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Transformer Load Sharing with Real Time Thermal Protection and Overload Monitoring

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Abstract : This project proposes a Transformer Load Sharing and Real-Time Monitoring system aimed at optimizing transformer operation and preventing overloads and thermal stress in power distribution networks. By integrating advanced sensors, IoT technology, and microcontroller-based control, the system ensures efficient load distribution among transformers, continuously monitoring parameters such as temperature, current, and voltage. The system detects faults and automatically activates relay switching to redistribute the load or isolate faulty transformers, preventing potential failures. This real-time monitoring and protection mechanism enhances transformer efficiency, reduces maintenance costs, and extends their lifespan. The system's smart load management capabilities ensure uninterrupted power supply, even in cases of overload or abnormal thermal conditions. By leveraging data analytics and automation, this project improves the safety, reliability, and overall performance of power distribution systems, providing a sustainable solution to modern transformer challenges.

Keywords- Transformer Load Sharing, Real-Time Monitoring, IoT Technology, Microcontroller, Temperature Sensor, Current Sensor, Voltage Monitoring, Relay Switching, Fault Detection.

I. INTRODUCTION

Transformers play a key role in electrical power distribution systems. They assist in moving electrical energy and keeping the voltage steady so that electricity can be delivered to houses, factories, and business places. However, transformers can sometimes have issues like overloading, overheating, and uneven load distribution, which may lower their performance and in some cases lead to breakdowns.

To solve these issues, this project presents a Transformer Load Sharing and Real-Time Monitoring System. The system checks key things like temperature, current, and voltage with the help of sensors. A microcontroller processes this information and automatically divides the electricity usage between the transformers.

If a transformer gets overloaded or overheated, the system moves some of the workload to another transformer through relays. This helps keep the transformer safe, makes the system work better, and ensures power keeps coming without stopping.

II. LITERATURE SURVEY

Transformers play a key role in electrical power systems, but they can run into issues like being too overloaded, getting too hot, or having an uneven share of the work, which can lower how well they work and lead to breakdowns. Many researchers have created monitoring and protection systems for transformers to manage these issues.

Some research has suggested using IoT systems to monitor transformers, where sensors are used to check things like temperature and current levels. These systems send live data to monitoring stations, allowing problems to be found early and repairs to be done on time [1].

Some other scientists have created protection systems using microcontrollers that can sense when there's too much electricity and then automatically turn off the transformer to stop it from getting damaged [2]. Besides that, some systems automatically share the electrical load among several transformers. These systems use relay switches to spread the load so that no single transformer gets too much and overloads[3].

The Arduino Uno is the main component of this project and acts as the brain of the system. In this project, two step-down transformers are used. The primary transformer works continuously, while the secondary transformer operates when an overload or overheating condition occurs. The system monitors important parameters such as current and

temperature. Two loads are used in this project: one is an AC load, which receives power from the transformers, and the other is a DC load, which receives power through a conversion board. In abnormal conditions, when an overload occurs, the Arduino sends a signal to the relay to switch on the secondary transformer so that both transformers share the load. At the same time, a buzzer produces a warning sound, and the values are displayed on the LCD display. If the temperature of the primary transformer rises above the threshold value, both transformers automatically share the load to reduce overheating and maintain safe operation.

