IoT BASED TRANSFORMER HEALTH MONITORING SYSTEM USING TELEGRAM BOT

Anuruthya S.S, Athulya, Deepika R.M, Tamilarasi K
Department of Electrical and Electronics Engineering, Sri Shakthi Institute of Engineering and Technology, L & T By - Pass, Sri Shakthi Nagar, Post, Sri Shakthi University, Chinniyampalayam, Coimbatore, Tamil Nadu 641062, India

ABSTRACT

The IoT-based Transformer Health Monitoring System, employing a Telegram Bot, has been meticulously developed to facilitate real-time monitoring and management of transformer health. This comprehensive system employs sensors to continuously measure critical parameters, including temperature and oil level within the transformer. The data gathered by these sensors is then transmitted to an IoT platform for processing and analysis, aimed at identifying anomalies or impending failures. The seamless integration with a Telegram bot further amplifies the system's functionality by providing instant alerts and notifications to maintenance personnel via the Telegram messaging app. This streamlined communication mechanism ensures prompt dissemination of deviations from standard operating conditions, enabling expedited responses and proactive maintenance actions. The primary objective of the system is to not only mitigate the risk of transformer failures and enhance operational efficiency but also to curtail downtime and maintenance costs. By harnessing IoT and Telegram Bot technology, the system presents an economical and reliable solution for transformer health management, ensuring uninterrupted and efficient power distribution. This pioneering approach underscores the transformative potential of IoT in fortifying the dependability and safety of critical infrastructure.

1. INTRODUCTION

The utilization of an IoT-based Transformer Health Monitoring System with integration of a Telegram Bot signifies a significant advancement in the domain of electrical infrastructure maintenance and management. Conventional techniques for monitoring transformers are often reactive and resource-intensive, relying on manual inspections and routine maintenance schedules that may not effectively prevent unforeseen failures. Conversely, this innovative system harnesses the potential of the Internet of Things (IoT) to furnish real-time monitoring and proactive maintenance of transformers, ensuring their optimal performance and longevity. By integrating a range of sensors, the system continuously monitors critical parameters such as temperature, humidity, oil level, and voltage. Subsequently, this data is transmitted to a central processing unit, typically an ESP32 microcontroller, which meticulously scrutinizes the information to promptly identify any anomalies indicative of potential faults. The inclusion of a Telegram Bot enriches the system's functionality by facilitating instantaneous notifications and remote monitoring. Operators are able to receive real-time alerts and comprehensive reports on their mobile devices via the Telegram messaging platform, allowing for immediate corrective actions if necessary. This novel approach not only mitigates the risk of transformer failures but also minimizes downtime and maintenance costs. Additionally, the user-friendly interface of the Telegram Bot enables effortless access to historical data and trends, thereby contributing to the implementation of predictive maintenance strategies. In summary, this IoT-based solution exemplifies the transformative capacity of modern technology to revolutionize traditional practices, thus fostering more effective and reliable power management systems.

2. LITERATURE SURVEY

The incorporation of Internet of Things (IoT) technology into the monitoring of transformer health stands as a critical domain for research and development, owing to its pivotal role in facilitating reliable and efficient management of electrical grids. This review of pertinent literature scrutinizes a range of studies and projects that have harnessed IoT and communication technologies to advance transformer monitoring systems. Special consideration is given to the utilization of Telegram bots for seamless real-time data reporting and adept system management.

In [1], the author introduces an IoT-based system designed for transformer health monitoring, employing Node-MCU, a cost-effective Wi-Fi-enabled microcontroller, alongside a range of sensors to monitor crucial parameters including temperature, oil level, leakage current, and fire detection within the transformer. The acquisition of sensor data is facilitated through the Node-MCU, which interfaces with the internet via Wi-Fi, subsequently transmitting the data to a cloud server for comprehensive analysis and visualization. The cloud server harnesses machine learning algorithms to process the data, enabling the prediction of potential faults or failures within the transformer. This proposed system distinguishes itself from conventional monitoring methods by virtue of its cost-effectiveness, achieved through the integration of low-cost sensors, real-time monitoring capabilities, and remote accessibility, empowering operators to oversee transformer health from a distance.

In [2], this paper proposes a methodology of the integration of technology in the agricultural sector which has become increasingly essential. As a pivotal sector of the economy, agriculture supports the livelihoods of a significant portion of the population. The predominant challenge faced in agriculture pertains to water scarcity, resulting in ineffective water resource management and wastage. To address this issue, there is a compelling need to automate the irrigation process. Leveraging Internet of Things (IoT) technologies in this domain presents an opportunity to mitigate water wastage. Through the deployment of IoT sensors and actuators, agricultural processes can be streamlined, rendering them more efficient and contemporary. This facilitates expedited and proficient task execution within compressed timeframes. The development of an intelligent system designed to monitor and govern soil moisture levels in plants and plantations accelerates operational processes and diminishes water wastage by dispensing optimal water volumes to the plants. Furthermore, this system dispatches Telegram notifications containing precise water content details for the plants, enabling real-time monitoring.

In [3], the author explains that the increasing integration of technology in agriculture has become imperative. Bearing the mantle of our nation's primary industry, agriculture supports a significant portion of our population. A pertinent issue faced in this sector is the scarcity of water, exacerbated by inefficient water resource management leading to wastage. An automation of the irrigation process, leveraging Internet of Things (IoT) technologies, offers promise in minimising water loss. Deployment of IoT sensors and actuators stands to enhance operational efficiency, culminating in expedited and resource-conserving agricultural practices. Propelling these advancements is the development of an intelligent system with a focus on monitoring and regulating soil moisture content in plants and plantations. This system augments productivity while addressing water conservation through tailored water allocation to plants. Furthermore, it integrates a reporting feature, disseminating plant water content details via Telegram for convenient and timely assessment.

In [4], the author explains that the transformers are crucial components of an electrical system, serving as the primary building blocks. Any damage to transformers can have a detrimental impact on the stability of an electrical system. Such damages are often a result of overloading and inefficient cooling. To address this issue, real-time monitoring of the health conditions of distribution transformers is imperative. This is achieved through the use of IoT technology, which enables the monitoring, processing, and recording of parameters such as temperature, voltage, and current of a transformer on servers. In this setup, three sensors are interfaced with AT328. The recorded data can be transmitted using a Wi-Fi module and accessed globally via IoT technology utilizing the HTTP protocol. This approach eliminates human dependency, enabling proactive identification and resolution of issues before they lead to failure.

