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SUPERVISORY CONTROL AND DATA ACQUISITION FOR REMOTE INDUSTRY

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ABSTRACT

One of the main things that shortens a transformer's lifespan is temperature. The main factor for shorter transformer life and insulation breakdown is elevated temperatures. Thus, this work provides an IOT embedded system that monitors transformer characteristics utilising temperature sensors and a microprocessor. The suggested system would use a buzzer to sound a high temperature alert when the temperature reaches a preset limit. Real-time data from this system will be remotely sent to a mobile device or PC at the substation using a Wi-Fi module.Therefore, transformer health monitoring will increase the transformer's service life and assist identify unforeseen circumstances before any major breakdown, which will undoubtedly lead to considerable cost savings and increased dependability.

I. INTRODUCTION

The most crucial component of power systems' equipment are transformers.Better transformer health will result in a longer transformer lifespan.Supervisory control and data acquisition, or SCADA, systems are used by many power companies to monitor transformers, although they are very costly and labor-intensive. Transformers may encounter a variety of challenging circumstances if their health is not routinely checked, as seen in Fig 1.These systems' primary shortcomings include their inability to provide information on voltage and current overloads, as well as scorching transformer windings and oil. These shorten the transformer's lifespan.In order to monitor a distribution transformer's winding and oil temperature, an Internet of Things (IoT) embedded system using microcontrollers and sensors is presented in this suggested study. IOT is used to transmit the aforementioned data to the distant server. When anomalies occur in the distribution system, the regulating unit regulates the load based on information gathered from the sensors. This technology will assist us in replacing the equipment before a significant malfunction arises and ensure that the power supply remains uninterrupted, increasing the system's dependability. Goel (2016)

Transformers have been essential for many years in many industries, substations, generating, distribution, etc. This paper's primary goal is to design and implement PLC (programmable logic controllers) automation to track and diagnose various substation conditions, including load, currents, transformer temperatures, and voltages. Distribution transformers are among the most crucial pieces of equipment in the power system network.[1] Data collection, condition monitoring, and automated control are crucial concerns in the power system since there are many transformers and other components dispersed across a big region. Relays and sensors are used in the suggested PLC-based system to identify transformer failures, including overloading, overvoltage, undervoltage, phase-to-phase, and overtemperature issues.[2] Distribution transformers are definitely more likely to have problems, hence transformer protection is crucial. Automation control is used

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in a number of systems to operate machinery. Certain procedures are fully automated. Automation improves quality, accuracy, and precision while saving labour, energy, and materials.Reduces the need for human intervention and decision-making in any process Stepping down the voltage used in the distribution lines to the level utilised by the customer, a distribution transformer delivers the last voltage change in the electrical power distribution system. Distribution transformers typically have ratings of less than 200 KVA, yet they may be classified as distribution transformers up to 5000 KVA according to certain national regulations. Since these transformers are always powered on, it is crucial that they function properly, necessitating robust protection.[4] This paper's primary goal is to protect the power system network's distribution transformer from both internal and external failures. Transformer overloading, which is nothing more than an overcurrent problem on the secondary side of the distribution transformer or an increase in load, may raise the temperature of the transformer's winding and oil. An rise in winding temperature will put more strain on the insulation, which might cause it to fail or degrade. External power system problems might cause the transformer's voltage to fluctuate, resulting in an overvoltage or undervoltage issue.A thorough transformer protection strategy must include protection against overload, undervoltage, overvoltage, phase-to-phase fault, and overtemperature as current rises when a fault occurs. The suggested method that includes all of these safeguards is the one that follows.

II. LITERATURE SURVEY

1. Pathhak A.K., et al. [5] This article describes the design and construction of a mobile embedded system that uses a standalone single chip microcontroller and several sensors to monitor and record important distribution transformer characteristics including oil temperature and winding temperature. It is situated at the distribution transformer location, and the embedded system's analogue to digital converter (ADC) is used to capture the aforementioned characteristics. The system memory is used to process and store the acquired parameters. In the event of an anomaly or emergency, the system utilises preprogrammed instructions stored in the microcontroller to send SMS (short messaging service) messages to the mobile phones with details about the anomaly. With the aid of this transportable technology, the transformers will function more efficiently and be able to detect issues before they become disastrous.
   a. One drawback of the current system is that transformers may fire with ease.
   b. Not precise.
   c. The system's frequency interference.
   c. The network is noisy.
2. Agarwal Monika and others. [6] According to this document, they are building a system in which the operator and the system are not in communication. Transformers, microcontrollers, logic level converters, and GSM, or the worldwide system for mobile communication modem, are the tools we're employing for this. Through message delivery to the system, this GSM modem assists in transformer health monitoring.
3. ABB (2000: 596–599) [8] states that the purpose of condition monitoring is to

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find flaws before they become serious so that repair tasks may be scheduled. An additional objective of condition monitoring is to enable the avoidance of unneeded maintenance intervals. The same source separates condition monitoring into root cause analysis, action recommendation, fault diagnosis and prognosis, and detection.

