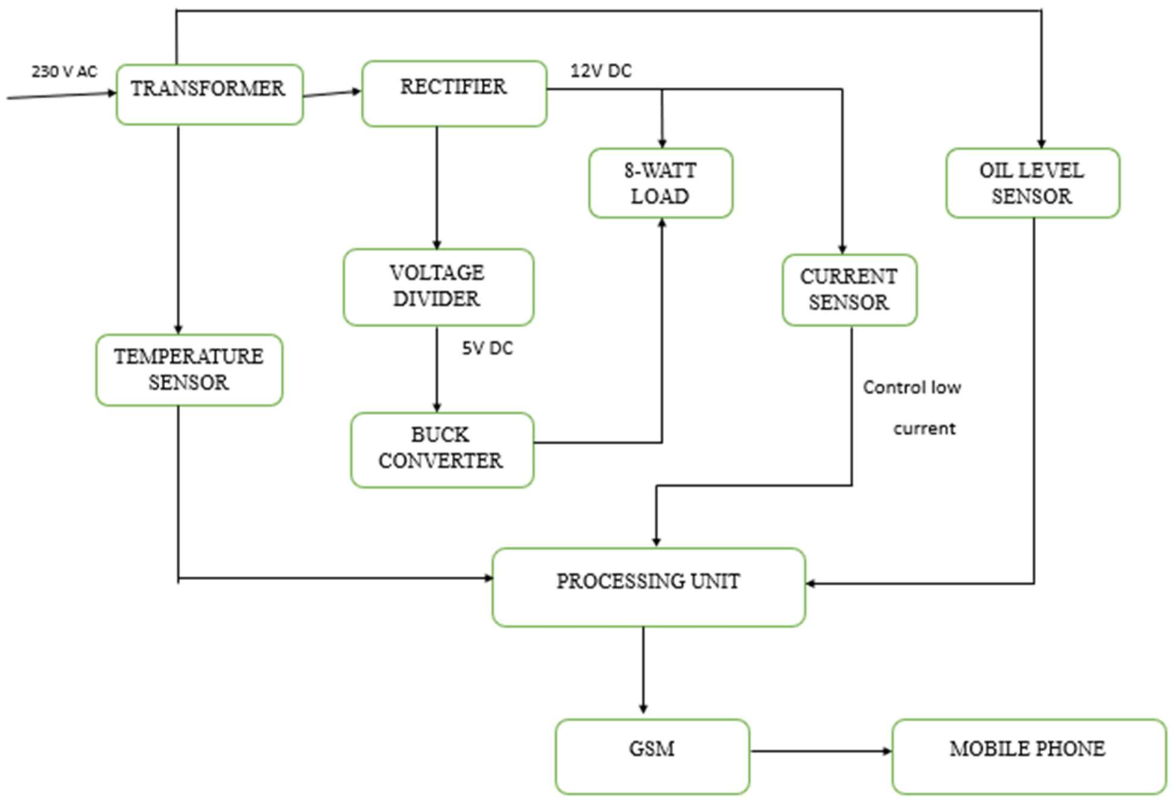
The above block diagram shows the integration of different sensors (namely-Oil level sensor, Temperature sensor, Current sensor and Voltage sensor) and other components working together.

The diagram shows an Analog to digital converter which converts the analog signals from respective sensors and convert it to digital form. The digital signals are processed in Arduino and the values are displayed in the LCD monitor. The GSM modem will send a mobile notification to the operator if the values exceed the threshold value.

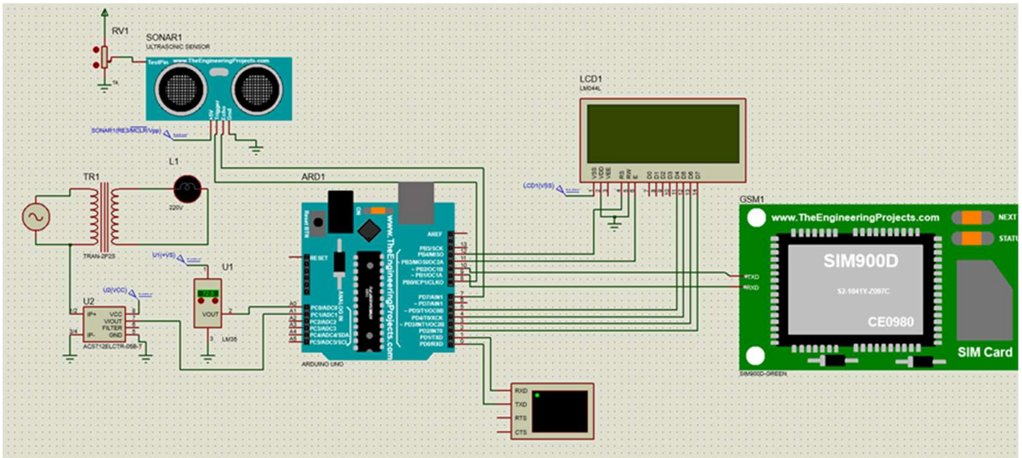
Power Supply Block Diagram:



FLOW CHART


230 V AC
TRANSFORMER
RECTIFIER
12V DC
8-WATT LOAD
OIL LEVEL SENSOR
VOLTAGE DIVIDER
CURRENT SENSOR
TEMPERATURE SENSOR
5V DC
BUCK CONVERTER
Control low current
PROCESSING UNIT
GSM
MOBILE PHONE

SIMULATION



<u>Fig III (1)</u>: CIRCUIT DIAGRAM OF GSM BASED TRANSFORMER FAULT DETECTION SYSTEM

Working Process:

•The Arduino Uno continuously reads data from the current sensor, temperature sensor, and oil level sensor.

•Analog or digital signals from the sensors are converted into meaningful values.

•The Arduino processes the sensor data to obtain relevant information about the transformer's current, temperature, and oil level.

