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GSM Based Transformer Healthcare Monitoring with Overload Alert and Protection

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Abstract: *The "Transformer Health Monitoring System" project presents a proactive and cost-effective solution for monitoring power transformers in electrical distribution networks, addressing the critical need for reliable maintenance. Leveraging the ATmega328P microcontroller, the system continuously monitors vital parameters such as oil level, quality, voltage, current, and temperature. With real-time data visualization through a user-friendly display module and advanced fault detection algorithms, the system ensures prompt identification of issues. Integration of a GSM module enables instant alerts to designated recipients, facilitating swift response to faults. Scalability across multiple transformers streamlines monitoring and maintenance, enhancing grid stability, reducing downtime, and supporting environmental conservation efforts. This project underscores a commitment to reliability, safety, and sustainability in power distribution networks..*

Keywords: Health Monitoring, ATmega328P, Real-time data, fault detection, GSM.

I. INTRODUCTION

1.1 Overview

The reliable and uninterrupted supply of electrical power is indispensable to modern society, with transformers serving as the backbone of our power infrastructure. These often overlooked devices play a vital role in efficiently transmitting electricity over long distances and delivering it safely to homes and businesses. Yet, the durability of transformers is not indefinite; they degrade over time and are prone to failure. To ensure the resilience of power grids and avoid costly downtime, advanced monitoring systems are essential. Enter the "Transformer Health Monitoring System," a groundbreaking initiative aimed at safeguarding the indispensable role transformers play in our daily lives.

This project is a comprehensive solution designed to tackle the intricate challenge of transformer health and reliability. Centered around the ATmega328P microcontroller, it takes a holistic approach to monitoring transformers, evaluating crucial parameters that signify their overall condition. These parameters encompass oil level, oil quality, output current, voltage, and temperature – all pivotal indicators of a transformer's health.

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Additionally, the system boasts proactive fault detection capabilities, continuously monitoring critical parameters to identify anomalies and deviations from optimal operating conditions. In the event of a fault or hazardous condition, an automatic shutdown process is triggered to prevent further damage, thereby reducing the risk of catastrophic failures and minimizing repair costs. To facilitate seamless communication and alerting, the project incorporates a GSM module, enabling real-time notification of detected faults to designated personnel or authorities. Such rapid communication is crucial in facilitating immediate responses, reducing downtime, and ensuring the reliability of electrical grids. In summary, the Transformer Health Monitoring System is not just a technological marvel but a critical tool in enhancing the resilience of electrical infrastructure and guaranteeing the continuous flow of power that fuels our modern world.

1.2 Motivation

The motivation behind the "Transformer Health Monitoring System" project is rooted in the critical importance of ensuring the reliability and resilience of power grids. With transformers playing a pivotal role in electricity distribution, the project aims to proactively address the risk of downtime, financial losses, and environmental hazards associated with transformer failures. By leveraging advanced monitoring technologies and real-time data analysis, the system seeks to enhance grid stability, protect investments, and ensure uninterrupted access to electricity, thereby safeguarding the vital services and infrastructure that depend on it.

1.3 Problem Definition and Objectives

The problem addressed by the "Transformer Health Monitoring System" project lies in the vulnerability of transformers to degradation and failure over time, posing risks to the reliability of power grids and incurring significant costs.

- To continuous monitor oil level to prevent oil shortages.
- To assess oil quality in real-time to ensure optimal transformer performance.
- To monitor and record output current and voltage for operational insights.
- To continuous measure and log transformer temperature for early overheating detection.
- To implement a user-friendly display module for data visualization.

1.4. Project Scope and Limitations

The scope of the "Transformer Health Monitoring System" project encompasses the development and implementation of a comprehensive monitoring solution for power transformers in electrical distribution networks. This includes the design of hardware and software components, integration of communication technologies, and real-time data visualization capabilities. The system aims to provide continuous monitoring of vital transformer parameters and facilitate proactive maintenance to enhance grid reliability.

Limitations As follows:

- The system's effectiveness may be limited by factors such as environmental conditions and variations in transformer designs.
- Integration with legacy infrastructure may present compatibility challenges, potentially limiting deployment in certain settings.
- The system's ability to predict all potential failure modes may be constrained by the complexity of transformer behavior and operating conditions.