IoT in Transformer Health Monitoring

The Internet of Things (IoT) has led to a significant transformation in the monitoring of transformers within the field of electrical engineering. Traditionally, transformer monitoring relied on manual inspections and offline data analysis, resulting in inefficiencies and inaccuracies due to its sporadic nature and human involvement.The emergence of IoT-based systems has ushered in a paradigm shift in monitoring practices, enabling continuous real-time monitoring for transformers. This transition from manual assessments to automated monitoring processes yields more precise and timely insights into transformer operational conditions.IoT technology provides engineers with real-time data on transformer performance, empowering proactive maintenance and rapid responses to emerging issues. This advanced monitoring framework enhances the operational efficiency and dependability of transformer systems while also bolstering safety protocols through early detection of potential concerns. Furthermore, IoT frameworks offer predictive capabilities, enabling engineers to anticipate and prevent potential failures before they occur. This proactive approach shifts maintenance strategies from reactive to preventive measures. By leveraging IoT devices, engineers make data-driven decisions to optimize performance and reliability, promising a future of enhanced operational resilience and efficiency in electrical engineering.

Several studies have highlighted the benefits of IoT in transformer health monitoring:

SENSOR INTEGRATION

Sensors are integral to the monitoring of transformer functionality as they facilitate the assessment of crucial parameters, including temperature, oil levels, and leakage current. The acquisition and analysis of data generated by these sensors enable the early detection of potential issues, thereby precluding the escalation of such matters into significant problems[1].

REAL-TIME MONITORING

Timely detection and intervention are imperative in the realm of real-time monitoring. IoT technology facilitates the continuous tracking of transformer conditions, thereby enabling immediate response to any anomalies that may arise[4].

USING TELEGRAM BOT FOR NOTIFICATIONS

Integrating a Telegram bot into the health monitoring system enhances user interaction by providing timely alerts and updates directly to users' mobile devices.

Instant Notifications:

Telegram bots can be programmed to send immediate notifications to users when specific thresholds are exceeded. For instance, if the temperature goes beyond a set limit, a notification is dispatched to the maintenance team[3].

Customization:

The bot can be customized to provide detailed reports, historical data, and even predictive analytics based on the collected data. This feature enhances decision-making and strategic planning for maintenance activities [3].

The integration of IoT technology with Telegram bots for transformer health monitoring offers a comprehensive solution for real-time data collection, analysis, and proactive maintenance. This approach not only improves the reliability and efficiency of transformers but also ensures timely interventions, reducing the risk of failures and extending the operational life of these critical components.

3. METHODOLOGY

The process for an IoT-based monitoring system for transformer health, utilizing a Telegram bot, encompasses the integration of diverse sensors and a microcontroller to continuously oversee critical transformer parameters including temperature, oil level, leakage current, and fire detection. These sensors interface with a NodeMCU microcontroller to capture and process real-time data. Subsequently, the processed data is transmitted to a central server via Wi-Fi connectivity. A cloud-based platform is employed for data storage and analysis, enabling efficient data management and real-time monitoring of the transformer’s condition. To enable remote monitoring, a Telegram bot is utilized to disseminate notifications and alerts. The bot is programmed to automatically dispatch messages detailing the transformer's status upon the surpassing of specific thresholds or detection of abnormal conditions. This configuration permits maintenance teams to receive immediate alerts and undertake timely interventions, mitigating failures and enhancing the reliability of power distribution systems. The amalgamation of IoT and Telegram bots offers a cost-effective and efficient solution for transformer health monitoring, capitalizing on the ubiquitous nature of smartphones and the ease of instant messaging to facilitate seamless communication and control.

1. Real-Time Monitoring and Data Collection:

IoT-enabled sensors play a pivotal role in the proactive management of transformers by providing continuous monitoring of crucial parameters like temperature and oil levels. These sensors facilitate real-time transmission of data to central servers or cloud platforms, enabling swift analysis for timely intervention. This constant surveillance not only enables swift issue identification, preventing transformer failures and enhancing operational longevity but also allows for the generation of predictive maintenance alerts. Technicians receive these alerts promptly, enabling them to address potential issues before they escalate, thus optimizing maintenance schedules and significantly minimizing downtime. This state-of-the-art approach not only transforms the landscape of transformer management but also ensures streamlined operations and substantial cost savings in the long term.

2. Data Analytics and Predictive Maintenance:

In contemporary IoT ecosystems, data analytics and machine learning algorithms play a pivotal role in pre-emptively predicting transformer malfunctions. Through the meticulous examination of historical data sets and the discernment of pertinent patterns, these sophisticated systems demonstrate a capacity to anticipate impending issues, enabling the strategic organization of maintenance initiatives well ahead of time. This proactive approach not only mitigates operational downtime but also substantially curtails maintenance expenditures, underscoring the unparalleled efficiency and cost-effectiveness that such predictive technologies offer within the realm of IoT infrastructure management.

Use of Telegram Bots in IoT Systems

The utilization of Telegram bots for the remote monitoring and management of IoT systems has become increasingly prevalent in recent times. Telegram, a cloud-based messaging platform, provides an API that allows developers to create sophisticated bots capable of both sending and receiving messages. This functionality makes Telegram an ideal platform for facilitating real-time notifications and control. By leveraging the power of instant communication, this approach ensures seamless oversight and efficient management of IoT systems. These bots can be programmed to monitor various parameters, send alerts, and even execute commands, thereby providing users with a robust and versatile solution for remote monitoring and control. This innovation significantly enhances the reliability and responsiveness of IoT systems, allowing for proactive maintenance and swift issue resolution, ultimately leading to improved system performance and user satisfaction. The integration of Telegram bots into IoT applications exemplifies the synergy between communication technology and IoT, resulting in smarter, more connected, and more manageable systems

