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ELECTROVITAL TRANSFORMER SUPERVISOR

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ABSTRACT- In order to guarantee the secure and effective functioning of power transformers in electrical networks, Electro Vital Transformer Supervisor is a crucial system. Power transmission and distribution depend heavily on transformers, and any malfunction in these systems might result in major power outages, monetary losses, and safety hazardsIn order to continually monitor crucial indicators like temperature, oil level, and other potential defects, this project develops a straightforward and affordable monitoring system at the diploma level. Early defect identification is essential to prevent unplanned breakdowns and lower maintenance costs since transformers are costly and vital equipment.The primary goal of the suggested system is to employ temperature sensors, such as thermistors or digital temperature sensors, to monitor the temperature of the transformer winding and insulating oil. Overloading, deteriorating insulation, or cooling system failure can all result in a temperature increase over the acceptable limit. Excessive heat can seriously harm the transformer winding and shorten its lifespan if it is not noticed in time. As a result, ongoing temperature monitoring is essential to preserving transformer health and guaranteeing secure operation under various load scenarios.

Keywords Transformer Health Monitoring, Power Transformer Protection, Temperature Monitoring, Oil Level Monitoring, Fault Detection System, Overvoltage Protection, Aurdino

I. INTRODUCTION

When environmental and operational issues make it impossible to continuously observe transformers, transformer monitoring systems are crucial. Transformer performance and dependability can be greatly impacted by elements including dust, humidity, intense sunshine, and wet weather. Therefore, in order to track critical metrics and guarantee safe operation, a suitable monitoring system is needed. Temperature, oil level, current, and voltage are the primary factors taken into account in this project as they have a direct impact on a transformer's efficiency and health. Power electronics, electronics, and electrical systems are the three primary components of the project. Every component is crucial to the measurement, processing, and analysis of transformer data. Electricity distribution in contemporary power systems rely on a number of parts and machinery that assist in controlling and distributing power in accordance with demand. The transformer is the most important of them as it provides low-voltage customers with direct electrical power distribution. The power network's overall performance and dependability are significantly impacted by the transformer's state of operation. The majority of transformers used in distribution systems have been in use for a long time under various mechanical, electrical, and environmental circumstances. A sizeable amount of capital investment in the power industry is made up of these transformers. Transformers must function within the rated parameters listed on their nameplates in order to have a long service life.

II. OBJECTIVES

- Main aim of reducing or overcoming faults that occur in transformers
- The system is designed to prevent transformer faults caused by overcurrent, temperature rise in transformer oil, and overvoltage conditions
- To alert the operator, the system uses a buzzer and display unit.
- To provide real-time condition assessment of the transformer based on its operating parameters and age.
- Another important aspect of this system is early fault detection

III. SYSTEM OVERVIEW

The Electro Vital Transformer Supervisor System was created to guarantee electrical transformers operate safely and effectively. Transformers are crucial parts of power networks because they distribute electricity and convert voltage. Any transformer failure can have major repercussions, including power outages, equipment damage, and financial loss. Therefore, to ensure performance and dependability, transformer parameters must be continuously monitored. This system employs a variety of sensors to monitor vital characteristics including temperature, voltage, current, and oil level. Real-time data collecting is made possible by the integration of various sensors, which aids in the early detection of aberrant circumstances. The system can identify problems like overheating, under voltage, overload, and oil level drop before they worsen by continually monitoring these factors. The Arduino Uno serves as the primary processing unit and is at the center of the system. It gathers information from every sensor that is attached and processes it in accordance with preprogrammed guidelines. In order to ensure that the system reacts promptly to any aberrant state, the microcontroller plays a critical role in decision-making. The system's power supply part is thoughtfully built to give every component a steady DC voltage. Together, the voltage regulator, bridge rectifier, and transformer transform an AC source into controlled DC power. This guarantees the microcontroller and sensors will operate dependably. Additionally, the system includes a display device, usually a 16x2 LCD, that shows transformer parameters in real time. This eliminates the need for sophisticated instruments and makes it simple for users to check the state of the system. Additionally, when a fault situation is recognized, a buzzer is added to offer aural notifications.