III. BLOCK DIAGRAM

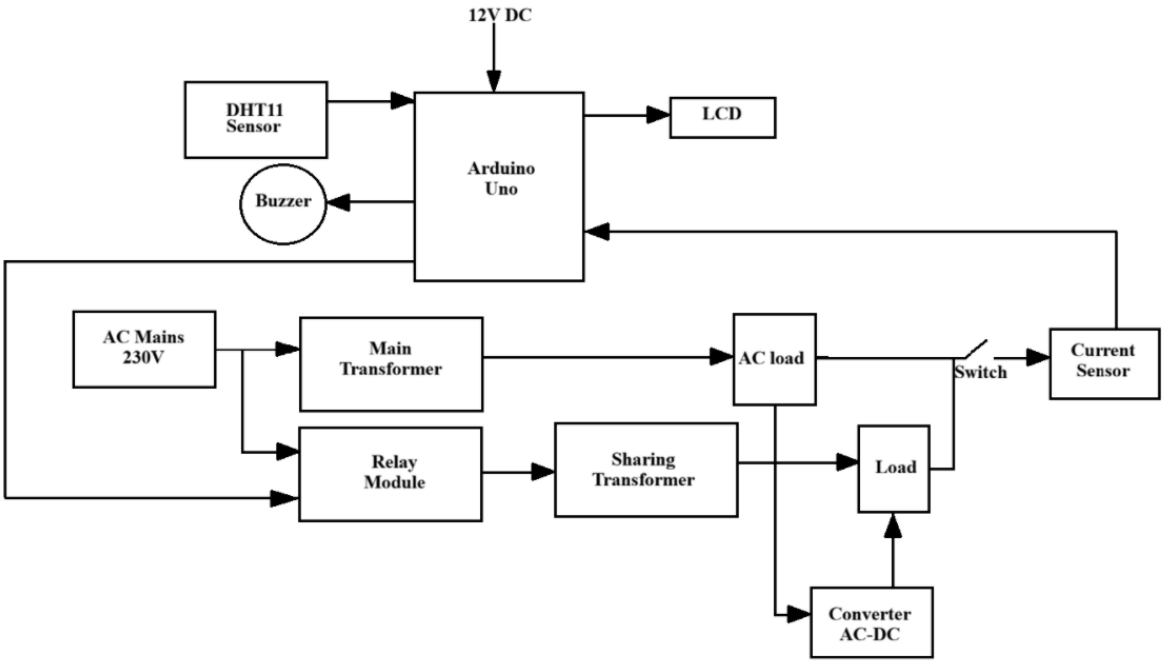

Fig. 1 Block Diagram

The block diagram shows how the Transformer Load Sharing and Real-Time Monitoring System operates. The Arduino Uno serves as the main controller for the system. It gets information from the current sensor and the DHT11 temperature sensor to check the load current and the transformer temperature. The main transformer gets the AC mains supply, which is 230 volts, and it usually sends power to the AC load. If there is too much electricity or the temperature gets too high, the Arduino sends a signal to the relay module. This causes the sharing transformer to turn on, allowing both transformers to share the load.

A buzzer is used to sound an alarm when something is wrong, and an LCD screen shows the current and temperature readings. An AC-to-DC converter is used to provide power to the DC load and the control circuit. This system stops transformers from getting too hot and makes the power distribution more dependable.

A) Description of Components

a) Arduino Uno

The Arduino Uno is a series of open-source microcontroller board based on a diverse range of microcontrollers (MCU). It was initially developed and released by the Arduino company in 2010.[5] [6] The microcontroller board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. [4] The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. [7] It can be powered by a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a rectangular 9-volt battery. It has the same microcontroller as the Arduino Nano board, and the same headers as the Leonardo board. [8][9] The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "uno" means "one" in Italian and was chosen to mark a major redesign of the Arduino hardware and software. The Uno board was the successor of the Duemilanove release and was the 9th version in a series of USB-based Arduino boards. Version 1.0 of the Arduino IDE for the Arduino Uno board has now evolved to newer releases. The ATmega328 on the board comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer. [6]

b) Transformers

Transformers are used to change AC voltage levels, such transformers being termed step-up or step-down type to increase or decrease voltage level, respectively. Transformers can also be used to provide galvanic isolation between circuits as well as to couple stages of signal-processing circuits. Since the invention of the first constant-potential transformer in 1885, transformers have become essential for the transmission, distribution, and utilization of alternating current electric power.[10] A wide range of transformer designs is encountered in electronic and electric power applications. Transformers range in size from RF transformers less than a cubic centimeter in volume, to units weighing hundreds of tons used to interconnect the power grid.

c) Converter (AC–DC Converter)

A converter is an electronic tool that changes electrical power from one type to another. In this project, an AC–DC converter is used to change AC, which is the type of electricity that comes from the wall outlet, into DC, which is the type of electricity used by most electronic devices.