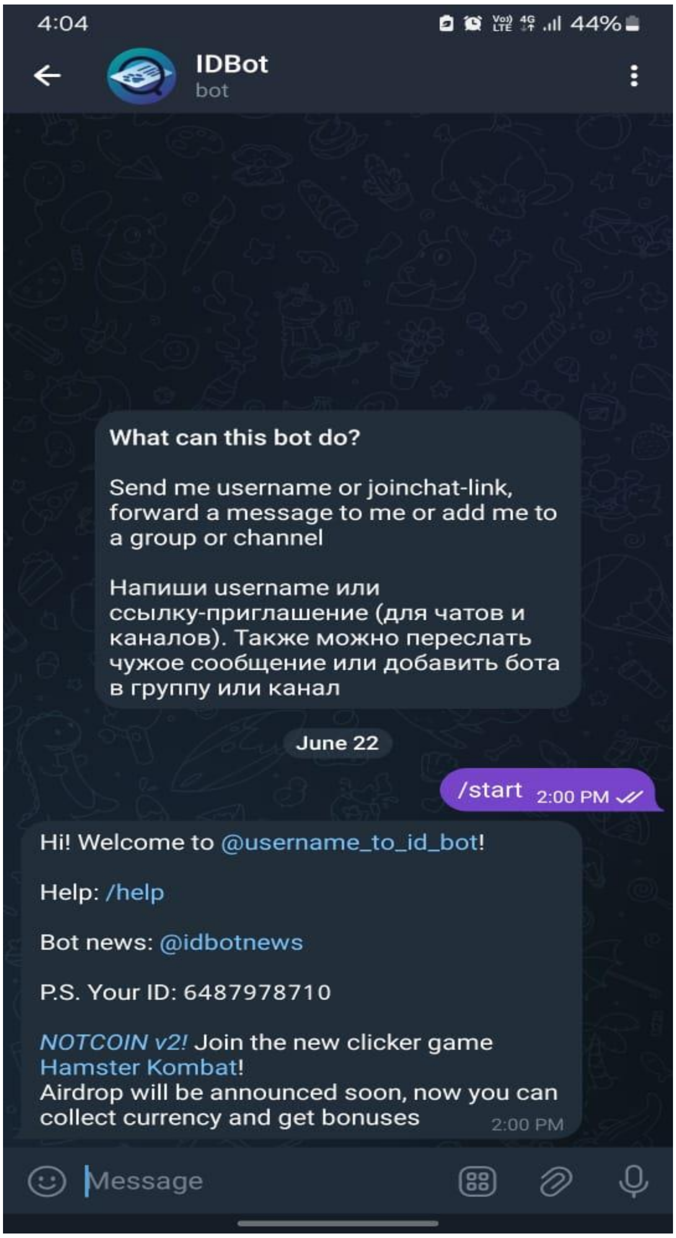

Fig1: Creating a Bot

1. Ease of Integration:

Telegram bots can be seamlessly integrated with IoT systems through the use of application programming interfaces (APIs). These bots possess the capability to receive data from IoT sensors and dispatch real-time alerts to designated users, providing crucial information about the status of the transformer. This enables operators to promptly respond to any irregularities, enhancing operational efficiency and ensuring timely maintenance. The integration of Telegram bots with IoT systems represents a significant advancement in monitoring and control, equipping infrastructure and facility managers with the tools to efficiently manage and maintain critical assets. By leveraging the instantaneous communication capabilities of Telegram bots, operators can gain real-time insights into the performance of transformers and immediately address any anomalies, ultimately contributing to increased reliability and resilience of the overall system.

2. User Interaction and Control:

Telegram bots are versatile tools that extend beyond simple notifications, as they are capable of accepting commands from users. This functionality enables interactive control of the IoT system, providing users with the ability to engage in two-way communication. By leveraging Telegram bots, users can query the status of various parameters, request historical data, and initiate specific actions, such as resetting a sensor or adjusting monitoring thresholds. This two-way interaction fosters a dynamic and responsive user experience, empowering individuals to actively engage with and control the IoT system. Ultimately, Telegram bots serve as a powerful interface for users to interact with IoT devices, offering a comprehensive and responsive means of managing and monitoring connected systems.

CIRCUIT DIAGRAM

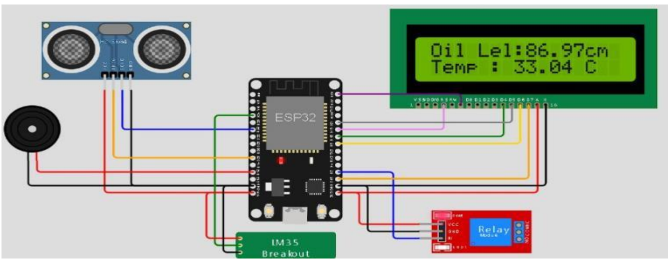

Fig2: Circuit diagram for transformer health monitoring system

The IoT-based transformer health monitoring system incorporates a Telegram bot to integrate diverse sensors and communication modules for real-time tracking of transformer health status. Critical parameters such as temperature and oil level, essential for transformer health evaluation, are measured by dedicated sensors connected to a microcontroller unit, typically a NodeMCU, which processes the data. The NodeMCU, featuring Wi-Fi capabilities, transmits the data to a cloud server for storage and analysis, while also interfacing with the Telegram bot API to provide instantaneous notifications. The system architecture encompasses power supply circuits for sensors and NodeMCU, signal conditioning circuits for precise sensor data, and protection circuits to ensure component safety from electrical faults. Upon detecting an anomaly, the sensor triggers an alert through the NodeMCU, which is then formatted into a message by the Telegram bot and dispatched to the user's device. This configuration enables uninterrupted remote monitoring and facilitates immediate response in the event of potential transformer malfunctions, thereby optimizing the maintenance and operation of electrical distribution systems.

TELEGRAM BOT

A Telegram bot is a robot programmed with various commands to carry out a series of user instructions. It is operated by software that includes AI features. In this project, the bot is used to send commands to and receive responses from a microcontroller. To start using this bot, the user needs to create a bot name using the command "/start". Once the Bot Username is created, a Token is obtained to access the HTTP API. This Token is then entered into the sketch to ensure the connection to the Telegram Bot.

