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CONDITION MONITORING OF DISTRIBUTION TRANSFORMER USING IOT

Puja Nanaji Choudhari[1], Prajakta Ravindra Kamble[2], Roshani Dilip Farkade[2], Vibhanshu Yogeshwar Turkar[2],Hitesh Kishor Kundre[2]

[1]Faculty, Department of Electrical Engineering (Electronics & Power), Priyadarshini College of Engineering Nagpur
[2]Students, Department of Electrical Engineering (Electronics & Power), Priyadarshini College of Engineering Nagpur

ABSTRACT

Transformer is important equipment in transmission and distribution network. Its operation and control are important aspects, which determine the reliability and quality of power supply. As large number of transformers are spread over wide area in the present power system, it is difficult to monitor the condition of each transformer manually. Therefore, development of Condition Monitoring System for transformers is done. This condition monitoring system can monitor several parameter status of transformer in real time aspect .This paper presents design & implementation of IoT based condition monitoring system to monitor the current ,voltage ,temperature ,humidity and level of transformer oil . This monitoring system is programmed with some predefined instructions to check the abnormal conditions based on their established values. This system can be an advanced step in automation, which does not depend on manual testing & human dependency. As it is a wireless communication system, it is cost effective. Temperature monitoring provides fundamental protection for the transformer by preventing operation in overheated condition as overheating leads to insulation damage and reduces transformer life expectancy. Thus, condition- monitoring offers improved transformer protection.

Keywords*: current, voltage, Transformer oil, humidity &Temperature, IoT, Arduino*

1. INTRODUCTION

The most crucial equipment of transmission and distribution of electric power is Transformer. Transformer is a device used in the power transmission of electrical energy. Transformer works on the principle of Electromagnetic Induction & Mutual Induction. Thetransmission current is AC. Their function is to increase ordecrease the supply voltage without change in the frequency of AC between circuits. Transformers are essentially required in various fields like Power generationgrid, Distribution sector, Transmission and electric energy consumption.

Condition monitoring of transformer is the process of acquisition and processing of data related to various parameters, to predict and prevent the failure of a Transformer. This can do by observing the deviation of the transformer parameters from their expected values. This will help and guide the utilities to optimally use the transformer and keep the equipment in operation for longer period. The proposed project presents design and implementation of system to measure different key parameters. This is possible by using on-line measuring system using Internet of Things (IoT) for fault condition alert, with Arduino Uno microcontroller and sensors installed with transformer. Whenever any change occurs in the condition of transformer oil exceeding the permissible range, the sensor detects these changes and relay will operate and automatically starts motor to fill oil in transformer tank from spare tank containing transformer oil up to its defined level. Motors Turn ON/OFF condition represent on LCD. This paper includes the description of components, block diagram and the results obtained.

2. PROPOSED SYSTEM

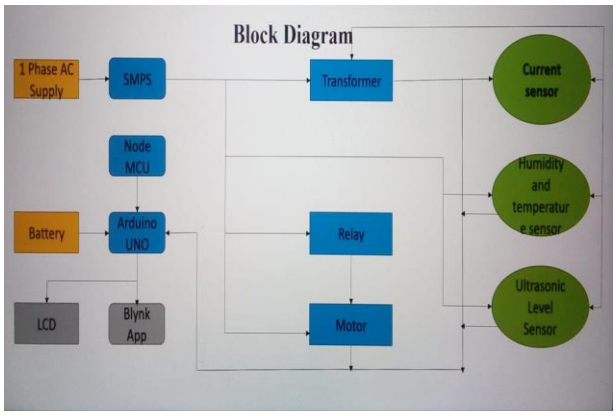


Fig. 2.1Block Diagram

A typical condition monitoring system for a transformer is capable of monitoring various components like temperature of transformer tank, Humidity, oil level, voltage, current etc.

The main objective of this paper is to design and implement a system for condition monitoring of transformer using IoT to check parameter variation of transformer and represent data on Blynk Application.