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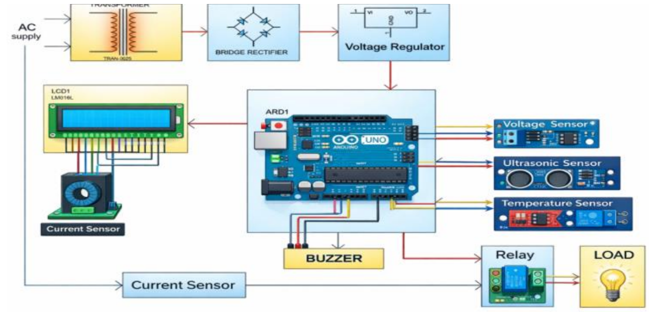

Fig.1- System Design

The load attached to the transformer is managed by a relay module. The relay protects the transformer from harm by instantly disconnecting the load in the event of any abnormal situation, such as extreme temperature or voltage fluctuation. This automated safeguard lowers the chance of failure and improves system safety. Additionally, an additional monitoring capability is included with the addition of an ultrasonic sensor for oil level measuring. Transformer cooling and insulation depend on maintaining the right oil level, and monitoring this level helps avoid overheating and insulation failure. All things considered, this method is an economical and effective way to monitor transformers It increases the longevity and safety of transformers, decreases the need for human inspection, and increases the precision of fault detection. It is quite appropriate for contemporary power system applications due to the integration of sensors, control units, and protective mechanisms.

IV. HARDWARE COMPONENTS

4.1 Arduino UNO (Microcontroller)

It is an open-source platform for electronics project development. A physical programmable circuit board, also known as a microcontroller, plus an IDE (Integrated Development Environment) piece of software that runs on your computer and is used to create and upload computer code to the board make up Arduino. For good reason, the Arduino platform has grown in popularity among those who are new to electronics. In contrast to the majority of earlier programmable circuit boards, the Arduino just requires a USB cable to load fresh code into the board rather than a separate piece of hardware known as a programmer.. FinallyArduino offers a standard form factor that simplifies the micro-controller's capabilities into a more manageable package. One of the most well-liked boards in the Arduino family, the Uno is an excellent option for novices. Later in the course, we'll discuss what's on it and its capabilities. Arduino has been the brains behind hundreds of projects throughout the years, ranging from sophisticated scientific apparatus to commonplace items. This open-source platform has brought together a global community of makers, including students, hobbyists, artists, programmers, and professionals. Their efforts have resulted in an amazing quantity of accessible knowledge that may be very helpful to both beginners and specialists.

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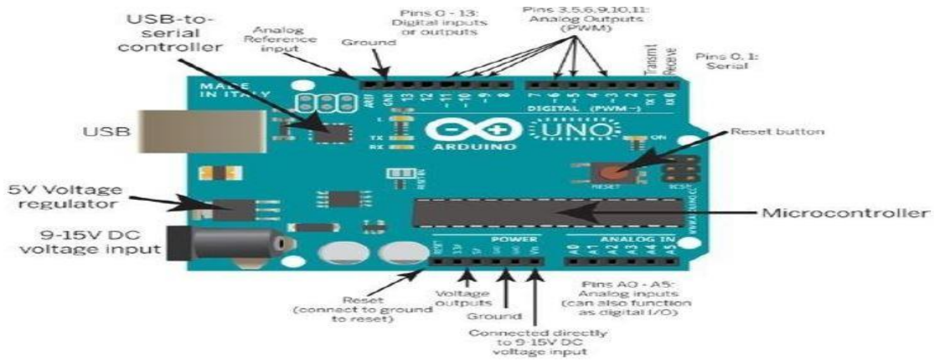

Fig.2- Arduino UNO (Microcontroller)

4.2 Bridge rectifier

An electrical device that changes alternating current (AC) into direct current (DC) is called a rectifier. Diodes' unidirectional conduction feature, which permits current to flow only in one direction (forward-biased) and blocks it in the other (reverse-biased), is the foundation of their operation. A typical component of electronic power supply is the bridge rectifier circuit. In order to power the numerous electronic fundamental components from the available AC mains supply, many electronic circuits require rectified DC power supplies. Numerous electronic AC power devices, such as household appliances, motor controllers, modulation processes, welding applications, etc., need rectifiers.