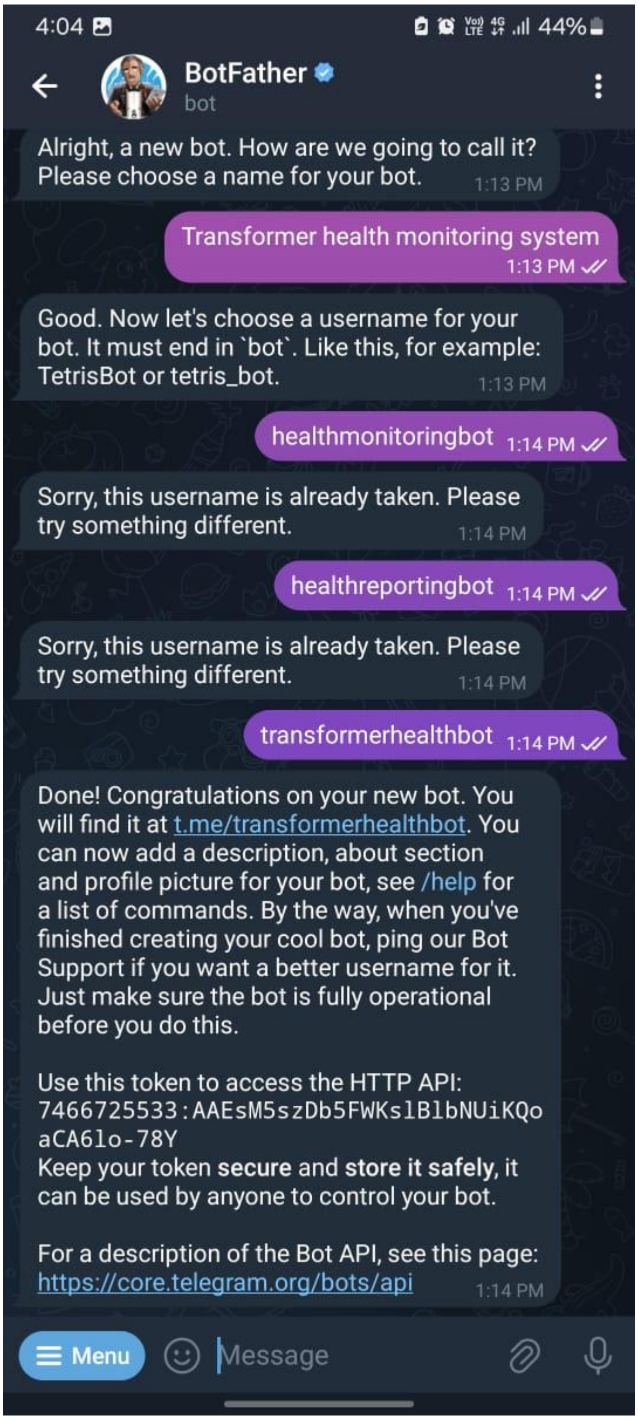

Fig3: BotFather

The fig3 is a screenshot showing a conversation with BotFather on Telegram. BotFather is used to create and manage bots on the platform. Here is a detailed explanation of the content.

The process starts with updating information in the Telegram server. After that, a notification message is sent to the admin server to inform the administrator about the latest data. Once the notification is sent, the process is complete. The flowchart illustrates a system that allows an administrator to interact with a program, request updates, and receive notifications. The updates are sent to a Telegram server, which helps the administrator communicate efficiently and make decisions.

4. COMPONENTS:

The components used in this project include,

- ESP 32
- 12V DC Fan
- LCD Display Regulator
- 10k Preset
- 220 ohms Resistor
- 5V Relay
- Ultrasonic Sensor
- Temperature Sensor - DMT 11
- Female header
- Ribbon wires
- Potentiometer - 10k
- Zeroth board
- 12V 1A[Adaptor/SMPS]
- Female Adaptor Pin

1. ESP 32

The ESP32 is a low-cost, low-power system on a chip (SoC) series with Wi-Fi and dual-mode Bluetooth capabilities. The ESP32 integrates a rich set of peripherals, ranging from capacitive touch sensors, Hall sensors, an SD card interface, Ethernet, high-speed SPI, UART, I2S, and I2C. For the transformer health monitoring system, the ESP32 serves as the central microcontroller that processes data from various sensors and transmits this data to the Telegram bot via Wi-Fi. Its powerful processing capability ensures real-time monitoring and quick response to changes in transformer health parameters.

2. 12V DC Fan

The 12V DC fan is used for cooling purposes in the system. Transformers tend to overheat under heavy loads or due to faults, and overheating can lead to significant damage or reduced efficiency. The fan is activated when the temperature sensor detects a temperature rise beyond a predefined threshold, ensuring the transformer operates within safe temperature limits.

The 12V DC fan is efficient, reliable, and easily controlled via the ESP32 through a relay.

3. LCD Display Regulator

An LCD display is incorporated into the system to provide a real-time, on-site readout of transformer parameters such as temperature, oil level, and other critical information. This allows technicians to quickly assess the transformer's health without the need for remote monitoring tools. The display regulator ensures the LCD operates within its specified voltage range, protecting it from fluctuations that could cause malfunction or damage.

4. 10k Preset

The 10k preset, or potentiometer, is used for adjusting the contrast of the LCD display. It allows fine-tuning of the display to ensure readability under various lighting conditions. This component is crucial for ensuring that the information displayed is clear and legible, especially in environments where lighting may vary.

5. 220 Ohms Resistor

A 220-ohm resistor is typically used in series with LEDs or other components to limit the current flowing through them, thereby preventing damage. In this system, resistors might be used to protect LEDs or other sensors from excessive current, ensuring their longevity and reliable operation.

6. 5V Relay

The 5V relay acts as a switch that allows the ESP32 to control high-power devices such as the 12V DC fan or other cooling mechanisms. When the ESP32 detects that the transformer temperature exceeds a certain level, it triggers the relay to turn on the fan, helping to cool the transformer and prevent overheating. Relays are crucial for interfacing low-power microcontroller signals with high-power devices.

7. Ultrasonic Sensor

An ultrasonic sensor is employed to measure the oil level in the transformer. Transformers require oil for cooling and insulation, and maintaining an adequate oil level is critical for safe operation. The ultrasonic sensor sends out sound waves and measures the time it takes for the echoes to return, which is then used to calculate the oil level. This information is vital for preventing issues related to low oil levels, such as overheating or dielectric failure.