4. Hongan Mao and others [4] Since many of the power distribution transformer stations in this article are located outside of cities, wireless GPRS transmission offers a useful communication option for managing these stations. This study presents the architecture of a GPRS wireless network-based remote wireless monitoring system for power distribution transformer stations. The primary implementation was a control terminal system that used GR47 as the date communication module and LPC2132 as the primary CPU. Additionally created were the flow chart and the monitor terminal software. Finally, an analysis is done on how to configure the GPRS module to connect to the network.

III. DESIGN OF HARDWARE

This chapter provides a quick explanation of the hardware. It goes into great depth about each module's circuit diagram.

ARDUINO UNO

A microcontroller board based on the ATmega328 is called the Arduino Uno (datasheet). It has a 16 MHz ceramic resonator, 6 analogue inputs, 14 digital input/output pins (six of which may be used as PWM outputs), a USB port, a power connector, an ICSP header, and a reset button. It comes with everything required to support the microcontroller; all you need to do is power it with a battery or an AC-to-DC converter or connect it to a computer via a USB connection to get going.The FTDI USB-to-serial driver chip is not used by the Uno, setting it apart from all previous boards. As an alternative, it has the Atmega16U2 (or Atmega8U2 up to version R2) configured as a serial-to-USB converter. The 8U2 HWB line on the Uno board is pulled to ground by a resistor, which facilitates DFU mode entry. The Arduino board now includes the following updates:

• 1.0 pin out: two further new pins, the IOREF, are positioned next to the RESET pin, the SDA and SCL pins that were introduced, and they enable the shields to adjust to the voltage supplied by the board. Shields will eventually work with both the Arduino Due, which runs on 3.3V, and the boards that utilise the AVR, which runs on 5V. The second pin is unconnected and set aside for future uses.

• A more robust RESET circuit.

• The 8U2 is replaced with an ATMega 16U2.

"Uno" is an Italian word for one, and it was chosen to commemorate the impending introduction of Arduino 1.0. Going future, the Arduino reference versions will be the Uno and version 1.0. The Uno is the most recent in a line of USB Arduino boards and the platform's standard model; see the index of Arduino boards for a comparison with earlier iterations.

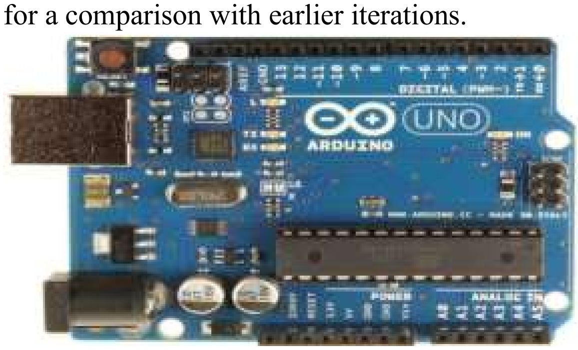

Fig: ARDUINO UNO

POWER SUPPLY:

The purpose of the power supplies is to convert the high voltage AC mains energy into a low voltage supply that is appropriate for use in electronic

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circuits and other devices. One may disassemble a power supply into a number of blocks, each of which carries out a specific task. "Regulated D.C. Power Supply" refers to a d.c. power supply that keeps the output voltage constant regardless of differences in the a.c. main or the load.

