TRANSFORMER MONITORING AND CONTROLLING WITH IOT

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ABSTRACT

New and exciting, the Internet of Things (IoT) enables machine-to-machine connectivity (M2M), which in turn enables the description of physical objects equipped with sensors, software, and processing capabilities, and opens the door to the prospect of autonomous devices exchanging data through the internet. This work presents the design and implementation of a system that can monitor essential operating characteristics of a distribution transformer in real-time. These characteristics include the load current, voltage level of the transformer oil, and environmental factors including temperature and humidity. Working efforts are reduced while accuracy, efficiency, and stability are improved by this project. The main characteristics of a transformer, such as voltage, current, oil level, and temperature, are detected by a number of sensors. With the help of a Wi-Fi module and the Thingspeak software, the discovered data is sent to a microcontroller, where it is validated against certain parameters before being sent to an Internet of Things web server. In this way, the operator is certain to get reliable data and may draw intelligent conclusions prior to any disastrous failure.

I. INTRODUCTION

Electricity is essential to our daily lives. A number of parts and pieces of machinery work together to transmit and regulate the flow of electricity in response to demand.The transformer is an essential piece of machinery for the distribution and transmission of electricity.Power supply for low voltage customers and its operating conditions are handled by distribution transformers, which are an integral part of the network's operation and account for a significant amount of the capital investment. If operated under tested conditions, distribution transformers have a long lifespan. However, when exposed to extreme temperatures, overloading, catastrophic failure due to low or high voltage/current, or a loss of supply to a large number of The reliability of a system is impacted by how customers behave. The distribution transformer often fails due to an abnormality that occurs when many factors, such as load current, load voltage, oil level, oil temperature, and inefficient cooling, fluctuate. Currently, there is a pricey recommendation to use Supervisory Control and Data Acquisition (SCADA) for web-based monitoring of systems like distribution transformers. By using the internet of things (IOT), which is centred on linking previously unconnected objects, the current system may be enhanced.

Website that provides assistance and keeps track of crucial As it is, distribution transformers may be physically seen when a guy stops by to check on its parameters every so often. Overheating of the transformer's oil and windings, as well as inadvertent overload, are not detectable by this kind of monitoring. A shorter transformer life may result from any one of these causes.

2) In order to improve equipment stability and save expenses, a monitoring system can only keep an eye on the operating state of distribution transformers.

3) A single transformer parameter, such current or voltage, is often found using a health measuring system. Although there are methods that can detect cases with several parameters when the testing speed is inadequately fast and the operation parameter periods are too lengthy.

Fourthly, the operator will not have enough time to evaluate the distribution transformer's three-phase equilibrium because the data for lucky detection will not be given.

This project is appealing for both audio media and wide area network applications because to its proposed real-time monitoring system for distribution transformers that utilises the Internet of Things (IoT) and the widespread usage of mobile networks and GSM modems, which aim to address the aforementioned shortcomings.

II. LITERATURE SURVEY

A transfor works on the idea of mutual inductance, which is essentially a connection between two circuits that are connected by a shared magnetic flux. The two inductively connected coils of a basic transformer are electrically isolated from one another but are magnetically coupled via a reluctance channel. A transformer, in a nutshell, performs the following tasks:(1)Conduction of current from one electrical circuit to another.(2)Conveying electrical energy at a constant modulation rate.Thirdly, use electromagnetic induction as a transfer mechanism.(4)Reverse induction connects the two electrical circuits.

Problems and unusual circumstances with the transformer.Internal problems include: (1) old insulation (2) broken windings (3) excessive heat (4) oil contamination Another example of an internal fault is a phase-to-phase fault. The transformer may be turned off if insulation begins to degrade, since it might cause a short circuit inside the device. Winding and overheating issues might also result from a high current flow. When the cooling system stops working, it might be due to a mechanical issue as well. Insulation may be damaged by high current levels, which is a common reason for faults. Testing and maintenance can avoid most of these issues.

Impartiality:(1) lightning strikestwo, overloaded system, three, short circuit In most cases, maintenance will not be able to avert external failures, which occur outside the transformer. The transformers are vulnerable to uncontrollable external factors, such as lightning strikes. Given the unpredictability of these events, it is crucial to establish a strategy to address repairs promptly. These may be very little, but they can harm the insulation and eventually create issues with the transformer's internal workings. The more serious issue arises in the event that an external event prompts the transformer to instantly turn off.

