Arduino Based Intelligent Transformer Cooling System

[1]Naman Prasad, [2]Anirudh Tiwari, [3]Aniruddh Singh Chauhan, [4]G.S. Chaurasia
[1]Student, [2]Student, [3]Student, [4]Assistant Professor
[1]Electrical And Electronics Engineering,
[1]SRM Institute of Science & Technology, Ghaziabad, India

Abstract : This paper proposes a system that can be used to obtain control over the cooling system of a transformer in a way to maintain optimum level of operating temperatures of a transformer. Transformers when subjected to high temperatures lead to lesser efficiency and in worse cases cut off in supply. This may be due to ineffective cooling systems. The system proposed in this paper has a microcontroller that is used to manage the cooling of transformer winding. The microcontroller present in the Arduino UNO board (AT mega 328P) controls the fan in the output terminal corresponding to the temperature set. Temperature sensor LM35 is used to sense the temperature of the winding and is input to the Arduino UNO analog input pin for processing.

***Index Terms* – Transformer Cooling, Arduino UNO, LM 35 Temperature Sensor, Relay Module.**

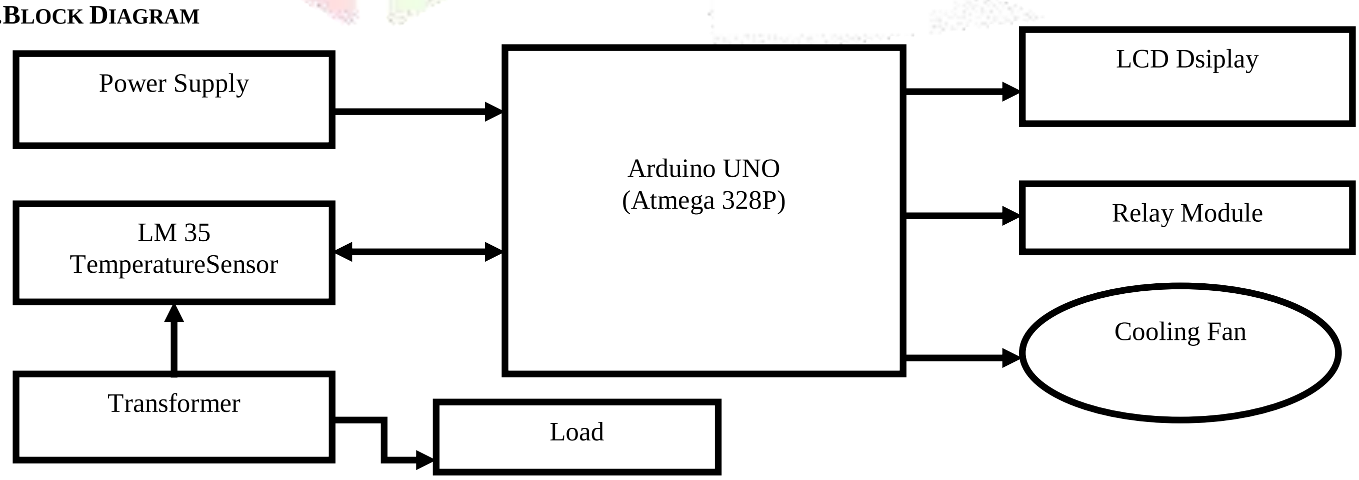
I.INTRODUCTION

Transformers form the main element in production, transmission and distribution of electricity anywhere in the world. Power or Distribution transformers both are largely employed in any electrical system. The technique explained in this paper is developed to attain faster, reliable and correct operation of cooling device installed in a transformer. The system uses a distribution transformer, Arduino UNO, LM35 temperature sensor, relay module and a DC fan. The sensor is attached to the transformer to continuously sense the temperature of the transformer windings and send to the microcontroller for processing. The microcontroller, which is the brain of the system, compares the temperature at its input to the desirable temperature values set by the user. If the limit is exceeded, it sends a command to the fan to turn it ON so that the cooling of the transformer begins. In severe case, that is, when the fan is unable to lower the temperature of the windings, a critical temperature limit is set in the code. When this limit is exceeded, the transformer supply is cut off using a relay circuit to avoid any damage to the winding. Meanwhile the fan operates to allow the transformer to cool down.