•Based on predefined thresholds or conditions, the Arduino makes decisions about the transformer's status.

•For example, if the current exceeds a certain limit or the temperature rises beyond a safe level, it may trigger an alert.

•When a critical condition is detected, the Arduino uses the GSM module to send an alert message via SMS.

•The message may include details about the current, temperature, and oil level, as well as the nature of the issue.

•The user or maintenance personnel can receive real-time updates about the transformer's status on their mobile phones.

•This enables prompt actions to be taken in case of abnormal conditions, preventing potential damage or failures.

CHAPTER IV

HARDWARE IMPLEMENTATION

TECHNICAL SPECIFICATIONS OF HARDWARE USED:

1. Microcontroller: Arduino Uno Crystal: 16 MHz
2. LCD: 16X2 LCD
3. GSM: SIM900C
4. Level Sensor: Ultrasonic Sensor
5. Temperature sensor: DHT11
6. Tank Moisture sensor: Moisture sensor
7. Buzzer: 5V/12V
8. DC Relay: 12V DC
9. Electromagnetic Power Source: 9V Lead Acid Battery

1. SIM900C GSM Module:

SIM900A GSM Module is a dual-band GSM/GPRS engine that works on frequencies EGSM 900MHz and DCS 1800MHz. SIM900A features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. This module can be used in your IoT based projects and embedded systems.

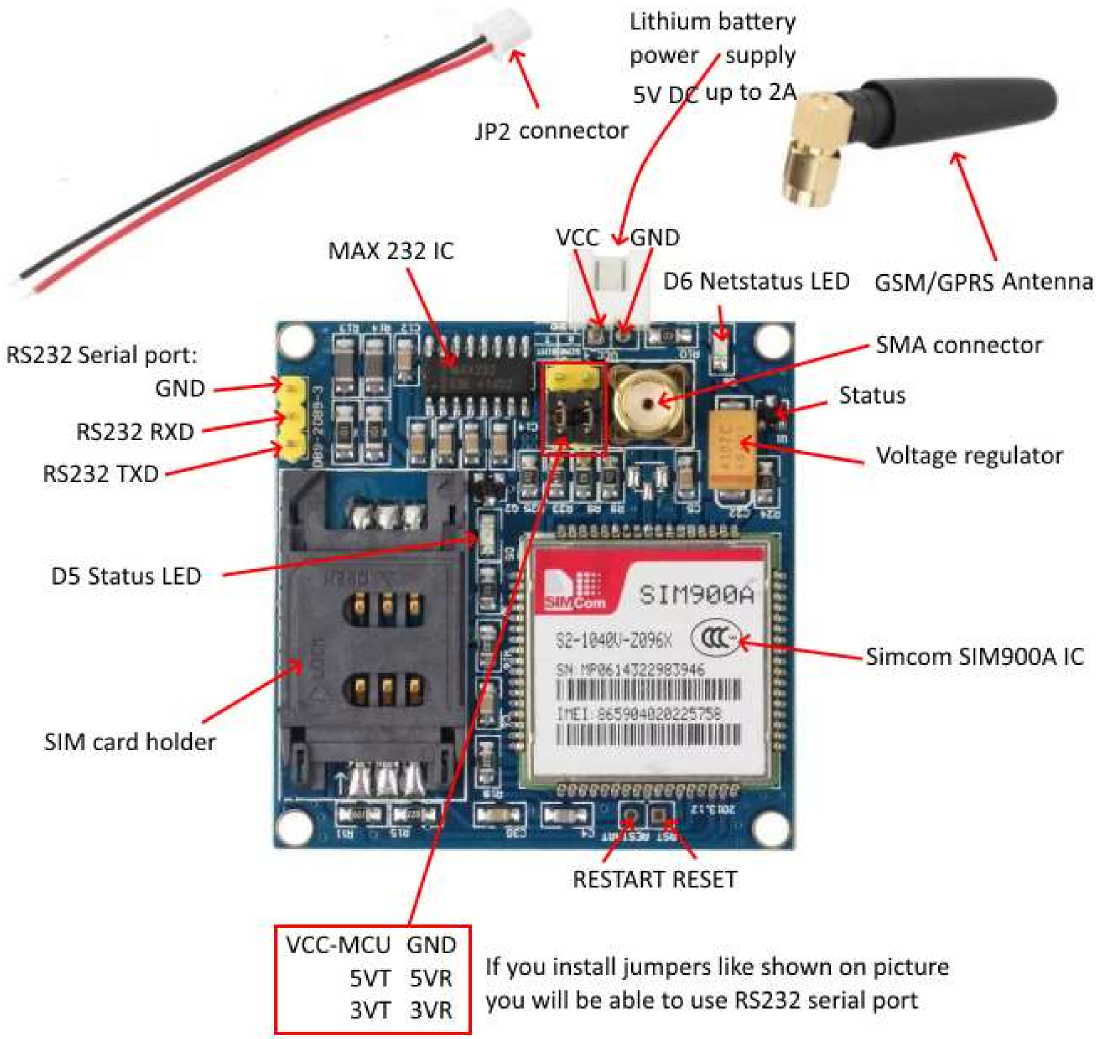


Fig IV (1): GSM MODULE

The module is powered by a 4.0V power supply that can deliver up to 2A of current. Care should be taken as any voltage over 4.5V would damage the module. The communication with this module is done through UART Interface. The data is sent to the module or received from the module through the UART interface. So you can communicate with your controller like Arduino, AVR, Raspberry Pi with just two wires.

2. Arduino Uno:

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button.