3. HARDWARE REQUIREMENTS

3.1 ACS 712 Hall Effect-Based Linear Current Sensor

The ACS712 is a fully integrated, hall effect-based linear current sensor with 2.1kVRMS voltage isolation and a integrated low-resistance current conductor.ACS712 Current Sensor uses Indirect Sensing method to calculate the current. To sense current a linear, low-offset Hall sensor circuit is used in this IC. This sensor is located at the surface of the IC on a copper conduction path. When current flows through this copper conduction path it generates a magnetic field which is sensed by the Hall effect sensor. A voltage proportional to the sensed magnetic field is generated by the Hall sensor, which is used to measure current ACS712 Current Sensor is available as a small, surface mount SOIC8 package.

3.2 Ultrasonic level Sensor

HC-SR04 ultrasonic distance sensor. This economical sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit. There are

only four pins that you need to worry about on the HC-SR04: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground). You will find this sensor very easy to set up and use for your next range-finding project! This sensor has additional control circuitry that can prevent inconsistent "bouncy" data depending on the application.

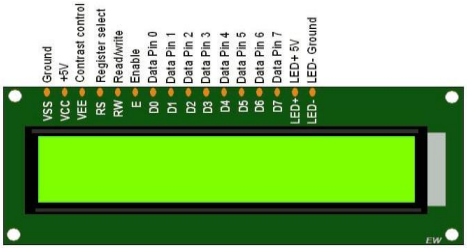
Operating Voltage: 5V DC

Operating Current: 15mA

Measure Angle: 15°

Ranging Distance: 2cm - 4m

3.3 LCD DISPLAY



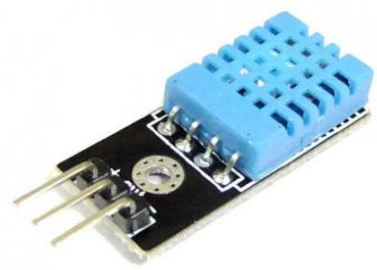
Liquid Crystal Display screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is a very basic module and are commonly used. A 16x2 LCD means it can display 16 characters per line and there are two such lines. LCD modules are very commonly used in most embedded projects, the reason being it is program friendly and it is economically. LCD 16x2 can be used in 4-bit mode or 8-bit mode. It is also possible to create custom characters. It has 8 data lines and 3 control lines that can be used for control purposes. It represent the data as voltage rating, current rating motor turn on /turn off condition, temperature of transformer.

3.4 WIFI MODULE (Node MCU)

serial communication is required to transfer sensor data or any data from one device to another device. In this device ESP8266 NodeMCUand Arduino is used . transfer DHT22 Sensor data, Acs712 current sensor data and humidity and temperature sensor data from Arduino to NodeMCU .The NodeMCU (Node MicroController Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266.

The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds..

3.5 Humidity and Temperature Sensor



DHT11 is a humidity and temperature sensor which generates calibrated digital output. DHT11 can be interface with Arduino .It is low cost humidity and temperature sensor which provides high reliability and long term stability.

Power Supply： 3.3~5.5V DC

Output： 4 pin single row

Measurement Range： Humidity 20-90%RH,

Temperature 0~50℃

Accuracy： Humidity +-5%RH, Temperature +-2℃

Resolution： Humidity 1%RH, Temperature 1℃

Interchangeability： Fully Interchangeable

Long-Term Stability： <±1%RH/year

Pin description -

Pin 1: Power +ve (3.3VDC to 5.5VDC Max wrt. GND)

Pin 2: Serial Data Output

Pin 3: Power Ground or Power –ve

3.6 SMPS

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently .It converts 230 V AC supply to 5 v DC for Components and 12V DC for MOTOR .Consists of a controller IC, one or several power transistors and diodes as well as a power transformer, inductors, and filter capacitors. Some design complexities present (reducing noise/interference; extra limitations on maximum ratings of transistors at high switching speeds) not found in linear regulator circuits.

3.7 Relay

A 5v relay is an automatic switch that is commonly used in an automatic control circuit and to control a high current using a low current signal. The input voltage of the relay signal is 5v. Relay sense the low oil level in transformer tank and give signal to motor to refill the tank with oil from spare tank.

3.8 Water Pump

R385 12V DC Diaphragm based mini aquarium Water Pump

6-12V DC Diaphragm Based Mini Aquarium Water Pump is an ideal non submersible pump for variety of liquid movement application. It has enough pressure to be used with nozzle to make spray system. The pump can handle heated liquids up to a temperature of 80°C and when suitably powered can suck water through the tube from up to 2m and pump water vertically for up to 3m. Possible uses/projects include; a small aquarium pump, automatic plant watering system, making a water feature or music activated dancing water features to name but a few. When pumping a liquid the pump runs very quietly. The pump is also capable of pumping air, though when pumping air the pump is quite noisy in comparison.