The Transformer's Protection Features When the power source fluctuates, it may cause overvoltage and undervoltage. As a result of the mains input voltage being beyond or below an acceptable limit, the corresponding DC voltage becomes high or low, and this phenomena happens. As a result, the machine's insulation is severely compromised, the motor overheats, and losses in the stator and rotor rise. When the load on a motor is too great, overloading occurs. Motor overload is characterised by high current draw, low torque, and excessive heat. Overheating a motor is a leading cause of electrical and mechanical component failure due to early wear and tear. Imbalance: In three-phase induction motors, the windings are meticulously balanced in terms of number of turns, positioning, and winding resistance during design and manufacturing. The stator winding of a polyphase induction motor will experience unbalanced currents of varying magnitudes when the line voltages supplied to the motor are not perfectly balanced. Even a little voltage imbalance may cause the current to rise to dangerous levels. The engine could be severely damaged if it gets too hot and eventually burns out.As precisely as the commonly available commercial voltmeter can tell, the voltages should be balanced.

III. DESIGN OF HARDWARE

In this chapter, we will take a quick look at the hardware. It goes into great depth on the schematic of every module.

ARDUINO UNO

One such microcontroller board is the Arduino Uno, which uses the ATmega328 (datasheet). There are 14 I/O digital pins (with 6 being PWM outputs), 6 analogue inputs, a USB port, a power connector, an ICSP header, a reset button, and a 16 MHz ceramic resonator. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller.Unlike all of its predecessors, the Uno doesn't have the FTDI USB-to-serial driver chip. Instead, it has a USB-to-serial converter coded into the Atmega16U2 (or Atmega8U2 up to version R2). A resistor on the Uno board pulls the 8U2 HWB line to ground, simplifying the process of entering DFU mode. Here are some new features of the Arduino board:

The 1.0 pin out includes two more pins—the IOREF, which enable the shields to adjust to the board's voltage—near the RESET pin, as well as two additional pins—the SDA and SCL—near the AREF pin. Eventually, shields will be backwards-compatible with both the 5V AVR boards and the 3.3V Arduino Due boards. The second pin is retained for future use and is not yet connected.

The RESET circuit is now stronger.

The 16U2 is an upgrade over the 8U2.

In honour of the impending release of Arduino 1.0, the name "Uno" was chosen since it means "one" in Italian. As of this point on, the Uno and version 1.0 will serve as the Arduino reference versions. See the Arduino board index for a comparison with earlier generations; the Uno is the most recent USB Arduino board and the platform's base model.

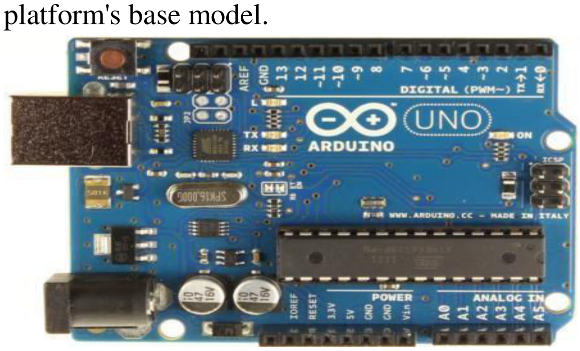


Fig: ARDUINO UNO

POWER SUPPLY:

Electrical circuits and other equipment rely on low-voltage power supplies, which transform high-voltage AC mains energy into a more manageable form. Dissecting a power supply into its component parts reveals that each one is responsible for a certain task. Regardless of changes in the alternating current (a.c.) mains or changes in the load, a "Regulated D.C. Power Supply" will keep the output voltage constant.

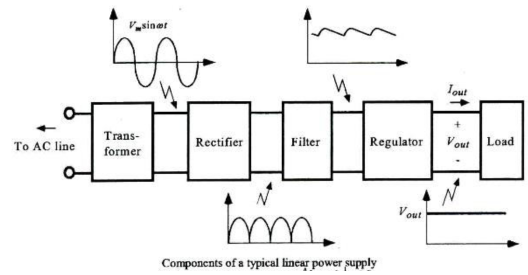


Fig: Block Diagram of Power Supply

LCD DISPLAY

The most popular model in practice is the one detailed here because of its cheap price and wide possibilities. It uses the Hitachi HD44780 microprocessor and has a 16-character message display capability on each of its two lines. It shows every letter of the alphabet, every Greek letter, every punctuation mark, every mathematical symbol, and more. Additionally, user-generated symbols may be shown. Among the most helpful features are those that automatically change the display's message (left and right shift), pointer appearance, lighting, and so on.