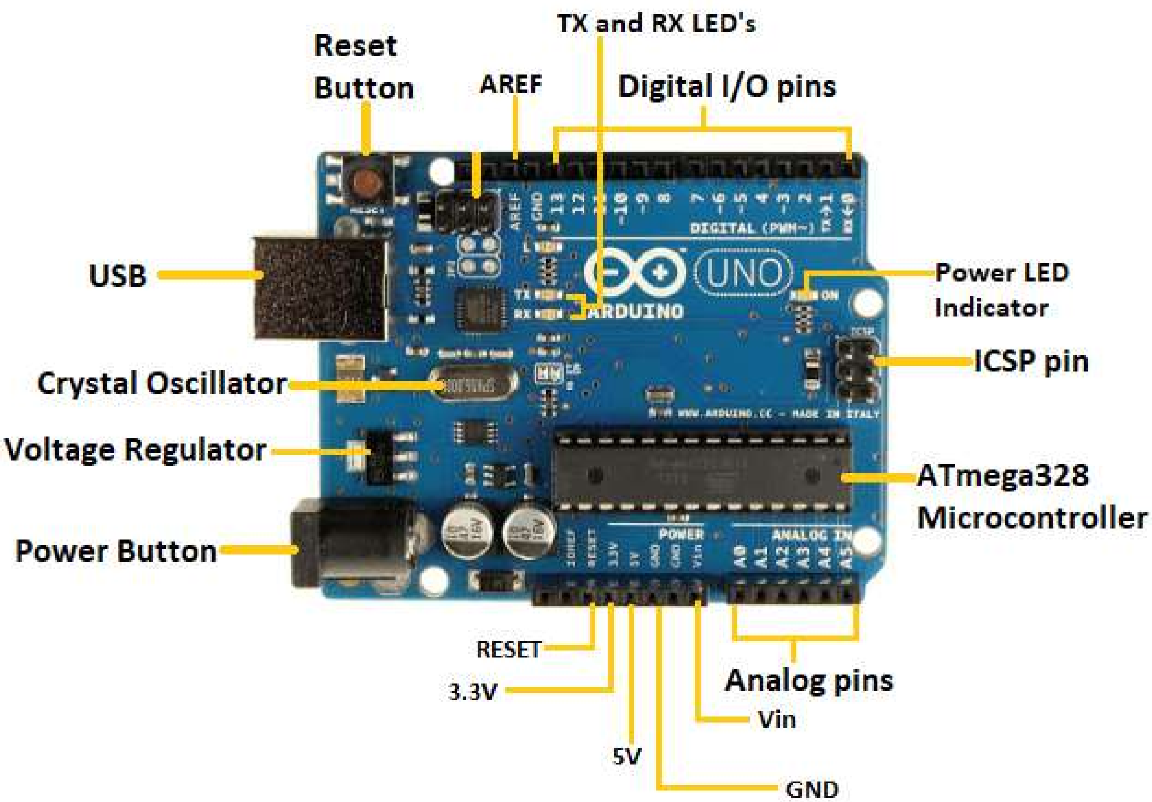


Fig IV (2): ARDUINO UNO

3. Ultrasonic Sensor:

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

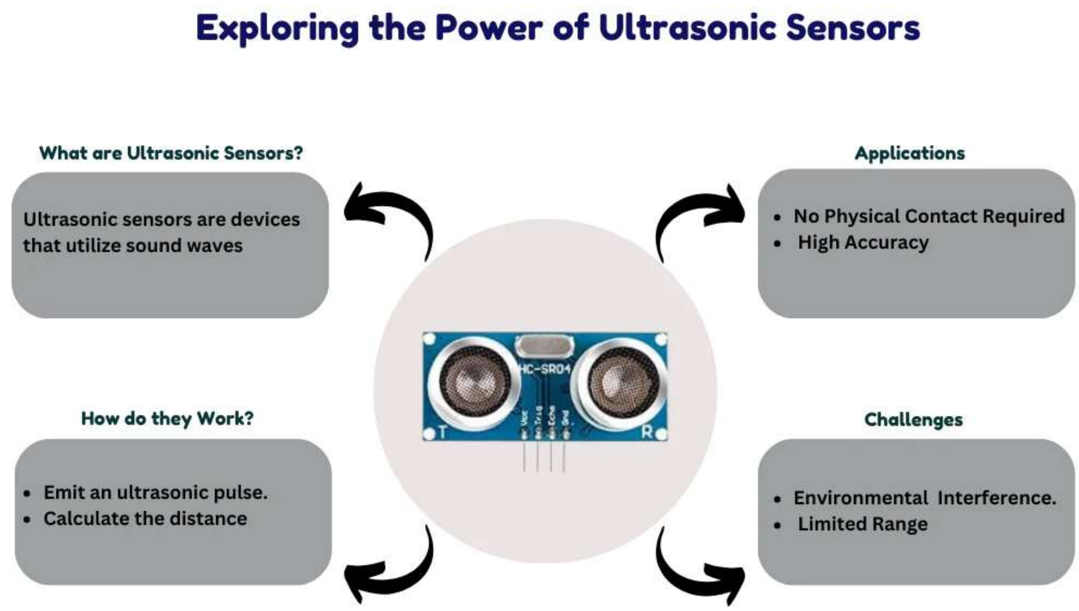


Fig IV (3): ULTRASONIC SENSOR

Ultrasonic sensing is one of the best ways to sense proximity and detect levels with high reliability. Our technical support gets emails all of the time about how our sensors work and what environments our sensors work (or don't work) in.

This guide was created as an introduction to ultrasonic sensing, its principles, and how ultrasonic sensors work in your applications.

Ultrasonic sensors work by sending out a sound wave at a frequency above the range of human hearing. The transducer of the sensor acts as a microphone to receive and send the ultrasonic sound. Our ultrasonic sensors, like many others, use a single transducer to send a pulse and to receive the echo. The sensor determines the distance to a target by measuring time lapses between the sending and receiving of the ultrasonic pulse.

The working principle of this module is simple. It sends an ultrasonic pulse out at 40 kHz, which travels through the air, and if there is an obstacle or object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated.