The electricity from the transformer is alternating current, but some parts like the Arduino Uno, sensors, and other control circuits need direct current to work. The converter takes the alternating current voltage and turns it into a steady direct current voltage so that the electronic parts can function correctly.

In this system, the converter also provides DC power to the DC load and control circuit, making sure the monitoring system runs smoothly and safely.

d) Relay Module

A relay is an electrically operated switch. It has some input terminals for one or more control signals, and some terminals for connecting the operating contacts. A switch can have different numbers of contacts, and these contacts can come in various forms, like contacts that connect (make contacts) or contacts that disconnect (break contacts), or a mix of both.

Relays help control a circuit using a separate low-power signal and can also manage multiple circuits with a single signal. They were first used in long-distance telegraph systems as signal repeaters that send a new version of the incoming signal to another circuit. Relays were widely used in telephone exchanges and early computers to carry out logical operations.

The traditional electromechanical relay uses an electromagnet to switch the contacts on or off, but other types of relays have also been developed. For example, solid-state relays use the properties of semiconductors to control the circuit without needing any moving parts. Relays that have been set to work properly and sometimes have more than one coil to trigger them are used to stop electrical circuits from getting too much current or having problems. In today's power systems, these jobs are done by digital devices that are still called protective relays or safety relays.

e) Temperature Sensor

The temperature sensor (DHT11) is used to measure the temperature of the transformer during operation. It helps in detecting overheating conditions that may occur due to overload or continuous operation. The sensor continuously sends temperature data to the Arduino Uno, which monitors the value and compares it with a preset threshold limit. If the temperature rises above the safe level, the Arduino activates the relay module and buzzer to alert the user and allows the secondary transformer to share the load. This helps protect the transformer from damage and improves the reliability of the power system[11].

f) Current Sensor

The current sensor is used to measure the electrical current flowing through the load. It continuously sends the measured current value to the Arduino Uno for monitoring. If the current exceeds the safe limit, indicating an overload condition, the Arduino sends a signal to the relay module to switch on the sharing transformer so that both transformers can share the load. This prevents the main transformer from overloading and ensures safe and efficient operation of the system[12].

g) Buzzer

A buzzer or beeper is an audio signaling device, [13] which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, train and confirmation of user input such as a mouse click or keystroke. The electric buzzer was invented in 1831 by Joseph Henry. They were mainly used in early doorbells until they were phased out in the early 1930s in favor of musical chimes, which had a softer tone.Piezoelectric buzzers, or piezo buzzers, as they are sometimes called, were invented by Japanese manufacturers and fitted into a wide array of products during the 1970s to 1980s. This advancement mainly came about because of cooperative efforts by Japanese manufacturing companies. In 1951, they established the Barium Titanate Application Research Committee, which allowed the companies to be "competitively cooperative" and bring about several piezoelectric innovations and inventions. A wire is a flexible, round bar of metal. Wires are commonly formed by drawing the metal through a hole in a die or draw plate. Wire gauges come in various standard sizes, as expressed in terms of a gauge number or cross-sectional area.

h) Wires

Wires are used to bear mechanical loads, often in the form of wire rope. In electricity and telecommunications signals, wire can refer to electrical cable, which can contain a solid core of a single wire or separate strands in stranded or braided forms. Usually cylindrical in geometry, wire can also be made in square, hexagonal, flattened rectangular, or other cross-sections, either for decorative purposes, or for technical purposes such as high-efficiency voice coils in loudspeakers. Edge-wound coil springs, such as the Slinky toy, are made of special flattened wire[14]

i) LED Light

An LED lamp or LED light [15]is an electric light that produces light using light-emitting diodes (LEDs).LED lamps are significantly more energy-efficient than equivalent incandescent lamps and fluorescent lamps. [16][17] The most efficient commercially available LED lamps have efficiencies exceeding 200 lumens per watt (lm/W) and convert more than half the input power into light. [18][19] Commercial LED lamps have a lifespan several times longer than both incandescent and fluorescent lamps.