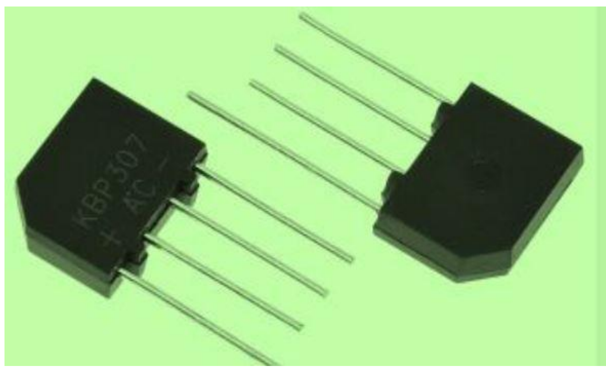

Fig.3- Bridge Rectifier

4.3 Voltage Regulator

An electrical circuit known as a voltage regulator keeps the output voltage steady despite variations in the input voltage or the load. It operates on the feedback control principle: The regulator modifies its internal resistance or conduction when the output voltage fluctuates to maintain a constant output. The Arduino, ultrasonic sensors, LEDs, and buzzer in this project are all supplied with a steady 5 V DC by the IC 7805, a fixed 5 V linear voltage regulator.

Voltage Regulator IC 7805:

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The integrated circuit 7805 is a voltage regulator. It belongs to the fixed linear voltage regulator integrated circuit (IC) 78xx class. A circuit's voltage source could fluctuate and fail to provide a fixed voltage output. The output voltage is kept constant by the voltage regulator integrated circuit. The fixed output voltage that 78xx is intended to supply is indicated by the xx. 7805 offers a controlled power source at +5V. Depending on the corresponding voltage levels, capacitors of appropriate values can be connected at the input and output pins.

4.4 Buzzer

A buzzer responds to an input of some kind by making a sound. They can make the sound using a variety of tools, such as electromechanical devices or metal clappers. A buzzer must be able to absorb energy and transform it into aural energy. Many buzzers are directly powered by the device's power source and are a component of a bigger circuit. In some situations, though, the buzzer can be battery-operated and activate in the event of a mains failure. To let the user know that they are operating on backup power rather than mains power, certain emergency power devices incorporate buzzers. An electrical gadget called a piezo buzzer is frequently used to create sound. It may be used in a variety of applications, such as computers, call bells, car/truck reversing indicators, and more, due to its light weight, straightforward design, and affordable pricing. The inverse principle of piezo electricity, which Jacques and Pierre Curie discovered in 1880, is the foundation of the piezo buzzer.