8. Temperature Sensor - DMT 11

The DMT 11 is a digital temperature and humidity sensor. It provides precise measurements of the transformer's ambient temperature, which is essential for monitoring thermal conditions. The ESP32 reads the data from the DMT 11 and, if necessary, takes actions such as activating cooling mechanisms or sending alerts via the Telegram bot. Accurate temperature monitoring helps in maintaining the transformer's health and preventing thermal-related failures.

9. Female Header

Female headers are used for making reliable connections between the various modules and the ESP32 on the circuit board. They provide a secure yet flexible way to connect and disconnect components, which is essential for maintenance and upgrades. Female headers ensure that the connections are stable and that the signals are transmitted accurately between components.

10. Ribbon Wires

Ribbon wires, also known as flat cables, are used to connect different components in the system. They are convenient for making organized and neat connections between the microcontroller, sensors, display, and other peripherals. Their flexibility and ease of routing make them ideal for complex circuits where space management is critical.

11. Potentiometer - 10k

Another 10k potentiometer might be used for various tuning purposes in the system, such as adjusting sensor thresholds or calibrating other parameters. Potentiometers provide a variable resistance that can be manually adjusted to fine-tune the system's performance, ensuring optimal operation under different conditions.

12. Zeroth Board

The Zeroth board, or prototyping board, is used for assembling and testing the circuit before final implementation. It allows for easy placement and connection of components, making it simpler to debug and modify the circuit. Using a prototyping board is essential for iterative development and ensures that the final design is robust and error-free.

13. 12V 1A Adaptor/SMPS

The 12V 1A adaptor or SMPS (Switch Mode Power Supply) provides the necessary power to the system. It converts the AC mains voltage to a stable 12V DC output required by the fan and other components. A reliable power supply is crucial for the continuous operation of the monitoring system, ensuring that all components receive the correct voltage and current.

14. Female Adaptor Pin

Female adaptor pins are used to connect power supplies and other external devices to the system. They ensure a secure and stable connection, preventing accidental disconnections that could disrupt the system's operation. These connectors are designed for ease of use and durability, providing a reliable interface between different parts of the system.

In summary, the IoT-based transformer health monitoring system comprises various components, each playing a specific role in ensuring the system's overall functionality and reliability. From the central processing unit (ESP32) to sensors, relays, and power supplies, each component is selected and configured to provide accurate real-time monitoring and effective management of the transformer's health. The integration of these components with a Telegram bot enables remote monitoring and timely alerts, enhancing the system's efficiency and responsiveness.

5. PROGRAM

This system is designed to monitor and report appliance power consumption in real time using an ESP32 microcontroller. The microcontroller is equipped with Wi-Fi connectivity and communicates with a Telegram bot to enable remote monitoring and control. Additionally, a liquid crystal display (LCD) is integrated into the setup to provide local data visualization, showing the power consumption of specific appliances such as a mixer, heater, and fridge.

Program to display in LCD:

```
#include <Arduino.h>
#include <LiquidCrystal.h>
#include <DHT.h>

#define TRIG_PIN 5
#define ECHO_PIN 15
#define BUZZER_PIN 22
#define RELAY_PIN 23

// DHT sensor settings
#define DHTPIN 4
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

// Constants
const float TANK_HEIGHT_CM = 100.0;

float duration_us, distance_cm, oilLevel_cm;
float hum, temp;

LiquidCrystal lcd(12, 14, 27, 26, 25, 33); // Pins for
LCD RS, EN, D4, D5, D6, D7

void setup() {
  Serial.begin(9600);
  lcd.begin(16, 2);
  dht.begin();
  pinMode(BUZZER_PIN, OUTPUT);
  pinMode(RELAY_PIN, OUTPUT);
  pinMode(TRIG_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);
}

void loop() {
  // Read temperature and humidity from DHT sensor
```

```
hum = dht.readHumidity();
temp = dht.readTemperature();

// Print temp and humidity values to serial monitor

Serial.print("Temp: ");
Serial.print(temp);
Serial.println(" C");

// Measure distance to oil surface
digitalWrite(TRIG_PIN, HIGH);
delayMicroseconds(10);
digitalWrite(TRIG_PIN, LOW);
duration_us = pulseIn(ECHO_PIN, HIGH);

// Calculate the distance in cm
distance_cm = 0.017 * duration_us;

// Calculate oil level in the tank
oilLevel_cm = TANK_HEIGHT_CM - distance_cm;

// Display on LCD
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Oil Lvl:");
lcd.print(oilLevel_cm);
lcd.print("cm");

lcd.setCursor(0, 1);
lcd.print("Temp : ");
lcd.print(temp);
lcd.print(" C");

// Print to Serial Monitor
Serial.print("Oil Level: ");
Serial.print(oilLevel_cm);
Serial.println(" cm");

Serial.print("Temperature: ");
Serial.print(temp);
Serial.println(" C");

digitalWrite(RELAY_PIN, LOW);
digitalWrite(BUZZER_PIN, LOW);


// Control the fan based on temperature
while(temp > 40.0) {
  digitalWrite(RELAY_PIN, HIGH);
  delay(5000);// Turn on the fan
 }

 digitalWrite(RELAY_PIN, LOW);

 // Control the buzzer based on oil level
 if (oilLevel_cm < 90.0) {
  digitalWrite(BUZZER_PIN, HIGH); // Turn on the buzzer
  delay(5000);
  digitalWrite(BUZZER_PIN, LOW);// Keep the buzzer on for 10 seconds
 } else {
  digitalWrite(BUZZER_PIN, LOW); // Turn off the buzzer
 }

 delay(1000); // Wait for 1 second before next measurement
}
```

This Arduino program is designed to monitor the oil level in a tank and the temperature and humidity using a DHT11 sensor. It utilizes an ultrasonic sensor to measure the distance to the oil surface and calculates the oil level by subtracting this distance from the tank's height (100 cm). The DHT11 sensor provides temperature and humidity readings. The system displays the oil level and temperature on an LCD and prints these values to the serial monitor. If the temperature exceeds 40°C, a relay is activated to turn on a fan for cooling. If the oil level drops below 90 cm, a buzzer is activated to signal a low oil level. Both the fan and buzzer are controlled based on the sensor readings to ensure proper operation and safety.