Ultrasonic sensors are a great solution for the detection of clear objects. For liquid level measurement, applications that use infrared sensors, for instance, struggle with this particular use case because of target translucence.

4. Temperature sensor: DHT11

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use but requires careful timing to grab data. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old.

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc… to measure humidity and temperature instantaneously.

DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor.

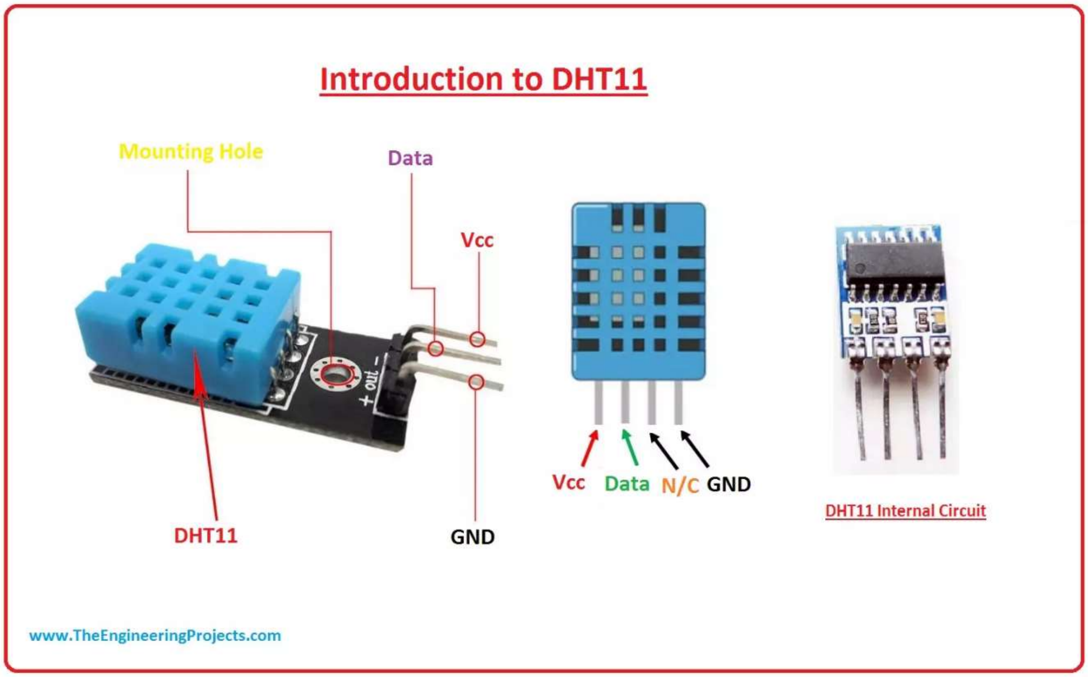


Fig IV (4): TEMPERATURE SENSOR

5. Tank Moisture sensor: Moisture sensor

The soil moisture sensor (SMS) is a sensor connected to an irrigation system controller that measures soil moisture content in the active root zone before each scheduled irrigation event and bypasses the cycle if soil moisture is above a user- defined set point. This sensor can be use to detect moisture level in transformer oil tank.

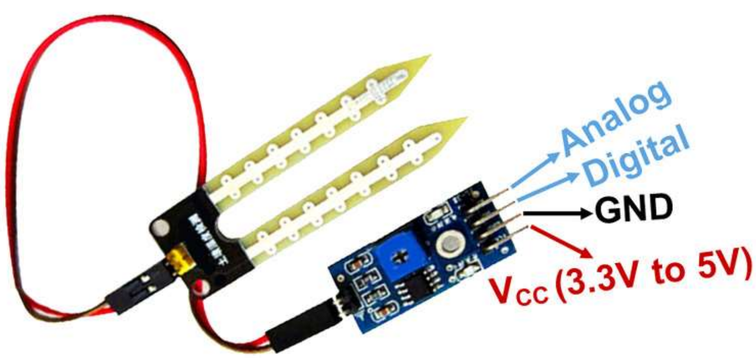


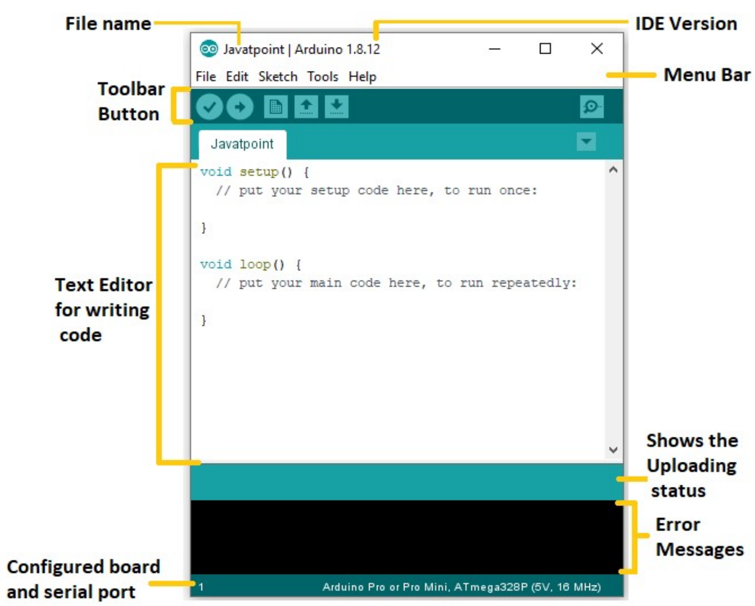
Fig IV (5): MOISTURE SENSOR

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content.

6. 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 hardware to upload programs and communicate with them.