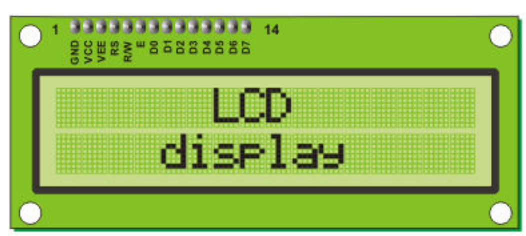
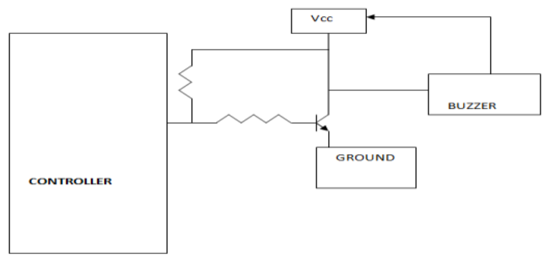


Fig: LCD

BUZZER

Not enough current is flowing via digital systems and microcontroller pins to power the circuits (buzzer circuits, relay circuits, etc.). Although these circuits have a current need of around 10 milliamps, the pin on the microcontroller can only provide 1-2 milliamps. This is why the microcontroller and buzzer circuit are separated by a driver, such a power transistor.



WIFI MODULE:

Chinese firm Espressif Systems makes the ESP8266, an affordable Wi-Fi microprocessor that can function as a microcontroller and has a complete TCP/IP stack.[1]

Ai-Thinker, a third-party producer, brought the chip to the attention of western OEMs in August 2014 with their ESP-01 module. With this little gadget, microcontrollers can establish basic TCP/IP connections using Hayes-style instructions and connect to a Wi-Fi network. Unfortunately, there was a severe lack of English-language information on the chip and the orders it could process back then.Many hackers were interested in the module, chip, and software on it, and they translated the Chinese documentation, because of the cheap pricing and the fact that there were very few external components on the module, which indicated that it may someday be extremely affordable in volume.the third

As an ESP8266 with 1 MiB of on-chip flash, the ESP8285 enables single-chip devices to establish Wi-Fi connections.[4]

The ESP32 is the chipset that will replace these microcontrollers.

LED:

One kind of semiconductor that can produce light is known as a light-emitting diode (LED). When turned on, this p-n junction diode produces light.[5] By applying an appropriate voltage to the leads, the device enables electrons to recombine with electron holes, resulting in the release of energy as photons.

This phenomenon is known as electroluminescence, and the semiconductor's energy band gap dictates the light's colour, which is proportional to the photon's energy. LEDs often have tiny surfaces (less than 1 mm2) and may have optical components built in to control the beam's angle of incidence.

Indicator lights for electrical equipment often used early LEDs, which succeeded tiny incandescent bulbs. Digital clocks and other numeric readouts quickly began to incorporate them into seven-segment displays. Modern advancements have produced LEDs that are well-suited for both ambient and task illumination. Because of their rapid switching rates, LEDs have found usage in cutting-edge communications technology and have spawned new kinds of displays and sensors.Lower energy usage, longer lifespan, increased physical robustness, smaller size, quicker switching—these are just a few of the numerous benefits that LEDs provide over incandescent light sources.

Aviation lights, car headlights, advertising, general illumination, traffic signals, camera flashes, and illuminated wallpaper are just a few of the many uses for light-emitting diodes. On top of that, they use much less energy and, ostensibly, pose less disposal-related environmental risks.

DHT TEMPERATURE & HUMIDITY SENSORS.

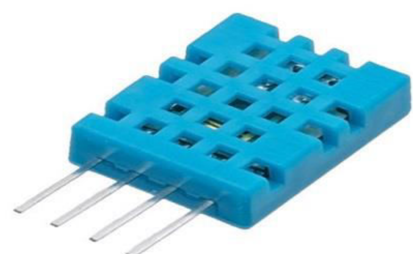
These sensors aren't fast or sophisticated, but they're perfect for amateurs who just want to record the bare minimum. A thermistor and a capacitive humidity sensor are the two main components of a DHT sensor. In addition, a simple internal chip converts analogue signals to digital ones and then puts out a digital signal including the environmental variables (heat and humidity, for example). Any microcontroller should have no trouble deciphering the digital stream.