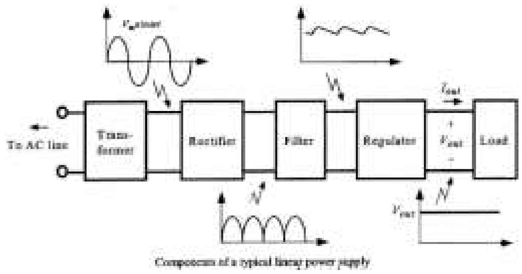


Fig: Block Diagram of Power Supply

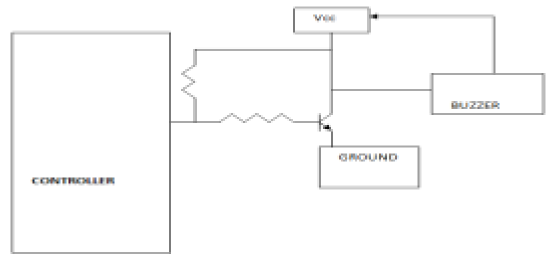
LCD DISPLAY

The model shown here is the one that is most often utilised in practice due to its cheap cost and enormous potential. Its HD44780 microcontroller (Hitachi) platform allows it to display messages in two lines of sixteen characters each. All of the alphabets, Greek letters, punctuation, mathematical symbols, etc., are shown. Furthermore, it is possible to show custom symbols created by the user. Some important features are the automatic changing of the message on the display (shift left and right), the presence of the pointer, the lighting, etc.

Fig: LCD

BUZZER

Relays, buzzer circuits, and other circuits cannot be driven by the current available on digital systems and microcontroller pins. The microcontroller pin can provide a maximum of 1-2 milliamps of current, even though these circuits need around 10 milliamps to work. Because of this, a driver—such as a power transistor—is positioned between the buzzer circuit and microcontroller.



WIFI MODULE:

A low-cost Wi-Fi microprocessor with complete TCP/IP stack and microcontroller functionality, the ESP8266 is made by Chinese firm Espressif Systems, located in Shanghai.[1]

In August 2014, a third-party producer named Ai-Thinker's ESP-01 module brought the chip to the attention of western manufacturers for the first time. With the help of this little module, microcontrollers may establish basic TCP/IP connections and connect to Wi-Fi networks by utilising Hayes-style instructions. But at the time, there wasn't much documentation available in English on the chip or the commands it could execute.[2] Many hackers were drawn to investigate the module, chip, and software on it as well as translate the Chinese documentation because of its very cheap cost and the fact that it had very few external components, suggesting that it may someday be very affordable in production.[3]

With its 1 MiB of integrated memory, the ESP8285 is an ESP8266 that enables single-chip Wi-Fi capable devices.[4]

The ESP32 is these microcontroller chips' replacement.

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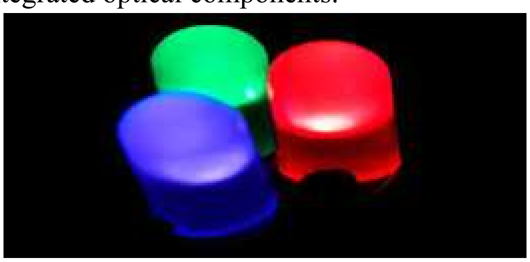
LED:

A light source made of semiconductors with two leads is called an LED. When turned on, this p-n junction diode generates light.[5] Within the device, electrons may recombine with electron holes when a proper voltage is given to the leads, releasing energy in the form of photons.

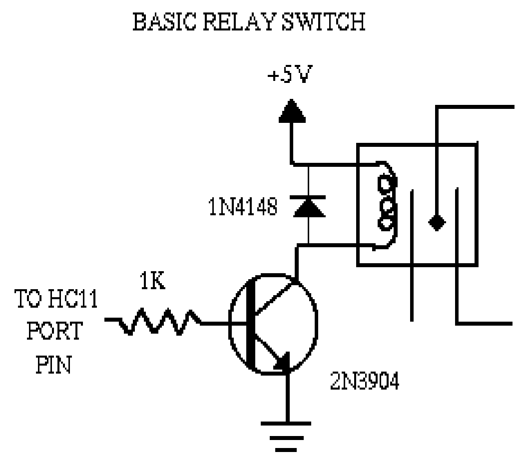
This phenomenon is known as electroluminescence, and the energy band gap of the semiconductor controls the colour of the light, which corresponds to the photon's energy. Since LEDs are usually tiny—less than 1 mm2—the radiation pattern may be modified by integrated optical components.



Early LEDs were often utilised to replace tiny incandescent bulbs as indication lighting for electrical equipment. They were quickly bundled into seven-segment displays for use as numeric readouts, and digital clocks became popular with them. Modern advancements have led to the creation of LEDs that are appropriate for task and ambient lighting. New displays and sensors have been made possible by LEDs, and enhanced communications technology has benefited from their rapid switching rates.Compared to incandescent light sources, LEDs are smaller, quicker switching, more physically resilient, need less energy, and have a longer lifespan.

Applications for light-emitting diodes are many and include traffic signals, advertising, traffic lights, camera flashes, lit wallpaper, aircraft illumination, and car headlights. Additionally, they are much more energy-efficient, and their disposal may pose less environmental risks.

RELAY



The fundamental circuit is shown in the following diagram.