II. LITERATURE REVIEW

Transformer Health Monitoring System Based Internet of Things:

Authors: gayathri.r, nanthini.s, maheshwari.m, akila.s.

Summary: The paper proposes a real-time monitoring system for transformers using IoT technology. It utilizes sensors to collect transformer parameters and sends data to a microcontroller, which is then transmitted to an IoT

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web server. This system aims to minimize effort and improve accuracy and efficiency in monitoring transformer health.

Transformer Health Monitoring and Protection Using IoT:

Authors: Dr. Sachin gee paul, Ashiksanthosh, Bintothambi, Denitshibu, Devaprasad.

Summary: This paper focuses on monitoring transformer parameters such as temperature, current, voltage, and oil level using IoT. Data collected by sensors is sent to an Arduino Uno microcontroller and transmitted through an ESP8266 Wi-Fi module, allowing remote access and identification of potential failures.

Transformer Health Monitoring System Using Android Device:

Authors: Suja.k, Yuvaraj.t.

Summary: The paper utilizes IoT to monitor and detect transformer faults, sending immediate alerts to authorized individuals. Sensors measure temperature, oil level, and vibration, with data transferred to a controller. If indicators exceed threshold values, alerts are sent to concerned personnel via an Android device.

Transformer Real-Time Health Monitoring By Using IoT:

Authors: VaibhavShashikantKanase, SatishBabasoPatil, PruthvirajDinkarPatil, Sanket Sanjay Wadkar.

Summary: This project employs IoT-based software to detect real-time faults in transformers. Sensors measure temperature, voltage, current, and other parameters, with data sent to a remote location for monitoring. The system aims to enhance reliability and reduce costs by identifying potential failures early.

IoT Based Distribution Transformer Health Monitoring System Using Arduino, NodeMCU, and ThingSpeak:

Authors: Bijurajan b, Amanraj s, Akhil s, Nayana s.

Summary: This paper proposes real-time monitoring of distribution transformer health using IoT. Sensors measure temperature, voltage, and current, with data recorded and processed using Arduino. The system aims to improve reliability and reduce human dependency by identifying and solving problems before failures occur.

III. REQUIREMENT AND ANALYSIS

DS18B20 Sensor:

- **Working Principle:** Utilizes the One-Wire protocol for digital temperature measurement. It communicates with a microcontroller through a single data line.
- **Key Features:** High precision, wide temperature range, ability to connect multiple sensors on a single bus, parasite power mode, waterproof versions, and low power consumption.
- **Communication:** Uses the One-Wire protocol for digital communication with the microcontroller.
- **Applications:** Environmental monitoring, industrial automation, HVAC systems, consumer electronics, and scientific research.
- **Interfacing:** Easily interfaced with microcontroller platforms like Arduino and Raspberry Pi.
- **Accuracy and Calibration:** Provides accurate temperature measurements, but calibration may be necessary for specific applications.

ATmega328P Microcontroller:

- **Features:** 8-bit microcontroller with 32KB Flash memory, 2KB SRAM, and 1KB EEPROM. Offers 23 GPIO pins, a 10-bit ADC, multiple timers/counters, and support for USART, SPI, and I2C communication interfaces.
- **Applications:** Widely used in robotics, IoT devices, and various embedded systems applications.
- **Interfacing:** Can be programmed using a bootloader, making it popular in the Arduino community.
- **Pin Descriptions:** Provides various I/O pins, analog input pins, communication pins, interrupts, and PWM outputs.

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GSM Module (900A):

- **Frequency Band:** Operates in the 900 MHz frequency band with specific ranges for uplink and downlink.
- **Modulation:** Utilizes Gaussian Minimum Shift Keying (GMSK) modulation for encoding digital information onto radio waves.
- **Multiple Access:** Employs Time Division Multiple Access (TDMA) and Frequency Division Multiple Access (FDMA) techniques.
- **Data Transfer:** Supports voice communication and data transfer at relatively low speeds.
- **Network Architecture:** Consists of various components like Mobile Stations, Base Transceiver Stations, Base Station Controllers, etc.
- **Security:** Incorporates encryption and authentication for protecting communications.
- **Applications:** Voice communication, text messaging (SMS), international roaming, and security.