V. WORKING PRINCIPLE

Circuit Diagram: -

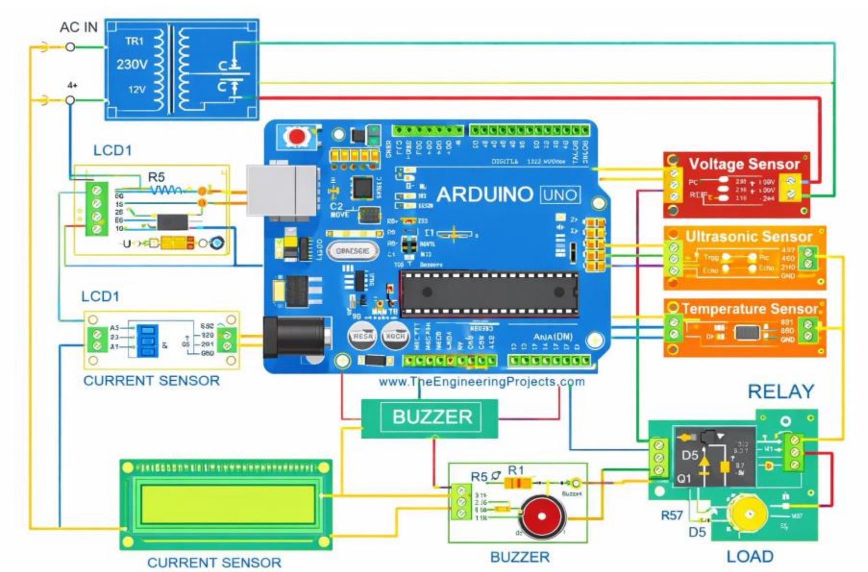

Fig.4- Circuit Diagram of the System

An Arduino Uno controller-based smart transformer monitoring and protection system is depicted in the circuit diagram. The system starts with an AC supply that is converted from 230V to 12V via a converter. A bridge rectifier is then used to convert this lower AC voltage to DC, and capacitors are used to filter out any ripples. A voltage regulator guarantees the steady DC output (usually 5V)

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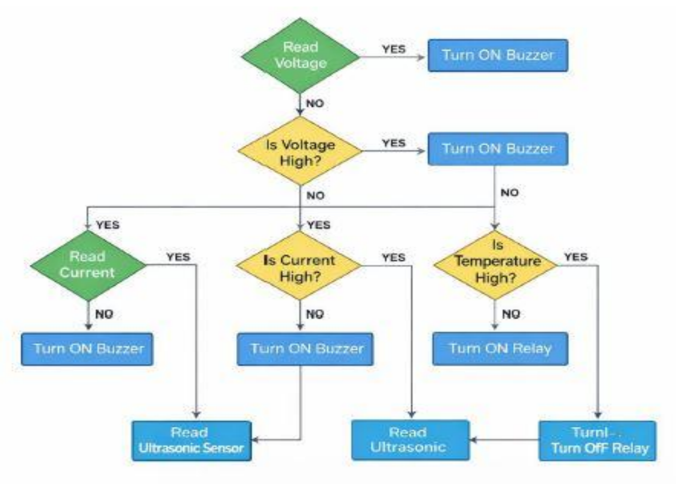
needed to power the Arduino and related parts. As the system's central processing unit, the Arduino Uno continually gathers information from various sensors and makes decisions based on that Information . To keep an eye on the input or transformer voltage levels, the voltage sensor is attached. It gives the Arduino analog signals, which are then analyzed to identify overvoltage or undervoltage situations. In a similar vein, the current sensor helps detect overload or fault conditions by measuring the load current passing through the system.

In order to ensure that overheating circumstances are identified early, a temperature sensor is also installed to monitor the transformer oil or ambient temperature. An ultrasonic sensor is also provided, which, depending on the application, can be utilized for distance tracking or level measurement (such as the oil level in the transformer tank). The Arduino is interfaced with an LCD display to offer real-time visual feedback on variables like temperature, voltage, and current. This makes it easier for the operator to keep an eye on system conditions. As an alert system, a buzzer is connected.

An open-source application called the Arduino Integrated Development Environment (IDE) is used to write, compile, and upload programs (sketches) to Arduino microcontroller boards, including the Arduino UNO, Mega, Nano, and others. By integrating a code editor, compiler, and uploader into a single program, the IDE offers an intuitive platform that streamlines embedded system development.