LED lamps require an electronic LED circuit to operate from mains power lines, and losses from this circuit means that the efficiency of the lamp is lower than the efficiency of the LED chips it uses. The driver circuit may require special features to be compatible with lamp dimmers intended for use on incandescent lamps. Generally the current waveform contains some amount of distortion, depending on the luminaires' technology.

j) Display (LCD)

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers to display information. Liquid crystals do not emit light directly[20] but instead use a backlight or reflector to produce images in color or monochrome.[21]

LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden: preset words, digits, and seven-segment displays (as in a digital clock) are all examples of devices with these displays. They use the same basic technology, except that arbitrary images are made from a matrix of small pixels, while other displays have larger elements.

LCDs are used in a wide range of applications, including LCD televisions, computer monitors, instrument panels, aircraft cockpit displays, and indoor and outdoor signage. Small LCD screens are common in LCD projectors and portable consumer devices such as digital cameras, watches, calculators, and mobile telephones, including smartphones. LCD screens have replaced heavy, bulky and less energy-efficient cathode-ray tube (CRT) displays in nearly all applications since the late 2000s to the early 2010s.

IV. CONTROLLER DESIGN AND IMPLEMENTATION

The controller is the main part of the system that handles monitoring and distributing the load. In this project, the Arduino Uno is used to control the system. It gets signals from the temperature sensor and the current sensor and keeps checking the condition of the transformer all the time. The Arduino checks the data from the sensor and compares it with set limits to find out if something is wrong, like too much load or high temperature.

When the system is working as it should, the main transformer provides electricity to the load. If the electricity level goes over the safe amount or the temperature goes above the set limit, the Arduino gives a signal to the relay module. The relay turns on the secondary transformer, so both transformers can handle the load together and stop any damage from happening.

The controller also sends information to the LCD screen to show the current and temperature values as they happen. A buzzer goes off to warn when there are unusual situations. This design using a controller makes sure the transformer system automatically watches over itself, provides protection, and shares the load efficiently.

V. RESULT

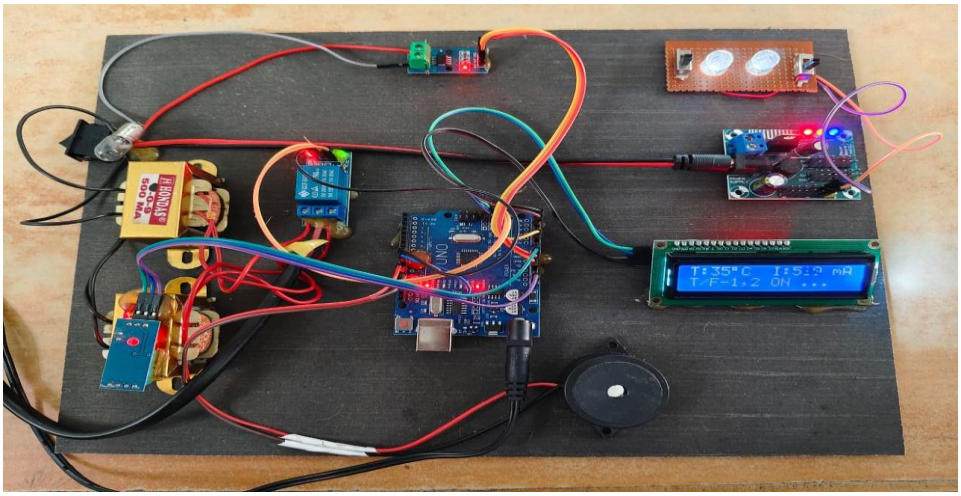

Fig.2 Complete Kit Setup

VI. CONCLUSION

This project successfully presents a Transformer Load Sharing and Real-Time Monitoring system that enhances the efficiency, safety, and reliability of power distribution networks. By integrating sensors, microcontroller-based control, relay switching, and IoT technology, the system ensures continuous monitoring and intelligent load management among transformers.