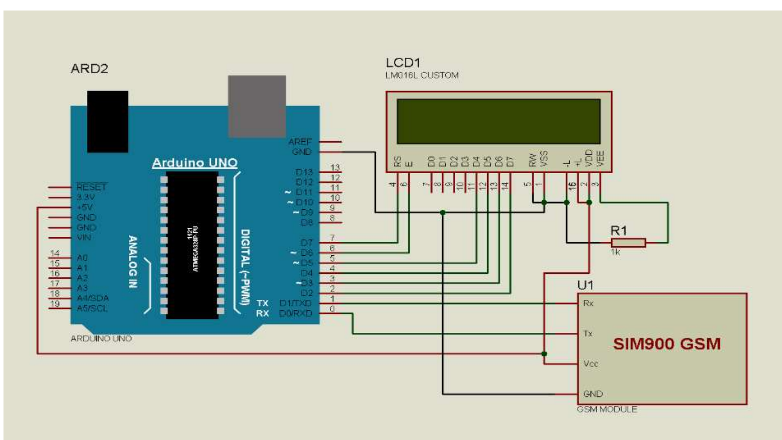
The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment. The program or code written in the Arduino IDE is often called as sketching. We need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino.' The Arduino IDE will appear as:



<u>Fig IV (6)</u>: ARDUINO IDE

7. LCD (liquid crystal display) :

The display is a 16x2 Liquid Crystal Display (LCD), which means there are 16 characters per line and two lines. The HD44780U standard refers to the controller chip that accepts data from an external source (in this case, the Atmega328) and communicates directly with the LCD. The LCD is set to its 8 bit mode, which means it uses an 8 bit data bus. EN, RS, and RW are the three control lines. "Enable" is the name of the EN line. This control line is used to inform the LCD that data is being sent. The application should first set the other two control lines or put data on the data bus before delivering data to the LCD. Bring EN high and wait for the minimum amount of time specified by the LCD datasheet before bringing it low again. The RS line stands for "Register Select." The data is handled as a command or special instruction when RS is low (0) (such as clear screen, position cursor, etc.). The data delivered when the RS is high (1) is text data that is displayed on the screen. Set RS high, for example, to display the letter "B" on the screen. The "Read/Write" control line is the RW line. The information on the data bus is written to the LCD when RW is low (0). The software successfully question s (or reads) the LCD when RW is high (1). The read command consists of only one instruction ("Get LCD status"). All of the other instructions are written commands, so RW will always be below The lines of an 8 bit data bus are designated as DB0, DB1, DB2, DB3, DB4, DB5, DB6, and DB7.



<u>Fig IV (7)</u>: LIQUID CRYSTAL DISPLAY (LCD)

8. Step Down Transformer:

It is a device for stepping down voltage from 230V to 15V. The transformer for 5V supply is 0-9V and transformer for 12V supply is 0-15V. 2) Bridge Rectifier The bridge rectifier converts ac voltage to dc voltage. The advantages of bridge rectifier are the centre tap of the transformer secondary is eliminated. It provides output twice that of centre taps circuits for the same secondary voltage. The peak inverse voltage is one half of the centre tapped circuits. C.

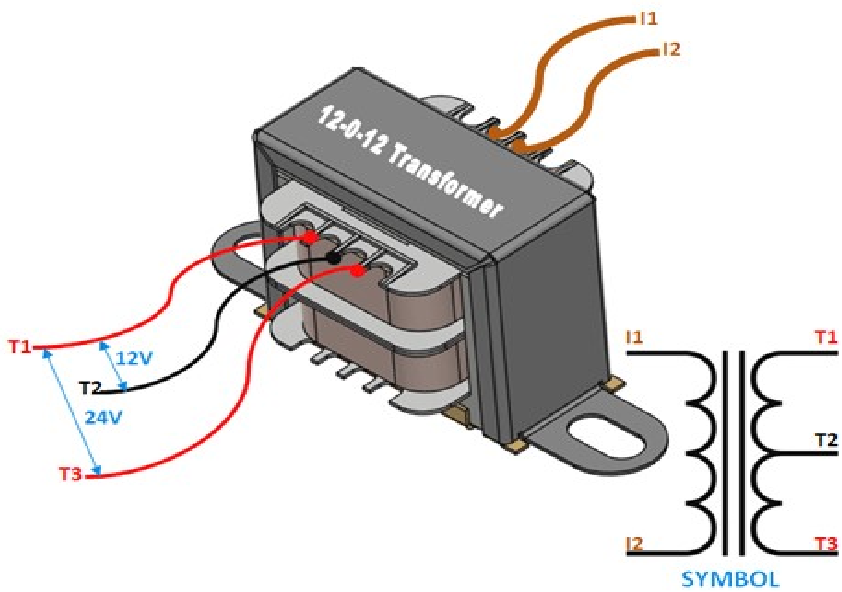


Fig IV (8): 12-0-12V STEP DOWN TRANSFORMER

9. Voltage Regulator (LM7805):

The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. Voltage regulator (LM7805) is used to maintain a constant out voltage of +5v. It is a member of 78xx series of fixed linear voltage regulator ICs. The 7800 series of the three terminal positive voltage regulators are monolithic integrated circuits designed for fixed voltage regulator for a wide variety of applications including local regulators.

It is available in seven fixed output voltage options from +5V to +24V DC The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. It is a three-terminal device. The voltage of +12v is applied to the input and it gives out +5v of output which is the requirement of microcontroller, LCD display (16*2), MAX232 and various other devices used in this project.

Fig IV (9): VOLTAGE REGULATOR

10. Lead Acid Battery:

The lead-acid battery was invented in 1859 by French physicist Gaston Plante and is the earliest, yet still most widely used, type of re-chargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, its ability to supply high surge currents means that the cells have a relatively large power-to-weight ratio. These features, along with their low cost, make them attractive for use in motor vehicles to provide the high current required by automobile starter motors.

The electrical energy produced by a discharging lead—acid battery can be attributed to the energy released when the strong chemical bonds of water (H20) molecules are formed from H ions of the acid and 0^2 ions of Pb02.[191] Conversely, during charging the battery acts as a water-splitting device, and in the charged state the chemical energy of the battery is mostly stored in the acid.