II.NECESSITY OF INTELLIGENT COOLING

Transformers are the electrical devices that form the major part of electrical production and distribution system. Transformers perform the significant operation of stepping up and stepping down of AC voltages for transmission of electrical power. It is therefore very important to provide proper operating conditions to these devices. Temperature rise reduces the operating life of these devices. It is therefore necessary to deploy an intelligent cooling system so that the temperature is kept under limits. The addressed system offers better accuracy than conventional systems because of the use of high performance microcontroller and broad range temperature sensor. The combined effect of these instruments provides faster and accurate control of cooling device which is the fan in this case.

III.BLOCK DIAGRAM



. **Fig.1.** Block diagram with devices at both input and output side of Arduino UNO is shown.

IV.WORKING

In the proposed methodology, the transformer temperature is controlled by the brain of the system, that is, the microcontroller. The microcontroller reads the analog input from the LM35 sensor attached to the transformer. The LM35 sensor outputs a certain mV (10mV/˚C) whenever temperature changes. This value is converted into degree Celsius in the Arduino code. The read value is compared by microcontroller to the set values in the program stored in the memory of microntroller. Now, unlike other systems, this system uses a different concept. ***There are two stages of temperature protection suggested in this paper.*** There are two values of temperature written in the code, exceeding which the microcontroller gives different commands. ***When the lower value is exceeded, the microcontroller sends PWM signal to the fan at the output. This turns the fan ON as the signal is applied to the gate of the MOSFET, which is used as a switch in the fan circuit.*** Here the aim is to lower the temperature of the transformer windings by cooling. If the temperature is lowered, the fan again turns OFF and operation of the transformer remains uninterrupted.

V.

However, if the upper limit of the temperature is exceeded, the relay also operates. Therefore, both fan and relay are operating in this case. This is done because the temperature reached is dangerous enough to damage the windings and hence supply is interrupted while the fan operates continuously to lower the temperature.

V. SYSTEM DETAILS

5.1 Power supply

The voltage requirements of the Arduino UNO board and relay module is 5V and 12V respectively. A normal 230V/12V transformer is used to obtain 12V AC. This AC is converted into pulsating DC using a bridge rectifier. Bridge rectifier is used as it eliminates the need of a center tapped transformer. A 470 micro farad capacitor is used to filter this ripple. The ripple free 12V is given to relay module. For Arduino UNO supply, a LM7805 voltage regulator is used to obtain 5volts supply from input 12 volts.

5.2 Arduino UNO

Arduino UNO board has AT mega 328P microcontroller, 14 digital input/output pins and 6 analog input pins. A 16 MHz quartz crystal is present along with a USB connection to upload the C language program to be executed. The Arduino IDE software is used to develop and transfer the C program.

5.3 Relay module

A 12V DC electromagnetic relay is used to switch the circuit of transformer under protection in case critical temperature limit set in the Arduino code is exceeded as measured by the LM35 sensor. An LED is present in the module to indicate the status of relay.

5.4 LM35 Temperature sensor

LM35 temperature sensor is a semiconductor based temperature sensor that produces an output voltage proportional to temperature (in degree Celsius). It has three pins, a supply pin, an analog voltage output pin and a ground. It is linear and produces a 10mV per degree Celsius. This voltage is converted into Celsius in the Arduino Code.

LM35 has advantages over other sensors due to its linearity.

5.5 DC brushless fan

A 2W, 12volts DC brushless fan is used to at the output side to cool the transformer when commanded by Arduino. It is a quiet, low-speed fan which is used with a MOSFET as a switch. The signal from the Arduino is given to the gate of the MOSFET which controls the conduction hence the turning ON/OFF of the fan.

5.6 Transformer

A 230V/12V normal transformer is used, which has a LM35 sensor attached to its winding. The transformer drives a 12 volts gear motor as load.

5.7 LCD

The 16x2 character LCD is interfaced with Arduino UNO to display the current temperature values as signaled by the temperature sensor.