The amount of water vapour in the air is called humidity. Numerous physical, chemical, and biological processes are impacted by the atmospheric humidity level. Humidity has the potential to impact product costs, worker health, and safety in industrial settings. Therefore, humidity measurement is crucial in the semiconductor and control system sectors. Gases may be a combination of water vapour, nitrogen, argon, or pure gas, and the quantity of moisture in them can be determined by measuring their humidity. The units of measurement distinguish between two main kinds of humidity sensors. There are two types of humidity sensors: absolute and relative. The digital humidity and temperature sensor DHT11.

Working Principle of DHT11 Sensor

An element that measures capacitive humidity and a thermistor that measures temperature make up a DHT11 sensor. A moisture-holding substrate acts as a dielectric between the two electrodes of the humidity-sensing capacitor. Variations in relative humidity cause a shift in the capacitance value. When the resistance values change, the IC measures them, processes them, and then converts them to digital form.

A thermistor with a negative temperature coefficient, which means that its resistance value decreases as the temperature increases, is used to measure the temperature with this sensor. The use of semiconductor ceramics or polymers allows this sensor to achieve a greater resistance value with even a modest change in temperature. With a 2-degree precision, DHT11 measures temperatures between zero and fifty degrees Celsius. The accuracy of this humidity sensor is 5% across a range of 20 to 80%. This sensor provides a reading once per second, or 1 Hz, which is its sampling rate. With an operational voltage range of 3 to 5 volts, DHT11 is a tiny little chip. The measurement current cannot exceed 2.5 mA.

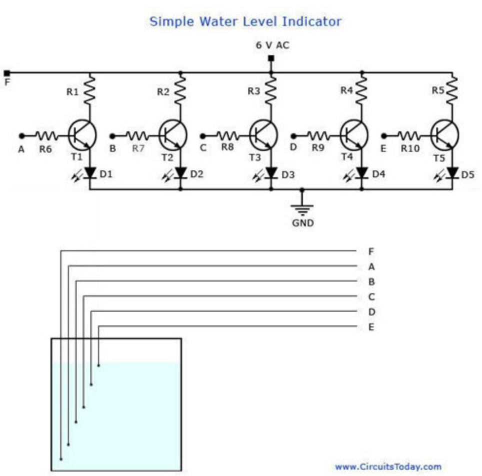


Water Level Indicator:

The following is a schematic of a basic, corrosion-free water level indicator that may be used in homes and businesses. Actually, this circuit can measure the level of any conductive non-corrosive liquid. This circuit relies on five transistor switches. As current flows into the bases of the transistors from the water via the electrode probes, they turn on and power up the matching LED.

At the base of the tank, there is one electrode probe (F) that is connected to 6V AC. A series of additional probes are progressively positioned atop the base probe. Each transistor's base is connected to 6V AC via water and its matching probe as the water level rises. As a result, the water level is shown by the transistors conducting light to illuminate the LED. The water tank level indicator's probe ends are linked to certain places in the circuit, as seen in the circuit diagram.

To make the probe, just cut the insulation from the ends of insulated aluminium wires. Put a PVC pipe with the probes arranged in a depth-wise fashion into the tank. The probes are protected against electrolysis by means of AC voltage. You may expect this configuration to last for quite some time. I promise that it will run smoothly without any repairs for at least two years. What I received is still going strong.



IV. WORKING AND BLOCK DIAGRAM

The **Transformer Monitoring and Controlling System** using IoT technology focuses on real-time monitoring of transformer parameters like temperature, humidity, and oil level to ensure proper functioning and longevity of the transformer. The system uses the **DHT11 sensor** to measure temperature and humidity, an **oil level sensor** to detect the oil level in the transformer, and an IoT module to send the data to a cloud platform for remote monitoring. The goal is to detect any abnormalities, like overheating or low oil levels, early on, thus preventing transformer failures and reducing maintenance costs.