Fig IV (10): 9V LEAD ACID BATTERY

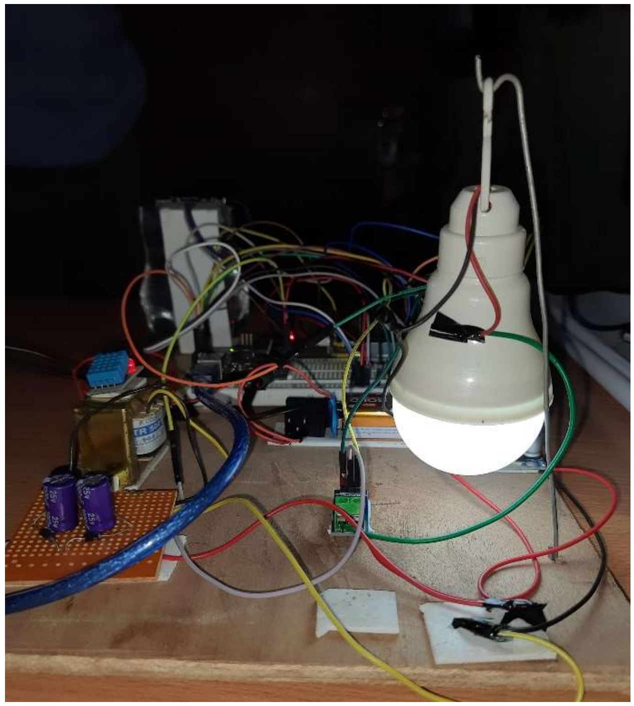
PROJECT SYSTEM EXECUTION

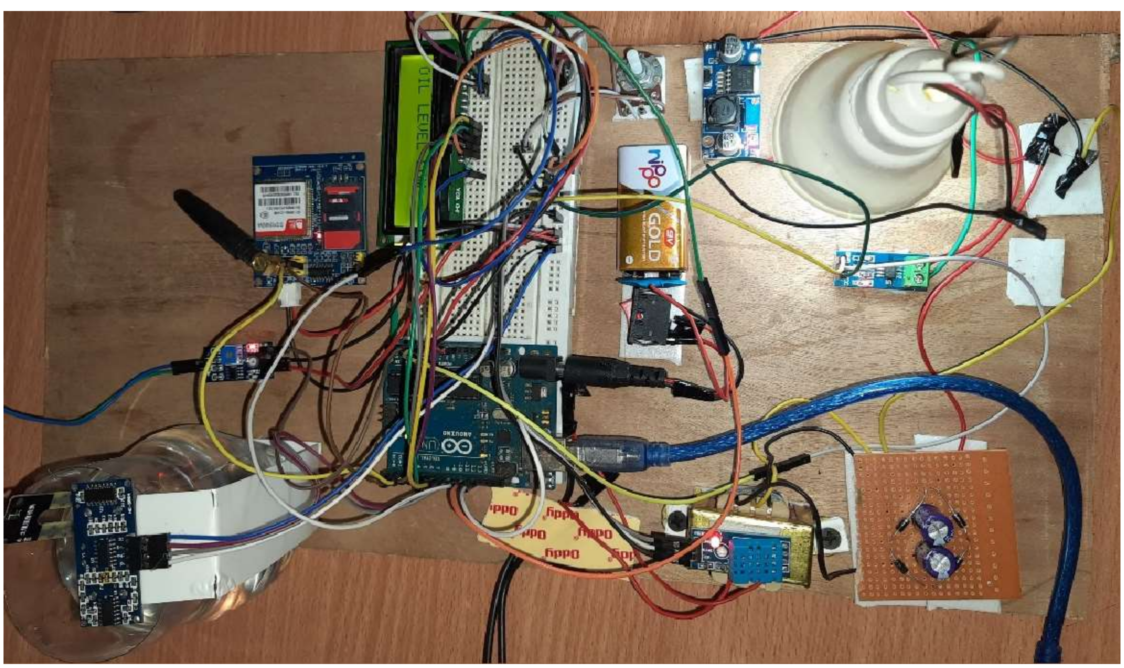
The proposed system uses an Arduino to monitor a distribution transformer's voltage, current, oil level, temperature and Moisture content. These distribution transformer parameters can be displayed on a computer or mobile device using GSM technology, which is a high-performance technology. The monitored parameters are compared to the transformer's rated values, and the Arduino is programmed to take protective action if the monitored values surpass the rated values, displaying the value on a remote PC. Transformer temperature and oil level, oil tank moisture level were detected using an DHT11 temperature sensor , ultrasonic sensor and moisture sensor.

During the development of the overall system, the hardware and software components were split into units. Smaller components of the system were built and tested, making it more manageable and efficient. The power supply unit was initially tested to confirm that it could provide the circuit with the necessary power. Before connecting with the microcontroller, the temperature sensing device was also tested, and it was discovered to be capable of generating an accurate output signal corresponding to varying temperatures. The current sensor was then verified before being connected to the microcontroller.

The outputs from the module were conditioned and supplied to the microcontroller once it was determined that the temperature sensing unit and current sensing unit gave accurate data. The GSM modem was tested with a DC 9V battery before interfacing with the microcontroller. After the final testing and coupling of the modules, the device was found to be working according to the transformer information. Analysis of the recorded data will assist the utility in monitoring the functioning of its distribution transformers and identifying issues before they become catastrophic, resulting in considerable cost savings and improved system dependability.