Program to display in Telegram Bot

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 14, 27, 26, 25, 33);
#ifdef ESP32
#include <WiFi.h>
#else
#include <ESP8266WiFi.h>
#endif
#include <WiFiClientSecure.h>
#include <UniversalTelegramBot.h>   // Universal Telegram Bot Library written by Brian Lough:
```

```
https://github.com/witnessmenow/Universal-Arduino-Telegram-Bot
#include <ArduinoJson.h>
#include <NTPClient.h>
#include <WiFiUdp.h>
#include <DHT.h>
#include <Arduino.h>

#define TRIG_PIN 5
#define ECHO_PIN 15
#define BUZZER_PIN 22
#define RELAY_PIN 23
// DHT sensor settings
#define DHTPIN 4
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
// Constants
const float TANK_HEIGHT_CM = 100.0;
float duration_us, distance_cm, oilLevel_cm;
float hum, temp;


// Replace with your network credentials
const char* ssid = "DHIVANAN";
const char* password = "12112004";
String DT;

WiFiUDP ntpUDP;
NTPClient timeClient(ntpUDP, "in.pool.ntp.org", 19800); // UTC offset for Chennai (5 hours 30 minutes ahead)


// Initialize Telegram BOT
#define BOTtoken "7466725533:AAEsM5szDb5FWKslBlbNUiKQoaCA6lo-78Y"
#define CHAT_ID "6487978710"

#ifdef ESP8266
X509List cert(TELEGRAM_CERTIFICATE_ROOT);
#endif

WiFiClientSecure client;
UniversalTelegramBot bot(BOTtoken, client);

// Checks for new messages every 1 second.
int botRequestDelay = 1000;
unsigned long lastTimeBotRan;

void handleNewMessages(int numNewMessages) {
  Serial.println("handleNewMessages");
  Serial.println(String(numNewMessages));

  for (int i = 0; i < numNewMessages; i++) {
    // Chat id of the requester
    String chat_id = String(bot.messages[i].chat_id);
    if (chat_id != CHAT_ID) {
      bot.sendMessage(chat_id, "Unauthorized user", "");
      continue;
    }

    // Print the received message
    String text = bot.messages[i].text;
    Serial.println(text);

    String from_name = bot.messages[i].from_name;

    if (text == "/state") {
      // Combine all the information into a single string
      String message = "Oil level : " + String(oilLevel_cm)
+ " cm" + "\n" +
                       "Temperature: " + String(temp) + " C";

      // Send the message to Telegram
      bot.sendMessage(chat_id, message, "");
    } else {
      bot.sendMessage(chat_id, "Invalid input", "");
    }
  }
}

void setup() {
  lcd.begin(16, 2);
  delay(1000);
  Serial.begin(115200);
  delay(1000);
  dht.begin();
  delay(1000);
  pinMode(BUZZER_PIN, OUTPUT);
  pinMode(RELAY_PIN, OUTPUT);
  pinMode(TRIG_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);
  delay(1000);

  lcd.clear();
```

```
  lcd.setCursor(0, 0);
  lcd.print("Oil Lvl: 96.3cm");

  lcd.setCursor(0, 1);
  lcd.print("Temp : 28.6 C");

#ifdef ESP8266
  configTime(0, 0, "pool.ntp.org");      // get UTC time via NTP
  client.setTrustAnchors(&cert); // Add root certificate for api.telegram.org
#endif
  // Connect to Wi-Fi
WiFi.mode(WIFI_STA);
WiFi.begin(ssid, password);
#ifdef ESP32
client.setCACert(TELEGRAM_CERTIFICATE_ROOT); // Add root certificate for api.telegram.org
#endif
while (WiFi.status() != WL_CONNECTED) {
    delay(1000);
    Serial.println("Connecting to WiFi..");
  }
  Serial.println("Connected to WiFi");

  // Print ESP32 Local IP Address
  Serial.println(WiFi.localIP());

  bot.sendMessage(CHAT_ID, "Bot Started", "");
  // Initialize NTP client
  timeClient.begin();
  timeClient.update();
}

void loop() {

   // Read temperature and humidity from DHT sensor
  hum = dht.readHumidity();
  temp = dht.readTemperature();

  // Print temp and humidity values to serial monitor

  Serial.print("Temp: ");
  Serial.print(temp);
  Serial.println(" C");

  // Measure distance to oil surface
  digitalWrite(TRIG_PIN, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIG_PIN, LOW);
  duration_us = pulseIn(ECHO_PIN, HIGH);

  // Calculate the distance in cm
  distance_cm = 0.017 * duration_us;

  // Calculate oil level in the tank
  oilLevel_cm = TANK_HEIGHT_CM - distance_cm;

  // Display on LCD

  // Print to Serial Monitor
  Serial.print("Oil Level: ");
  Serial.print(oilLevel_cm);
  Serial.println(" cm");

  Serial.print("Temperature: ");
  Serial.print(temp);
  Serial.println(" C");

  digitalWrite(RELAY_PIN, LOW);
  digitalWrite(BUZZER_PIN, LOW);


  // Control the fan based on temperature
  while(temp > 40.0) {
   digitalWrite(RELAY_PIN, HIGH);
   delay(5000);// Turn on the fan
  }

  digitalWrite(RELAY_PIN, LOW);

  // Control the buzzer based on oil level
  if (oilLevel_cm < 90.0) {
   digitalWrite(BUZZER_PIN, HIGH);
   String message = "Oil level is decreased... \n Oil Level : " + String(oilLevel_cm)+ " cm";
     bot.sendMessage(CHAT_ID, message, "");// Turn on the buzzer
   delay(5000);
   digitalWrite(BUZZER_PIN, LOW);// Keep the buzzer on for 10 seconds
  }
  else {
   digitalWrite(BUZZER_PIN, LOW); // Turn off the buzzer
  }
```