The automated load sharing mechanism effectively prevents overloads and excessive thermal stress, thereby reducing the risk of transformer failures. Real-time fault detection and protective actions contribute to improved system stability and reduced maintenance requirements. The implementation of this system demonstrates a cost-effective and scalable solution suitable for modern smart grid applications.

Overall, the proposed system achieves its objective of optimizing transformer performance, ensuring uninterrupted power supply, and extending transformer lifespan, making it a practical and sustainable approach for power distribution management.

VII. REFERENCES

[1] S. R. Bhat and R. P. Kulkarni, “IoT Based Transformer Monitoring System,” International Journal of Electrical Engineering, 2016.

[2] A. K. Singh and P. Kumar, “Smart Transformer Protection Using Microcontroller and Sensors,” International Journal of Power Electronics and Drive Systems, 2018.

[3] M. S. Bhaskar and N. Kumar, “Automatic Transformer Load Sharing Using Relay Control,” International Journal of Electrical and Computer Engineering, 2019.

[4] "Arduino FAQ". 5 April 2013. Archived from the original on 27 November 2020. Retrieved 21 February 2018.

[5] "What is Arduino?". learn.sparkfun.com. Retrieved 4 February 2018.

[6] "Arduino Older Boards". Retrieved 2023-02-08.

[7] "Board; Uno R3; Store". Arduino.

[8] Bedell, Frederick (1942). "History of A-C wave Form, Its Determination and Standardization". Transactions of the American Institute of Electrical Engineers. **61** (12): 864. doi:10.1109/T-AIEE.1942.5058456. S2CID 51658522.

[9] A. D. Dhananjay and S. Patel, “Temperature Monitoring System Using DHT11 Sensor and Arduino,” International Journal of Electronics and Communication Engineering, 2019.

[10] J. Smith and R. Brown, “Current Measurement and Monitoring Using Hall Effect Sensors,” IEEE Journal of Electrical Systems, 2018.

[11] "buzzer - definition of buzzer by The Free Dictionary". Retrieved 22 May 2015

[12] Swiger Coil Systems. "Edgewound Coils". Swiger Coil Systems, A Wabtec Company. Archived from the original on 19 December 2010. Retrieved 1 January 2011.

[13] LED revolution: The big switch". India Today. 2 December 2015. Retrieved 11 April 2025.

[14] "How Energy-Efficient Light Bulbs Compare with Traditional Incandescents". Energy.gov. Archived from the original on 24 August 2021. Retrieved 11 April 2025.

[15] "CFL vs. LED Lights: Which is the Energy Efficient Light Bulb? | Green America". www.greenamerica.org. Retrieved 11 April 2025.

[16] "Lighting world first: Philips breaks 200 lumens per watt barrier" (PDF). Philips.com. Retrieved 2 August 2019.

[17] "Philips and Dubai unveil world's most efficient LED bulb". New Atlas. 6 October 2016. Retrieved 11 April 2025.

[18] Ciugudeanu, Calin; Buzdugan, Mircea; Beu, Dorin; Campianu, Angel; Galatanu, Catalin Daniel (12 December 2019). "Sustainable Lighting-Retrofit Versus Dedicated Luminaires-Light Versus Power Quality". Sustainability. **11** (24):

[19] 7125. Bibcode:2019Sust...11.7125C. doi:10.3390/su11247125. ISSN 2071-1050.

[20] "Bosch's Smart Visor Tracks the Sun While You Drive". IEEE Spectrum. January 29, 2020.

[21] "Definition of LCD". Merriam-Webster.com. Archived from the original on February 25, 2021. Retrieved February 15, 2015.