<u>**COMPLETE HARDWARE MODEL**</u>





RELATIONSHIP BETWEEN TIME, TEMPERATURE & TRANSFORMER OIL

The relationship between time, temperature and the current in the transformer oil can be understood through the thermal dynamics and electrical load behaviour of a transformer. Here is a detailed explanation of each factor and their relationship:

- Thermal Model Equation:

  The temperature rise (ΔT) of transformer oil can be approximated by the equation:

  $$\Delta T = P \times R_{th}$$

  Where P is the total power loss and R_{th} is the thermal resistance.

- Power loss in transformer:

  Let's say transformer is running with a load current I. The power losses P can be calculated as:

  $$P = I^2 \times R_w + R_{core}$$

  Where R_w is the resistance of the windings and P_{core} is the core loss.

  The temperature rise delta T over time over time can then be monitored to ensure it stays within safe operational limits.

HARDWARE RESULTS

This report summarizes the findings of transformer fault detection using a GSM module. The parameters monitored including current, voltage, temperature, moisture content and oil level . These parameters are critical for ensuring the safe and efficient operation of transformer .If the measured value exceeds the threshold value, it indicates a fault condition and send alerts via GSM .

Here are the operation and results :-

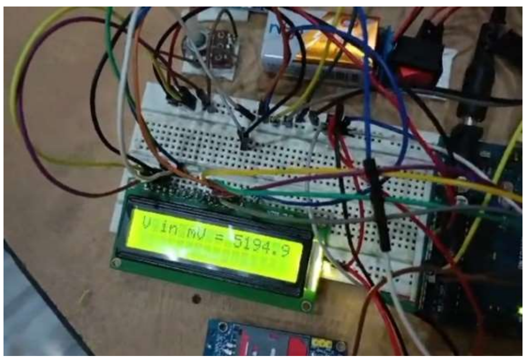


Fig IV (11): VOLTAGE READING IN mV

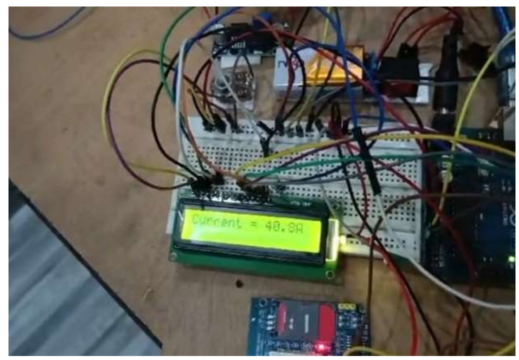


Fig IV (12): CURRENT READING IN AMP

Fig IV (13): OVER TEMPERATURE DETECTION

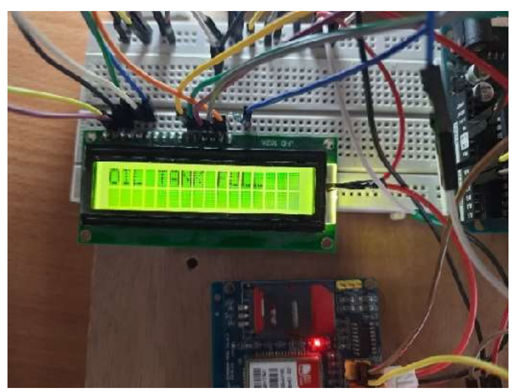


Fig IV (14): OIL LEVEL DETECTION

CHAPTER V

BENEFITS OF THE PROJECT

1. Real-Time Monitoring:

The use of GSM technology enables real-time monitoring of transformer parameters. This allows for the immediate detection of faults or abnormalities, reducing response time and minimizing the impact of potential issues.

2. Swift Fault Detection and Response:

With the integration of GSM modules, the system can send instant alerts and notifications to relevant personnel or control centres as soon as a fault is detected. This swift response capability is crucial for preventing further damage and ensuring the continuity of power supply.

3. Optimized Maintenance Planning:

Real-time data provided by the GSM-enabled system allows for more informed and efficient maintenance planning. Maintenance teams can prioritize tasks based on the actual condition of transformers, reducing the need for routine inspections and optimizing resource allocation.

4. Cost-Efficient Operation:

By focusing maintenance efforts on transformers that exhibit actual issues rather than conducting routine inspections on all units, the project contributes to a more cost-efficient operation of power distribution systems.

5. Enhanced Reliability of Power Distribution:

Overall, the benefits of a GSM-based transformer fault detection project contribute to the enhanced reliability of power distribution systems. The ability to detect and address faults in a timely manner ensures a more stable and dependable electricity supply.

LIMITATIONS OF THE PROJECT

While a GSM-based transformer fault detection system offers many advantages, it also has several limitations:

Network Dependency:

GSM Signal Availability: The system relies on GSM network coverage for communication. In remote or rural areas with poor GSM signal strength, the system may not function reliably.

Network Congestion: In areas with high network traffic, there might be delays in data transmission, leading to potential delays in fault detection and alerting.

Maintenance and Calibration:

Regular Maintenance: Sensors and GSM modules require regular maintenance and calibration to ensure accurate readings and reliable communication. This adds to the operational costs and complexity of the system.

Environmental Factors:

Weather Conditions: Extreme weather conditions can affect the performance of sensors and GSM modules. For instance, temperature sensors may provide inaccurate readings in extreme cold or heat.

Physical Damage: The system's components are vulnerable to physical damage from environmental factors such as lightning, storms, or animal interference.

Data Management:

Data Overload: Continuous monitoring generates a large amount of data that needs to be processed, analysed, and stored. Managing this data efficiently requires robust data management systems and analytical tools.

False Alarms: The system might generate false alarms due to sensor malfunctions or temporary fluctuations in monitored parameters, leading to unnecessary maintenance actions and operational disruptions.

Despite these limitations, a GSM-based transformer fault detection system can still be highly beneficial when properly implemented and maintained, especially with considerations for mitigating these challenges.