```
  if (millis() > lastTimeBotRan + botRequestDelay) {
    int numNewMessages = bot.getUpdates(bot.last_message_received + 1);
    while (numNewMessages) {
      Serial.println("got response");
      handleNewMessages(numNewMessages);
      numNewMessages = bot.getUpdates(bot.last_message_received + 1);
    }
    lastTimeBotRan = millis();
  }

  timeClient.update();
  delay(2000);
}
```

This Arduino program is designed to monitor and report the oil level, temperature, and humidity using various sensors and components, with communication capabilities via a Telegram bot. The system employs an ultrasonic sensor to measure the distance to the oil surface and calculates the oil level based on a predefined tank height. A DHT11 sensor is used to read temperature and humidity values. These readings are displayed on an LCD and printed to the serial monitor. The program includes functionality to control a relay (fan) and a buzzer: the fan is activated if the temperature exceeds 40°C, and the buzzer sounds if the oil level drops below 90 cm. The system connects to a Wi-Fi network and uses the Universal Telegram Bot library to handle Telegram messages. Users can request the current oil level and temperature by sending a "/state" command to the bot, which responds with the requested data. The program also synchronizes time using an NTP client to ensure accurate timestamping.

6. EXPERIMENTAL RESULTS

The results of the experiment conducted on an IoT-based transformer health monitoring system using a Telegram bot demonstrate a robust framework for real-time monitoring and control. This system integrates a variety of sensors to measure critical parameters, including temperature, oil level, and leakage current, offering a comprehensive health assessment of the transformer. Data from these sensors are continuously gathered and sent through the IoT module to a central server. The Telegram bot serves as an interface for users to receive alerts and updates on the status of the transformer, allowing for immediate action in the event of anomalies. Users can inquire about the current data from the bot at any time, ensuring ongoing awareness of the transformer's health. The system's real-time monitoring capability significantly improves preventive maintenance, reducing downtime and potential failures. The Telegram bot efficiently disseminates information quickly and effectively, ensuring that relevant personnel are promptly informed of any critical issues, thereby enhancing the overall reliability and safety of the power distribution network. Experimental validation has confirmed the system's effectiveness in real-world conditions, indicating its potential for widespread adoption in transformer monitoring applications.

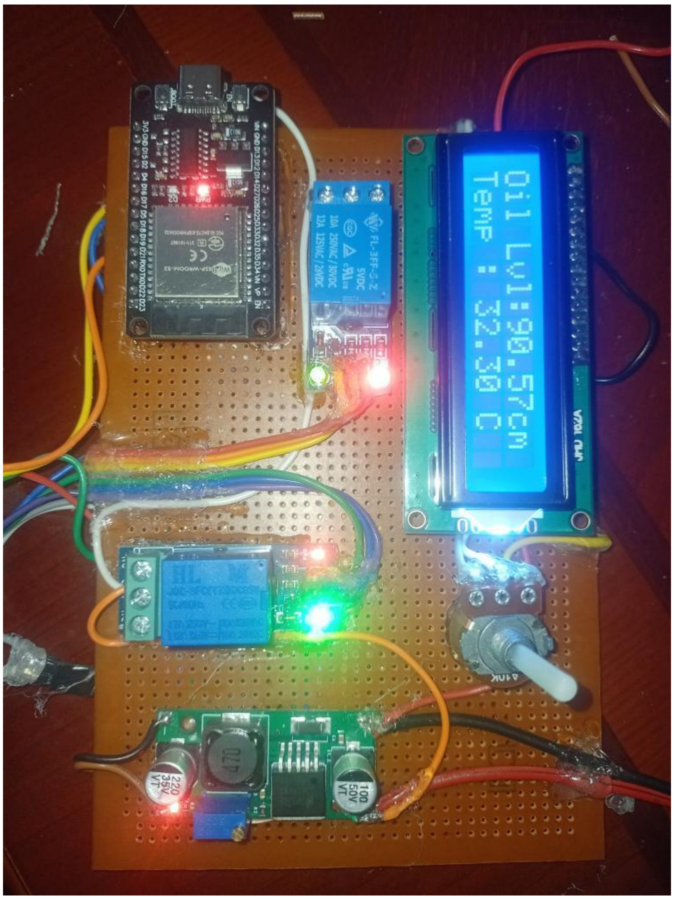

Fig4: Output of LCD Display

This IoT-based transformer health monitoring system using a Telegram bot in Fig3, combines advanced sensor technology and real-time data communication to ensure the efficient operation and maintenance of transformers. This system involves the use of various sensors to monitor critical parameters such as temperature, oil levels, leakage current, and fire detection in transformers.

These parameters are crucial for the safe and reliable functioning of transformers, which are essential components in electrical power distribution. By leveraging IoT technology, the system continuously collects data from these sensors and transmits it to a central server for processing. The integration with a Telegram bot allows for instant notifications and alerts to be sent to maintenance personnel or system administrators, facilitating prompt responses to any anomalies or potential faults detected. This approach not only enhances the efficiency of transformer maintenance by providing real-time insights but also helps in preventing severe damage and potential failures, thus ensuring a more stable power distribution network. The use of Telegram bots for communication offers a user-friendly and accessible platform for monitoring transformer health, making it easier to manage and maintain transformer systems effectively. This intelligent system thus represents a significant advancement in transformer health monitoring, providing a reliable, efficient, and easily accessible solution for the power industry.

7. CONCLUSION

The integration of Internet of Things (IoT) technology with transformer health monitoring systems represents a significant advancement in the field of electrical engineering and power management. The inclusion of a Telegram bot in such systems further enhances their functionality and accessibility, providing a real-time, user-friendly interface for monitoring and managing transformer health. This comprehensive conclusion delves into the multifaceted benefits, technical aspects, challenges, and future prospects of IoT-based transformer health monitoring systems with Telegram bot integration.

Benefits and Importance

The primary advantage of an IoT-based transformer health monitoring system lies in its ability to provide continuous, real-time monitoring of critical parameters. Transformers are vital components of power distribution networks, and their failure can lead to significant disruptions and financial losses. Traditional methods of monitoring transformers often involve periodic manual inspections, which are not only labor-intensive but also prone to delays and inaccuracies. By contrast, IoT-enabled systems utilize a network of sensors to continuously monitor parameters such as temperature, oil level, leakage current, and the presence of gases like hydrogen and carbon monoxide, which are indicators of transformer health [8].

These systems can detect anomalies and potential faults at an early stage, thereby allowing for timely maintenance and preventing catastrophic failures. The use of IoT technology ensures that data from the sensors is collected and transmitted in real-time to a central processing unit, where it is analyzed using advanced algorithms. This real-time data analysis can provide actionable insights and predictive maintenance recommendations, enhancing the reliability and efficiency of the power distribution network.

Technical Aspects

The technical implementation of an IoT-based transformer health monitoring system involves several key components. Sensors are deployed on the transformer to measure various physical parameters. These sensors are connected to a microcontroller, such as the NodeMCU, which serves as the central hub for data collection and transmission. The microcontroller processes the sensor data and transmits it to a cloud-based server via the internet. In the cloud, the data is stored, processed, and analyzed using machine learning algorithms to identify patterns and predict potential failures.