The R385 requires between 6 – 12V DC and between 0.5 – 0.7A and will deliver its maximum operating values when power is at the upper end of these ranges.

This immersible pump can be used to water your plants, make a fountain or waterfall, and even change your fish tank water. It works quietly with the sound level under 30db. The pump has a filter inside as well as a suction cup which can help stick it to smooth surfaces tightly.

Specifications and Features of R385 6-12V DC Diaphragm Based Mini Aquarium Water Pump:-

- Model : R385
- Rated Voltage : DC 6V to 12V (1 amps)
- Working current: 0.5A to 0.7A (Max)
- Power: 4W-7W
- Max Lift: 3m
- Max Suction: 2m
- Fluid: 0-100 ° C
- Input/output tube diameter: outer 8.5mm, inner 6mm approx.
- Max Current: Up to 2 Amps while starting up
- Life: up to 2500 Hours
- The maximum flow rate of up to 1 – 3L/min
- Max Water Temp: 80 °C
- Pump Size: 90mm * 40mm * 35mm approx.

3.9 ARDUINO UNO

Arduino UNO is a microcontroller board based on ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, USB connections, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller. Arduino UNO is open source microcontroller board based on microchip ATmega328P microcontroller Board equipped with sets of 14 digital and 6 analog input /output pins that interface with sensors, LCD and Node MCU for WiFi connection Programmable with Arduino IDE 1.8.19 software Powered by 9V external battery via B USB cable

3.10 TRANSFORMER

In this system Transformer is main component which we have to protect against faults. transformer, device that transfers electric energy from one alternating-current circuit to one or more other circuits, either increasing (stepping up) or reducing (stepping down) the voltage. Transformers are employed for widely varying purposes; e.g., to reduce the voltage of conventional power circuits to operate low-voltage devices, such as doorbells and toy electric trains, and to raise the voltage from electric generators so that electric power can be transmitted over long distances. here oil cooled Distribution Transformer is replaced with 220V AC to 5V DC transformer.

4. SOFTWARE REQUIREMENTS

4.1 ARDUINO IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++.[3] It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.[4]

The source code for the IDE is released under the GNU General Public License, version 2.[5] The Arduino IDE supports the languages C and C++ using special rules of code structuring.[6] The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution.[7] The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.[8] By default, avrdude is used as the uploading tool to flash the user code onto official Arduino boards.[9]

4.2 ISIS PROTEUS

The Proteus design suite is a proprietary software tool suits primarily for electronic design automation. Mainly electronic design engineers and technicians to create schematics and electronic print for manufacturing printed circuit broads use the software.

Proteus is used to simulate, design and drawing of electronic circuits. The Lab Centre Electronics invented it.

Proteus is a complete development platform product concept to design completion. Its advantage are intelligent principle layout, hybrid circuit simulation and accurate analysis, single chip software debugging, and peripheral circuit co- simulation, PCB automatic layout and wiring.

5. WORKING

A typical condition monitoring system for a transformer is capable of monitoring various components like current, voltage, temperature , moisture, oil level etc.

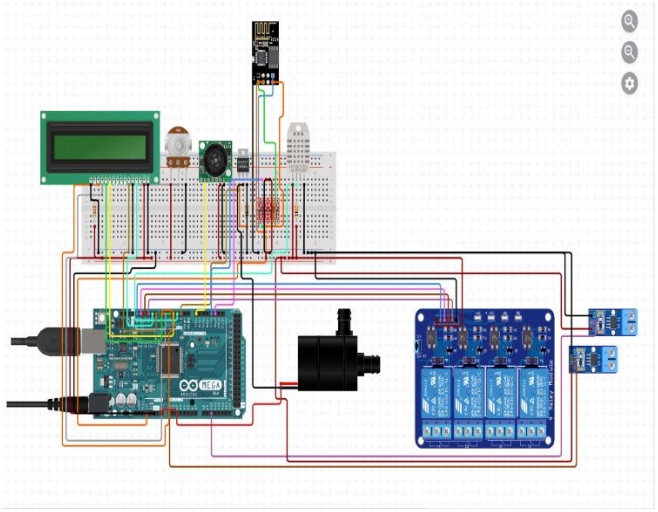
The main objective of this paper is to design and implement device which monitor key parameters using different sensors and provide real time data to authorized person on blynk app and LCD.