IR Sensor:

- **Working Principle:** Detects infrared radiation emitted by objects. Utilizes an IR LED transmitter and IR photodiode receiver.
- **Types:** Active IR sensor (with transmitter and receiver) and passive IR sensor (with only a receiver).
- **Applications:** Remote controls, motion detection, object detection, and proximity sensing.
- **Circuit Diagram:** Typically consists of an IR LED, photodiode, resistors, and a comparator circuit.

Ultrasonic Sensor:

- **Working Principle:** Emits sound waves at a high frequency and measures the time taken for the waves to reflect back from objects.
- **Features:** Wide range of detection, high accuracy, and immunity to background interference.
- **Applications:** Distance measurement, object detection, level sensing, and industrial automation.
- **Timing Diagram:** Describes the sequence of events in ultrasonic ranging.

Transformers:

- **Working Principle:** Transfer energy by inductive coupling between winding circuits.
- **Specifications:** Input voltage, output voltage, output current, mounting type, and winding material (usually copper).
- **Features:** Soft iron core, high current drain capacity, and copper winding.
- **Applications:** AC/AC conversion, battery chargers, and high-current applications.

16x2 LCD:

- **Features:** 16 characters per line, 2 lines, low power operation, and standard connector for easy interfacing.
- **Applications:** Displaying text and characters in various electronic devices and circuits.
- **Interface Pin Description:** Pins for power, data, and control signals.

Relay:

- **Function:** Electromechanical switch used for high-current applications. Provides isolation between control and load circuits.
- **Types:** Normally Open (NO), Normally Closed (NC), and Changeover (CO).
- **Applications:** Motor control, switching high-power devices, and automation systems.

Buzzer:

- **Function:** Produces audio signals for alarms, notifications, and user feedback.
- **Applications:** Alarm systems, timers, and user interface signaling.

Optocoupler PC817:

- **Function:** Optically couples input and output circuits, providing electrical isolation.
- **Features:** 4-pin DIP package, high isolation voltage, and high collector-emitter voltage.
- **Applications:** Isolated signal transmission, noise suppression, and voltage level shifting.

Transistor BC547:

- **Function:** Semiconductor device used for amplification or switching electronic signals.
- **Features:** Commonly used NPN transistor with high current gain.
- **Applications:** Amplifiers, switches, and signal processing circuits.

IV. SYSTEM DESIGN

4.1 Working of the Proposed System

The system for monitoring the health of a transformer comprises several key components. The primary focus is on the transformer itself, as it is the central asset under surveillance. The transformer's well-being is monitored through a set of sensors, each serving a specific purpose. These sensors include the oil level sensor, oil quality sensor, current sensor, voltage sensor, and temperature sensor. The role of these sensors is to collect essential data about the transformer's oil, current flow, voltage, and temperature.

At the heart of the system lies the Atmega328p microcontroller. This microcontroller serves as the brain of the operation, responsible for collecting data from the various sensors, processing it, and making determinations regarding the transformer's health. It compares the collected sensor data to predefined thresholds to assess the condition of the transformer.

The results of this assessment are displayed to the user via the display module, which provides real-time information on the transformer's health status, including details on oil level, oil quality, current, voltage, temperature, and an overall health assessment.

Furthermore, the system is equipped with a GSM module, which plays a crucial role in alerting the user in the event of a fault. Should any sensor data exceed the predetermined thresholds, the Atmega328p microcontroller triggers the relay module. This relay module, in turn, takes action by automatically closing the transformer output, preventing further damage. Simultaneously, the microcontroller utilizes the GSM module to notify the user of the issue through SMS messages or emails.

This versatile system is designed to monitor transformers of all sizes and types, offering a straightforward, cost-effective solution for transformer health monitoring. With its robust and interconnected components, it ensures the transformer's well-being and significantly reduces the risk of damage and downtime. Whether in industrial or utility settings, this system provides a reliable means of safeguarding these critical assets.

The below figure specified the system architecture of our project.