1. Components Overview:

- **Arduino**: Acts as the main controller, collecting data from the DHT11 sensor and oil level sensor and processing it.
- **DHT11 Sensor**: Monitors the temperature and humidity around the transformer. It is essential to maintain the operating temperature within safe limits to avoid overheating.
- **Oil Level Sensor**: Checks the level of insulating oil inside the transformer. A drop in oil levels can lead to poor insulation and overheating.
- **IoT Module (e.g., ESP8266 or GSM)**: Used for transmitting the collected data (temperature, humidity, oil level) to a cloud server for remote monitoring.
- **LCD Display**: (Optional) Displays real-time transformer status (temperature, humidity, and oil level).
- **Buzzer or Alarm**: (Optional) Triggers an alert when critical parameters go beyond safe limits.
- **Power Supply**: Powers the Arduino, sensors, and IoT module.

2. Key Functions of the System:

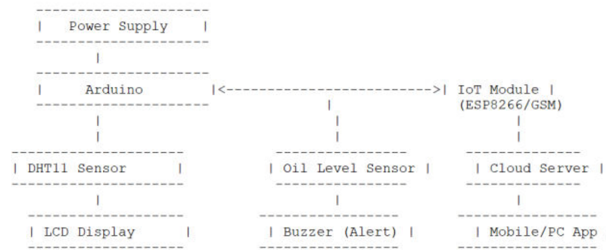
1. **Temperature and Humidity Monitoring**:
    - The **DHT11 sensor** monitors the surrounding temperature and humidity.
    - High temperatures may indicate an overload or a fault in the transformer, so the system continuously checks this to prevent overheating.
    - If the temperature crosses a threshold, the system sends a warning signal, both locally and remotely.
2. **Oil Level Monitoring**:
    - The oil level sensor tracks the amount of insulating oil inside the transformer, which is crucial for cooling and insulation.

- Low oil levels reduce the transformer's cooling efficiency, leading to potential overheating.
- If the oil level drops below a set point, the system sends an alert for immediate attention.

3. **IoT-Based Data Transmission**:
   - The IoT module sends the collected data (temperature, humidity, and oil level) to a cloud server in real time.
   - This allows remote monitoring of the transformer's health from any location via mobile apps or web-based dashboards.
4. **Local Alerts**:
   - If any of the parameters (temperature, humidity, oil level) exceed the predefined safe thresholds, an **alarm or buzzer** sounds to alert nearby personnel.
   - Simultaneously, the system sends a notification to the cloud for remote alerts.
5. **Remote Monitoring and Alerts**:
   - All sensor data is uploaded to a cloud platform, where authorized personnel can remotely monitor the transformer's health and receive alerts in real-time.
   - Users can also access historical data for analysis and predictive maintenance.

3. Block Diagram:

You can see the layout and interconnections of the transformer monitoring system's parts in the block diagram.



4. Working Flow:

1. **Initialization**:
   - The system powers on and initializes the **Arduino**, **DHT11 sensor**, and **oil level sensor**.
2. **Data Collection**:
   - The **DHT11 sensor** continuously measures temperature and humidity, and the **oil level sensor** checks the oil level in the transformer.
3. **Data Processing**:
   - The Arduino processes the data, comparing it with predefined thresholds for safe operation.
4. **Local Alerts**:
   - If the temperature, humidity, or oil level goes beyond safe limits, the system triggers a **local alarm** (buzzer) to notify personnel on-site.
5. **IoT Data Transmission**:
   - Simultaneously, the processed data is sent via the **IoT module** to a cloud server for remote monitoring.
6. **Remote Monitoring**:
   - The collected data (temperature, humidity, and oil level) is accessible via a **mobile app** or web interface, allowing operators to monitor the transformer's condition in real-time.
7. **Continuous Monitoring**:
   - The system operates continuously, ensuring the

transformer remains in optimal condition. Any abnormal condition is immediately reported, enabling quick intervention to prevent damage.

5. Alerts and Notifications:

- The system can send alerts through notifications if the transformer operates outside of normal parameters.
- This ensures early detection of potential failures, allowing preventive maintenance and reducing the risk of unexpected breakdowns.

V. CONCLUSION:

An effective and dependable method for keeping tabs on vital transformer characteristics like humidity, temperature, and oil level is this Internet of Things (IoT) monitoring and controlling system. The internet of things (IoT) and sensors work together to make transformers safer, last longer, cost less to maintain, and allow for remote monitoring. If electrical power transformers want to stay healthy and work well, this system is a must-have. The reduction of human effort and the enhancement of transformer efficiency is our primary goal in designing this gadget. Examine the transformer's electrical and physical parameters in real time using a monitoring system.

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