Flow Chart of the System



The flowchart uses a series of YES/NO decision processes to illustrate the ElectroVital Transformer Supervisors' operating logic. When the system first boots up, it reads the voltage value from the voltage sensor. The system instantly sounds the buzzer to signal a problem if the voltage is found to be abnormal (YES condition).If the answer is NO, it checks to see if the voltage level is high. The buzzer is activated once more to alert the user if excessive voltage is detected. The system shifts to use the current sensor to monitor the current if the voltage is normal. The buzzer serves as an alarm system if excessive current is found (YES). The system continues if the current is within limitations (NO). The temperature sensor is next examined. In order to prevent damage, the system disconnects the load by turning off the relay if the temperature is high (YES). The relay stays on if the temperature is normal (NO), enabling the load to operate normally. The ultrasonic sensor also keeps an eye on the environment all the while. This sequential YES/NO decision-making guarantees the transformer system's automated protection, fault detection, and real-time monitoring.

Experimental Set up

Fig.5- Experimental Set up

Critical parameters including voltage, current, temperature, and environmental variables are continually measured by the Electro Vital Transformer Supervisor's experimental setup. To give the control unit a steady supply, an AC supply is first stepped down using a transformer, converted to DC using a bridge rectifier, then stabilized using a voltage regulator. The Arduino Uno, which communicates with several sensors, is the central component of the system. A current sensor is linked in series with the load to identify overcurrent situations, and a voltage sensor is attached to track changes in input. To detect heat increase, a temperature sensor is affixed close to the transformer winding or surface. Additionally, anomalous external situations like item closeness are detected by an ultrasonic sensor.

VI. RESULT AND DISCUSSION

The system continuously reads sensor data and converts analog signals into digital values using ADC. These values are processed using the above equations to obtain real-time voltage, current, temperature, and power. If any parameter exceeds predefined thresholds (V>Vmax, I>Imax ,T>Tmax), the system triggers protective actions like buzzer alerts and relay shutdown

Sr.No.	Parameters	Normal Values Parameters	Abnormal Values of Parameters	Buzzer Condition	
				Normal	Abnormal
1	Voltage	230 V	Below or Above 230 V	Buzzer OFF	Buzzer ON
2	Current	1 A	Below or Above 1 A	Buzzer OFF	Buzzer ON
3	Power	200 W	Below or Above 200 W	Buzzer OFF	Buzzer ON
4	Temperature (Oil)	35^0 C.	Below or Above 35^0 C.	Buzzer OFF	Buzzer ON

1. The system monitors voltage with a normal value of 230 V; any deviation below or above this level is treated as abnormal, activating the buzzer to indicate unsafe operating conditions.

2. Current is maintained at a standard value of 1 A; if the measured current goes below or exceeds this limit, the system identifies it as a fault and turns the buzzer ON.

3. Power is expected to remain around 200 W under normal conditions; variations beyond this value indicate abnormal load behavior, triggering an alert through the buzzer.

4. Transformer oil temperature is set at a normal value of 35°C; any rise or drop beyond this level is considered dangerous and results in buzzer activation for safety.

In all parameters, the buzzer remains OFF during normal conditions, ensuring no unnecessary alerts during stable operation. The buzzer turns ON only during abnormal conditions, providing immediate fault indication. This structured monitoring improves system safety and prevents transformer damage.

VII. CONCLUSION

An efficient and clever way to monitor and safeguard transformer systems in real time is the Electro Vital Transformer Supervisor project. The system guarantees early identification of anomalous situations and averts any breakdowns by continually monitoring vital parameters including voltage, current, power, and oil temperature. Without the need for human interaction, automatic defect detection and preventative measures are made possible by the combination of sensors, microcontroller, buzzer, and relay. The system is affordable, simple to set up, and appropriate for both industrial and small-scale uses.By preventing serious damage, it increases transformer lifespan, lowers maintenance costs, and improves operational dependability. Despite a few little issues, such environmental sensitivity and sensor accuracy, the overall performance is still quite effective. To sum up, the Electro Vital Transformer Supervisor offers a clever, dependable, and scalable method for monitoring transformer health, greatly enhancing safety, effectiveness, and continuous power supply in contemporary electrical systems.

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