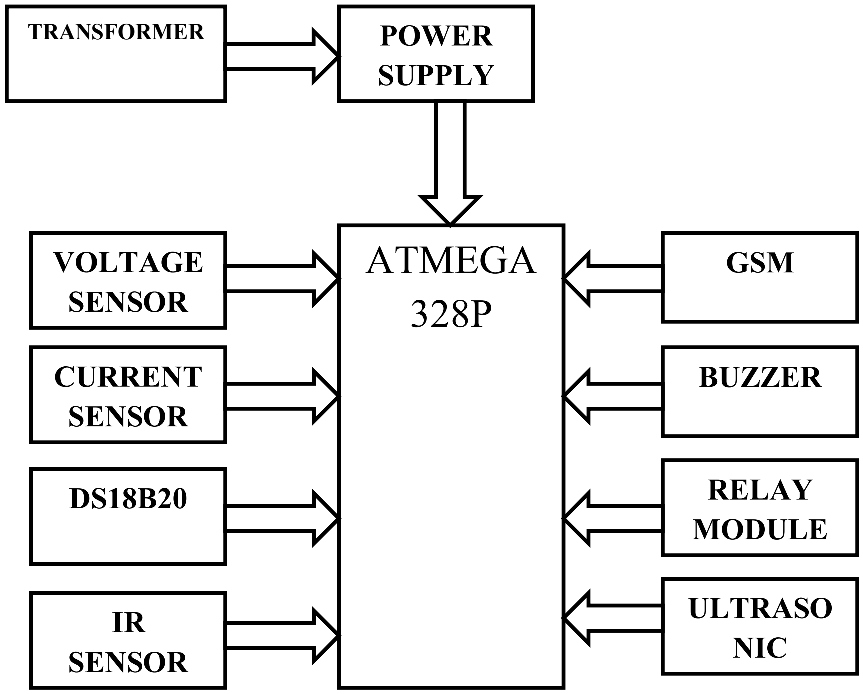

Figure 4.1: System Architecture Diagram

4.2 PCB Layout

The below figure specified the PCB Layout Diagram of our project.