CHAPTER VI

CODES USED FOR SIMULATION

```
//GSM based trsnsformer fault detection system
#include <Wire.h>
#include <LiquidCrystal.h>
#include<SoftwareSerial.h>
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
SoftwareSerial SIM900(9, 10);
const int trigPin = 8; // Trigger Pin of Ultrasonic Sensor
const int echoPin = 7; // Echo Pin of Ultrasonic Sensor
long duration;
int OilLevel;
int delayTime = 700;
int EarthCurrent;
float SensorReadEarth;
float sensitivity = 0.185;
int temp;
float TempSensorPin = A0;
float vout;

void setup() {
// put your setup code here, to run once:
```

```
pinMode(TempSensorPin,INPUT);
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
Serial.begin(9600);
SIM900.begin(9600);
delay(100);
Serial.println(" REMOTE TRANSFORMER MONITORING");
lcd.begin(20,4);
lcd.print("PROJECT WORK");
lcd.setCursor(2,1);
lcd.print("REMOTE");
lcd.setCursor(9,1);
lcd.print("MONITORING");
lcd.setCursor(4,2);
lcd.print("TRANSFORMER");
delay (delayTime);
lcd.clear();

}
void loop() {
//temperature//
vout = analogRead(TempSensorPin);
vout = (vout * 500) / 1023;
temp = vout;
```

```
//EARTH CURRENT//
SensorReadEarth = analogRead(A1)*(5.0 / 1023.0);     //We read the sensor output
EarthCurrent = (SensorReadEarth - 2.5)/sensitivity;   //Calculate the current value for earth
// SENSING OIL LEVEL//
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
OilLevel = duration * 0.034 / 2;
//LCD PRINTING//
lcd.setCursor(0,0);
lcd.print("Temperature:");
lcd.setCursor(12,0);
lcd.print(temp);
lcd.setCursor(15,0);
lcd.print("C");
lcd.setCursor(0,1);
lcd.print("Oil Level:");
lcd.setCursor(10,1);
lcd.print(OilLevel);
lcd.setCursor(14,1);
lcd.print("CM");
```

```
lcd.setCursor(0, 2);
lcd.print("Earth Current:");
lcd.setCursor(14, 2);
lcd.print(EarthCurrent,2);
lcd.setCursor(16, 2);
lcd.print("A");
delay(600);
condition();
}
void sms()
{
SIM900.print("AT+CMGF=1\r");
SIM900.println("AT + CMGS = \"+233558254026\"");// recipient's mobile number
Serial.println("AT + CMGS = \"+233558254026\"");// recipient's mobile number
SIM900.println("HIGH TRANSFORMER TEMPERATURE"); // message to send
Serial.println("HIGH TRANSFORMER TEMPERATURE");
SIM900.println((char)26); // End AT command with a ^Z, ASCII code 26
Serial.println((char)26);
SIM900.println();
}
void sms1(){
SIM900.print("AT+CMGF=1\r");
SIM900.println("AT + CMGS = \"+233558245026\"");// recipient's mobile number
Serial.println("AT + CMGS = \"+233558245026\"");// recipient's mobile number
```

```
SIM900.println("OIL TANK FULL"); // message to send
Serial.println("OIL TANK FULL");
SIM900.println((char)26); // End AT command with a ^Z, ASCII code 26
Serial.println((char)26);
SIM900.println();
}
void sms2(){
SIM900.print("AT+CMGF=1\r");
SIM900.println("AT + CMGS = \"+233558245026\"");// recipient's mobile number
Serial.println("AT + CMGS = \"+233558245026\"");// recipient's mobile number
SIM900.println("LOW OIL LEVEL"); // message to send
Serial.println("LOW OIL LEVEL");
SIM900.println((char)26); // End AT command with a ^Z, ASCII code 26
Serial.println((char)26);
SIM900.println();
}
void sms3(){
SIM900.print("AT+CMGF=1\r");
SIM900.println("AT + CMGS = \"+233558245026\"");// recipient's mobile number
Serial.println("AT + CMGS = \"+233558254026\"");// recipient's mobile number
SIM900.println("EARTH FAULT CURRENT"); // message to send
Serial.println("EARTH FAULT CURRENT");
SIM900.println((char)26); // End AT command with a ^Z, ASCII code 26
Serial.println((char)26);
```

```
SIM900.println();
}
//CONDITIONS
void condition()
{
  if (temp > 75)
{
lcd_tempPrint();
sms();
delay(300);
}
if (OilLevel > 800)
{
lcd_oilLevelFULLPrint();
sms1();


delay(1000);
}else if (OilLevel < 300)
{lcd_oilLevelLOWPrint();
sms2();
delay(300);
}
}
// LCD PRINTING CONDITION//
```

```
void lcd_oilLevelFULLPrint()
{
lcd.clear();
lcd.setCursor(1,1);
lcd.clear();                    //if condition temp for it to print.
lcd.print("OIL TANK FULL");
}
void lcd_oilLevelLOWPrint()
{
lcd.clear();
lcd.setCursor(0,2);
lcd.clear();                    //if condition temp for it to print.
lcd.print("OIL LEVEL LOW");
}
void lcd_tempPrint()
{
lcd.clear();
lcd.setCursor(0,0);
lcd.clear();                    //if condition temp for it to print.
lcd.print("HIGH TEMPERATURE");


}
```

CHAPTER VII

CONCLUSION

Our project on transformer fault detection using GSM technology represents a significant stride towards enhancing the reliability and efficiency of power distribution systems. The integration of GSM technology with transformer fault detection not only enables real-time monitoring but also facilitates prompt response to potential issues and preventing catastrophic failures. Through the implementation of advanced sensors and communication systems, the project has successfully demonstrated the capability to detect various transformer faults, including temperature fluctuations, oil level and abnormal voltage conditions.

The utilization of GSM technology offers a seamless and cost-effective solution for transmitting critical data to a central monitoring system. This remote monitoring capability allows for timely decision-making and the implementation of preventive measures, ultimately contributing to the overall resilience of the power grid.

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