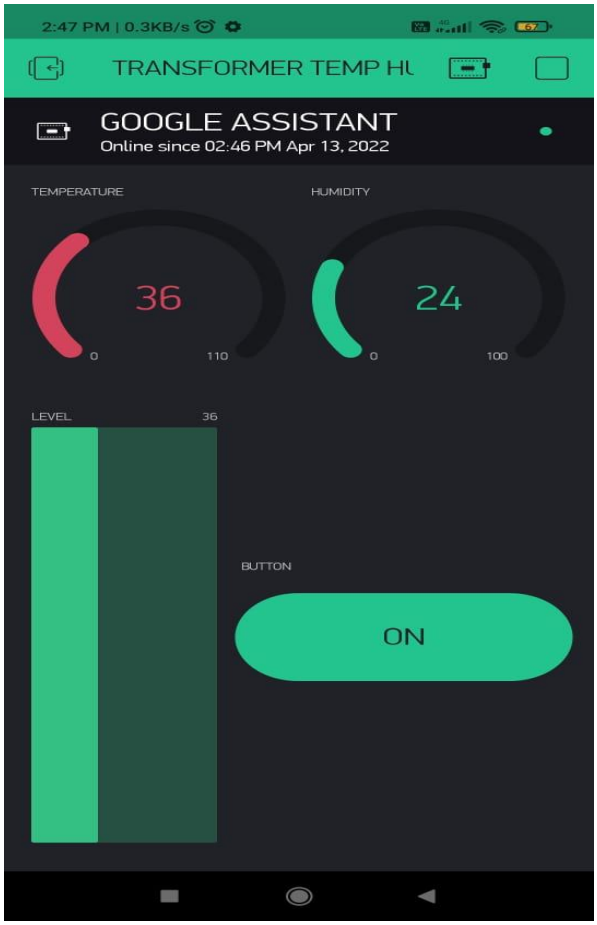
A predefined program uploaded to the Arduino, is calibrated the given input values and it provides the necessary output.

This work includes the process of monitoring of transformer oil's temperature range, current voltage and humidity. The sensed values are given to the Arduino.

The values given by the ultrasonic sensors are measured and compared with the nominal value predefined in the program in the comparators. If the measured value varies, the system will send an singal to relay to operate water pump and refill transformer oil from spare tank to the main transformer tank .also it send data to the concerned person on Blynk application which is installed on android with the help of Wi-fi module NODE MCU. The values also given by current sensor, temperature and humidity sensor and motor turn on /off condition send to blynk app .

The programmed output is displayed through a local display LCD screen. The same output is also transmitted through the Wi-fi module to the internet server and then to the mobile application Blynk as programmed in the Arduino





6. CONCLUSION

This study gives remedies from difficulties of determine fault occurring causes in transformer and it overcomes the drawback of Previous working methods. The project focuses mainly on the efficiency of monitoring process of transformer by using wireless communication that eliminates the use of large cables which are of high cost, low reliability and maintenance. The main goal of the project is to design and construct an internet of Things (IoT) based transform Condition monitoring system which can display real time states in transformer. After that construction of the device, the system was tested successfully. That is device can monitor the condition of transformers and send data accumulated from sensors through the WI-FI and display over the IOT platform that is Blynk app. All parameters that are critical and have exceeded their threshold limit can be sent through Blynk app for immediate action to be taken. It continuously monitors the parameters throughout its operation with high accuracy.

FUTURE SCOPE

We can design a special circuit which can automatically find the gaseous which are form due to oxidation of transformer oil. This system finds a big scope in transmission lines by using other communication protocols like Laura, MHz etc. Using genetic algorithm in determining best sensors readings or faulty sensors readings can be helpful in calculating accurate health index during faulty sensor situations. This system can be expanded to big campuses or societies with many acute substations which can be operated and monitored remotely. This system can be expanded to 3=phase transformer, which will display more accurate health condition.

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