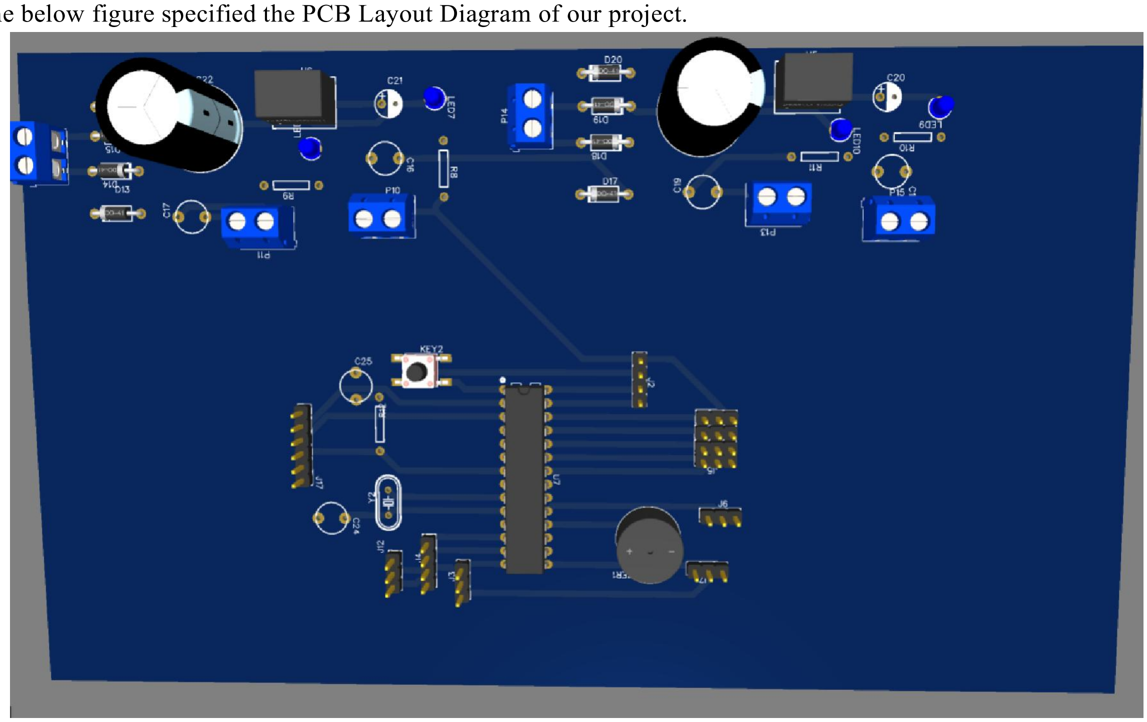

Figure 4.2: PCB Layout

4.3 Result

The GSM Based Transformer Healthcare Monitoring System with Overload Alert and Protection is designed to ensure the optimal functioning and safety of transformers in real-time. By integrating GSM technology, the system enables remote monitoring of transformer health parameters such as temperature, voltage, and current. In case of any abnormal conditions such as overload, the system triggers instant alerts via SMS, allowing for timely intervention to prevent damage or failure. Additionally, the system incorporates protective measures to mitigate potential risks, ensuring reliable and efficient operation of transformers while providing peace of mind to operators and maintenance personnel.

V. CONCLUSION

Conclusion

In summary, the Transformer Health Monitoring System is a valuable tool for safeguarding power distribution networks. It can detect issues early, reducing downtime and costs. However, it comes with setup complexity and maintenance requirements, and occasional false alarms. When used thoughtfully, it's a key asset for a more reliable and efficient power supply.

Future Work

In future iterations, the GSM Based Transformer Healthcare Monitoring System with Overload Alert and Protection could be enhanced by incorporating advanced machine learning algorithms for predictive maintenance. By analyzing historical data and patterns, the system could anticipate potential failures or abnormalities in transformer performance, enabling proactive maintenance actions to be taken before critical issues arise. Furthermore, integration with cloud-based platforms could enable remote access to real-time monitoring data, facilitating comprehensive analytics and reporting for improved decision-making and overall system efficiency. Additionally, exploring the integration of IoT (Internet of Things) sensors for more granular monitoring of transformer components could further enhance the system's capabilities and reliability.

BIBLIOGRAPHY

[1]. Dallas Semiconductor. (2007). DS18B20 Programmable Resolution 1-Wire Digital Thermometer. Datasheet. Retrieved from https://datasheets.maximintegrated.com/en/ds/DS18B20.pdf

[2]. Atmel Corporation. (2016). ATmega328/P Datasheet. Retrieved from http://ww1.microchip.com/downloads /en/DeviceDoc/ATmega48A-PA-88A-PA-168A-PA-328-P-DS-DS40002061A.pdf

[3]. GSM Association. (n.d.). GSM Technology. Retrieved from https://www.gsma.com/aboutus/history/

[4]. GSM Association. (n.d.). Global System for Mobile Communications (GSM). Retrieved from https://www.gsma.com/aboutus/history/gsm-technology/

[5]. Electronics Hub. (2022). Introduction to Infrared Sensors: Working, Types, and Applications. Retrieved from https://www.electronicshub.org/introduction-to-infrared-sensors/

[6]. Electronics Hub. (2022). IR Sensor Circuit and Working Principle. Retrieved from https://www.electronicshub.org/ir-sensor-circuit-working-principle/

[7]. Quora. (2019). What Is the Working Principle of Ultrasonic Sensor? Retrieved from https://www.quora.com/What-is-the-working-principle-of-ultrasonic-sensor

[8]. Microsonic. (n.d.). Ultrasonic Sensors. Retrieved from https://www.microsonic.de/en/products/ultrasonic-sensors.html

[9]. Electronics Hub. (2022). Working Principle of Ultrasonic Sensor. Retrieved from https://www.electronicshub.org/ultrasonic-sensor-working-principle/

[10]. Mouser Electronics. (n.d.). Murata. (2018). Potting, Encapsulation, and Coating Materials Selection Guide. Retrieved from https://www.mouser.com/pdfdocs/Murata%20Potting%20Encapsulation%20and%20Coating%20Materials%20Selection%20Guide.pdf

[11]. ElecCircuit.com. (2022). Working with Relays. Retrieved from https://www.eleccircuit.com/working-with-relays/

[12]. Electronics Club. (2022). How Relays Work. Retrieved from https://www.electronicsclub.info/relays.htm

[13]. Electronics Hub. (2022). How to Interface Relay with Microcontroller. Retrieved from https://www.electronicshub.org/interface-relay-microcontroller/

[14]. Electronics Hub. (2022). Basics of Buzzer or Beeper. Retrieved from https://www.electronicshub.org/basics-of-buzzer-or-beeper/