The integration of a Telegram bot adds a layer of accessibility and ease of use to the system. Telegram is a widely used messaging platform that supports the creation of bots, which are automated programs that can interact with users. By developing a Telegram bot for the transformer health monitoring system, users can receive real-time notifications about the status of the transformers directly on their smartphones. The bot can be programmed to send alerts in case of abnormal conditions, provide regular updates, and even respond to user queries about specific parameters [9].

Challenges

Despite the numerous advantages, implementing an IoT-based transformer health monitoring system with a Telegram bot presents several challenges. One of the primary challenges is ensuring the reliability and accuracy of the sensors. Sensors must be able to operate in harsh environmental conditions and provide accurate measurements over long periods. Any failure in the sensor network can lead to incorrect data being transmitted, potentially causing false alarms or missed detections. Another significant challenge is data security. Since the system involves the transmission of sensitive data over the internet, it is crucial to implement robust security measures to protect the data from cyber-attacks. This includes using encryption protocols for data transmission and storage, as well as ensuring that the Telegram bot is secure from unauthorized access. The scalability of the system is another important consideration. As the number of transformers being monitored increases, the system must be able to handle the increased data load without compromising on performance. This requires efficient data management and processing capabilities, as well as the ability to integrate with existing power management systems.

Future Prospects

The future prospects for IoT-based transformer health monitoring systems with Telegram bot integration are promising. Advances in sensor technology, data analytics, and artificial intelligence will continue to enhance the capabilities of these systems. For instance, the development of more advanced sensors with higher accuracy and longer lifespans will improve the reliability of the monitoring system. Similarly, the use of advanced machine learning algorithms can enhance the predictive maintenance capabilities of the system, allowing for even earlier detection of potential faults.

The integration of IoT-based transformer health monitoring systems with other smart grid technologies also holds significant potential. For example, integrating these systems with automated grid management systems can enable more efficient and responsive power distribution. In the event of a transformer fault, the system can automatically reconfigure the grid to minimize disruptions and ensure continuous power supply.

Moreover, the use of blockchain technology can address some of the data security challenges associated with IoT-based systems. Blockchain provides a decentralized and tamper-proof ledger for recording transactions, which can be used to securely store and transmit sensor data. This can enhance the security and integrity of the data, providing greater confidence in the system's reliability.

Culmination

In conclusion, the integration of IoT technology with transformer health monitoring systems, coupled with the use of a Telegram bot, represents a significant advancement in the field of power management. These systems offer numerous benefits, including real-time monitoring, early fault detection, and enhanced accessibility, which collectively improve the reliability and efficiency of power distribution networks. However, the implementation of these systems also presents several challenges, including ensuring sensor reliability, data security, and scalability.

Future advancements in sensor technology, data analytics, artificial intelligence, and blockchain are expected to further enhance the capabilities of IoT-based transformer health monitoring systems. As these technologies continue to evolve, they will play an increasingly important role in ensuring the reliable and efficient operation of power distribution networks, ultimately contributing to a more resilient and sustainable energy infrastructure.

8. RESEARCH PAPER

[1] IOT BASED TRANSFORMER HEALTH MONITORING SYSTEM USING NODE-MCU. (S.S.Sable1, P.S.Burande2, Aniket N3, Omkar B4, Sourabh J5,Vishal W6.
DY Patil) Institute of Engineering And Technology. International Journal of Scientific Research in Engineering and Management(IJSREM), ISSN:2582-3930, SJIF Factor: 8.448

[2] IOT BASED PLANT MONITORING SYSTEM USING TELEGRAM BOT (1Dr. Pravin Kshirsagar,2Prof.Avinash K. Ikhar,3Prof.Firoz Akhtar,4Deepak Harikishor Suryawanshi 1Associate Professor,23Assistant Professor,4Student Department Of Electronics & Telecommunication J D College of Engineering & Management, Nagpurnternational). Journal of Engineering Science and Advanced Technology (IJESAT), ISSN No: 2250-3676, Vol18 Issue 08,2018.

[3] IOT BASED PLANT MONITORING SYSTEM USING TELEGRAM BOT (1Mounika S,2Anitha A,3Jayalakshmi B,4Prabhavathamma Y 1,2,3Assistant Professor, , Department of ECE, Tadipatri Engineering College,Tadipatri,AP ,4Associate Professor, Department of ECE, Tadipatri Engineering College,Tadipatri,AP). Turkish Journal of Computer and Mathematics Education Vol.10 No.3(2019),1272-1278

[4] IoT Based Transformer Health Monitoring and Protection System (Mr.Omkar Kulkarni*, Ms.PoonamPatil, Ms.Asama Sande, Ms. Kajal Salunkhe, Ms. Snehal Chavan, P.S. Kambale) Department of Electrical Engineering, Jawant College of Engineering And Polytechnic, Shivaji University, Maharashtra, India. AIJR Publisher in the "Proceedings of National Conference on Relevance of Engineering and Science for Environment and Society" (R{ES}2 2021) July 25th, 2021. Organized by Shri Pandurang Pratishthan's Karmayogi Engineering College, Shelve, Pandharpur, India. Proceedings DOI: 10.21467/proceedings.118; Series: AIJR Proceedings; ISSN: 2582-3922; ISBN: 978-81-947843-6-4

[5] Monika Agarwal and Akshaypandya, "GSM Based Condition Monitoring of Transformer", IJSRD - International Journal for ScientificResearch&Development| Vol. 1, Issue 12, 2014 | ISSN (online):2321-0613

[6] Hongyan Mao, "Research of Wireless Monitoring System in Power Distribution Transformer Station Based on GPRS", Volume 5, C 2010 IEEE,978-1-4244-5586-7/10/$26.00

[7] Pathak A.K, Kolhe A.N, Gagare J.T and Khemnar SM, "GSM Based Distribution.

[8] ijsrem.com - IOT BASED TRANSFORMER HEALTH MONITORING SYSTEM USING NODE MCU

[9] researchgate.net - IOT BASED PLANT MONITORING SYSTEM USING TELEGRAM BOT