VI. RESULTS

The system was configured using the given components to experimentally verify the proposed method. The C language code was transferred into the memory of microcontroller using Arduino IDE. On connecting the load to the transformer under observation, temperature increase was observed. The status of fan and relay as per temperature variations are shown in the table below.

Table 1 Experimental Results

Temperature ‘T’ (degree Celsius)	Status of fan	Status of relay
T<=32	OFF	-----
32<T<=37	ON	-----
T>37	ON	Operates

VII. CONCLUSION

By developing the system suggested in this paper, ambient temperatures for operation of transformer were achieved. This was made possible due to the effectiveness of microcontroller and semiconductor sensor used. The proposed technique has advantages over conventional system, mainly being accuracy and shorter response times. This provided a better protection of transformer when subjected to undesirable temperatures.

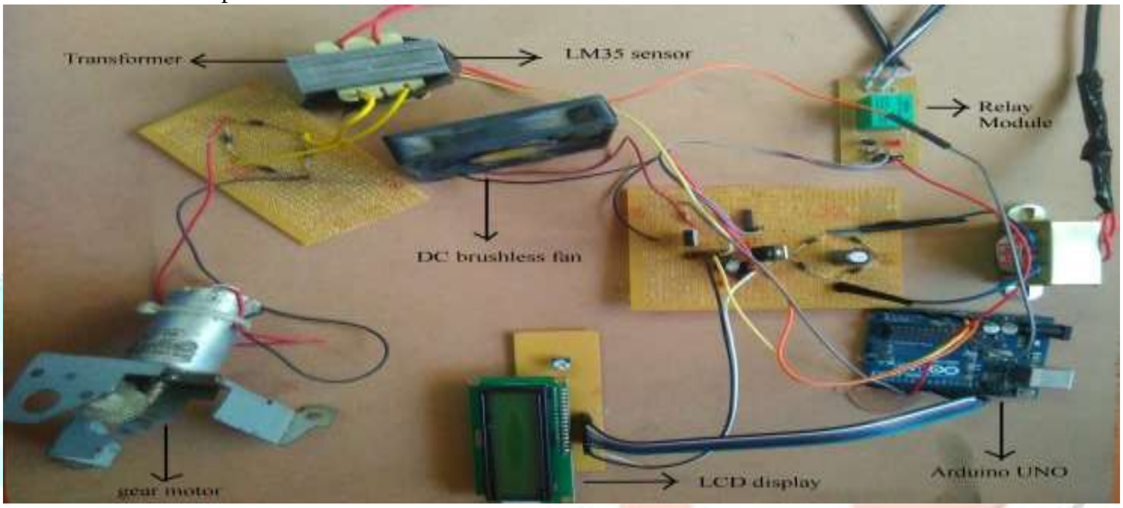


Fig.2. Arduino based Intelligent Transformer Cooling System.

VIII. ACKNOWLEDGMENT

Naman Prasad, Anirudh Tiwari and Aniruddh Singh Chauhan would like to thank Mr. G.S. Chaurasia, who had been a source of constant support and valuable guidance throughout the development of this system. We also express gratitude to the staff of Electrical & Electronics department for their efforts. The authors would also take this opportunity to thank their family members for bearing with them until the end of this venture.

REFERENCES

[1] Alan G. Smith, *Introduction to Arduino: A piece of cake!* September 30, 2011.

[2] Yusuf Abdullahi Badamasi, “The working principle of an Arduino,” in *11th International Conf. on Electronics, Computer and Computation (ICECCO)* , Abuja, Nigeria, 2014.

[3] Badri Ram, D.N. Vishwakarma, *Power System Protection and Switchgear*, Tata McGraw Hill Education, April 01, 2001.

[4] Poonam, Prof (Dr.) Yusuf Mulge, “*Remote Temperature Monitoring Using LM35 sensor and Intimate android user via C2DM Service*,” in International Journal of Computer Science and Mobile Computing, vol.2, Issue. 6, June 2013, pg.32-36.

[5] Jiaoyue Liu, Lin Ma, Juqing Yang, “Methods and techniques of temperature measurement,” in international Conf. on Electrical and Control Engineering (ICECE), Yichang, China, 16-18 September, 2011.