An electrically powered switch is called a relay. It turns on in a manner that switches on. It flips the opposite way when it's off. Relays may be used to turn high current devices on and off. A lightweight switch and an electromagnet known as a coil are found within a relay. The coil's magnetic field attracts a portion of the switch when it is energised, turning the switch on or off.

Mechanism of mechanical relay:

Standard Pin for mechanical relay connection

This is a crucial part of the article. This electrical control switch is introduced as a relay. Essentially, it is an electrically operated mechanical switch activation mechanism. This is not the same as a manually triggered switch. Put another way, it's a gadget that transforms electrical signals into mechanical energies and back again. They may be referred to as 2P2T,

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single pole double throw, etc., much like mechanical switches.

How does it operate? The relay's coil will be turned on by an electrical voltage. When the coil is cranked up, a magnetic force is produced that draws the lever in. The mechanical contact will be switched when this lever is drawn in the direction of the magnetised coil.

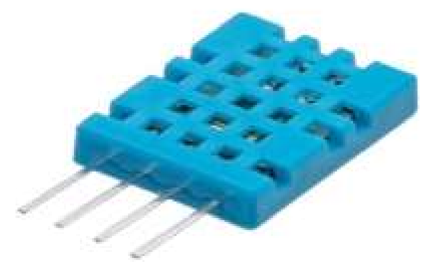
DHT TEMPERATURE & HUMIDITY SENSORS.

Although these sensors are sluggish and relatively basic, they are excellent for amateurs who want to do simple data recording. The capacitive humidity sensor and the thermistor are the two components that make up the DHT sensors. Additionally, there is a very simple chip inside that converts analogue to digital and outputs a digital signal that includes the humidity and temperature. Any microcontroller can easily interpret the digital signal.

The amount of water vapour in the air is measured as humidity. Air humidity has an impact on a number of physical, chemical, and biological processes. Humidity in industrial settings may have an impact on worker health and safety as well as the cost of the goods. So, humidity measurement is crucial in the semiconductor and control system sectors. The quantity of moisture in a gas, which may consist of a combination of water vapour, nitrogen, argon, or pure gas, etc., is determined by measuring its humidity. Based on their measuring units, there are two kinds of humidity sensors. A relative humidity sensor and an absolute humidity sensor are what they are. The digital temperature and humidity sensor DHT11 is used.

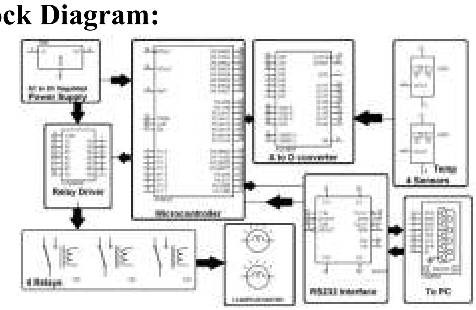
The DHT11 is an inexpensive digital sensor that measures humidity and temperature. Any micro-controller, including Arduino, Raspberry Pi, and others, may be readily interfaced with this sensor to monitor temperature and humidity instantly.

The DHT11 humidity and temperature sensor comes in both sensor and module form. The pull-up resistor and power-on LED distinguish this sensor and module from one another. A relative humidity sensor is DHT11. This sensor employs a capacitive humidity sensor and a thermistor to monitor the air around it.



IV. BLOCK DIAGRAM AND WORKING

Block Diagram:



A supervisory control data acquisition system, which is necessary in a big industrial setting, is what the project created. SCADA is a system that tracks and manages every industry operation while saving a significant amount of labour. The prototype continuously monitors the distant plant operations using temperature sensors interfaced to an 8051 series microcontroller. The temperature sensor data is continuously received by the PC via the microcontroller, which is linked to it. The temperature readings are shown and kept in the database by the DAQ system software that is installed on the PC. The system has parameters like set point, high point, and low point in the PC. Relays that are interfaced to

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the microcontroller allow it to switch on or off the bulbs based on changes in the measured temperature. In order to prevent system failure, the PC sounds an alert when the temperature hits a high or low limit.

V. CONCLUSION

One of the priciest pieces of equipment in the power system is the transformer. Frequent transformer health monitoring promotes greater dependability.The results of the suggested approach demonstrate the great accuracy of this protection strategy against any abnormal fault state.In the past, human labour and a set timetable were used to maintain the transformer. As technology advances, we may now employ WiFi modules to remotely receive fault information and provide it to authorities and operators, enabling them to respond to problematic conditions more quickly (Asadi, 2020).

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