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IoT based Condition Monitoring of Transformer

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***Abstract*— Transformer is an important asset 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 - with automatic data acquisition. This paper presents design & implementation of IoT based mobile embedded system to monitor the temperature of transformer oil and detection of various gases like Methane, Carbon monoxide, Hydrogen, Acetylene, Ethane etc. This monitoring system is programmed with some predefined instructions to check the abnormal conditions based on their established values. This remote monitoring system using IoT will help to identify problems before any failure occurs. Different faults can be identified from the data obtained using dissolved gas analysis (DGA), which is helpful in detecting the condition of transformers for its long tenure. 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:- Transformer oil, Temperature, Dissolved gas analysis IoT, Arduino

1. INTRODUCTION

Electricity plays an important role in our life. Every moment of our life depends upon electricity. Electricity has several components and equipment's, which help human to transfer and regulate the distribution according to usage.

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. The transmission current is AC. Their function is to increase or decrease the supply voltage without change in the frequency of AC between circuits. Transformers are essentially required in various fields like Power generation grid, 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 done 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 embedded system to measure temperature and different gas detection. This is possible by using on-line measuring system using Internet of Things (IoT) for fault condition alert, with Arduino 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 there is an alert via push messages. It also detects the faults such as electrical faults, Thermal fault and overheating of oil. This paper includes the description of components, block diagram and the results obtained.

2. PROPOSED SYSTEM

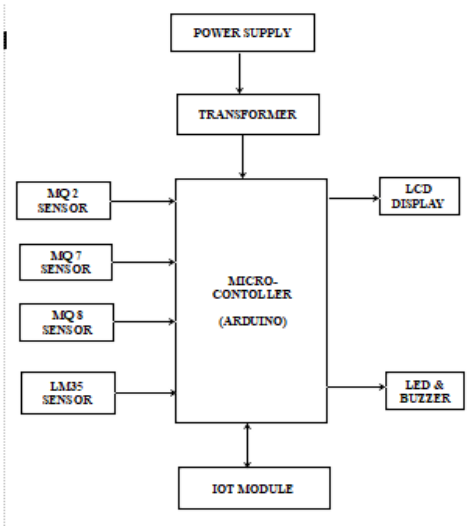

Fig. 2.1 Block Diagram

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

The main objective of this paper is to design and implement an embedded mobile & IoT based system to measure oil temperature and dissolved gases like Carbon monoxide, Hydrogen and Methane using sensors.

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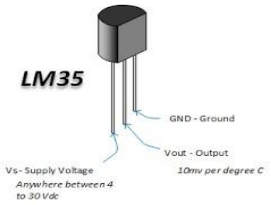
3. HARDWARE REQUIREMENTS

3.1 LM35 Temperature Sensor



LM35 is a temperature sensor that outputs an analog signal, which is proportional to the instantaneous temperature. Temperature in Celsius is obtained by easily interpreting the output voltage.

LM35 can measure from - 55 degrees centigrade to 150 degree centigrade. The accuracy level is very high if operated at optimal temperature and humidity levels.

The input voltage to LM35 can be from +4 volts to 30 volts. It consumes about microamperes of current.

3.2 MQ2 Sensor

MQ2 Sensor contains a sensing element mainly aluminium oxide based ceramic coated with Tin dioxide enclosed in a stainless steel mesh.

It is an electronic sensor used for sensing the concentration of gases such as methane, carbon dioxide etc.

The preheat duration is for 20 seconds, it is used as digital and analog sensor. The sensitivity of digital pin is varied using the potentiometers.

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

A16x2 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.

3.4 WIFI MODULE

The ESP8266 WIFI Module is a SOC (Security Operations Centre) with integrated TCP/IP (Transmission Control Protocol / Internet Protocol) protocol stack that can give any microcontroller access to your Wi-Fi.

The ESP8266 is a capable of either hosting an application or offloading all WIFI networking function from another application processor

3.5 MQ7 SENSOR

Sensitive material of MQ7 gas sensor is SnO2 which with lower conductivity in clear air. It makes detection by method of cycle high and low temperature, and detect Carbon Monoxide CO when low temperature (heated by 1.5V). MQ7 gas sensor has high sensitivity to carbon monoxide. The sensor could be used to detect different gases contains CO.

3.6 MQ 8 SENSOR

A Sensitive material MQ 8 Hydrogen gas sensor module H2 Alarm detection use in clean air low conductivity tin oxide. This sensor can detect a wide range of hydrogen gas, city gas in particular, is a low cost sensor for variety of applications.

Suitable for home or industrial hydrogen leakage monitoring devices.

3.7 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 is a open source electronics platform based on easy to use hardware and software.

4. SOFTWARE REQUIREMENTS

4.1 ARDUINO IDE

Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino module. This software makes code compilation too easy. It is easily available for operating system like MAC, Windows, LINUX

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and runs on the Java platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.

The main code,also known as a Sketch created on the IDE platform will ultimately generate a Hex file which is transferred and uploaded in the controller on the board.

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 oil temperature, gas in oil, moisture in oil, oil level, voltage, current etc.

The main objective of this paper is to design and implement an embedded mobile & IoT based system to measure oil temperature and dissolved gases like Carbon monoxide, Hydrogen and Methane using sensors.

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 and the gases present in the oil as well as transformer tank. The sensed values are given to the Arduino.

The values given by the 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 alert to the concerned person with the help of Wi-fi module, and as an physical indication the buzzer gives beep sound and also LED bulb glows

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 .

Data will be saved and can be used for the further analysis. The GSM modem is used as a short message server device that transmits parameters as an SMS.

By the use of software to store and perform the dissolved gas analysis of the measured data, the information on the state of health of the transformer and alarms raised when measured values exceed appropriate limits can be provided to the operator.

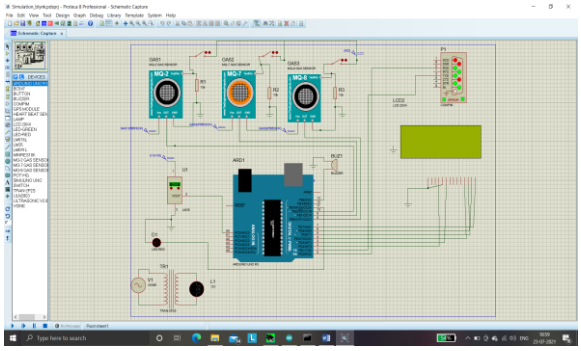

Fig. 5.1. Simulation circuit

6. RESULTS AND DISCUSSIONS

SL .No	TEMPERATURE	CH4 GAS	CO GAS	H2 GAS	HEALTH STATE	FAULT TYPE
1	LOW	LOW	LOW	LOW	NORMAL	NO FAULT
2	HIGH	HIGH	HIGH	HIGH	ALARM	Temp is HIGH Overheating of oil Thermal Fault Electrical Fault

Case 1: When temperature is normal and when the sensors do not detect the gases methane, carbon monoxide and hydrogen, the result display is shown below

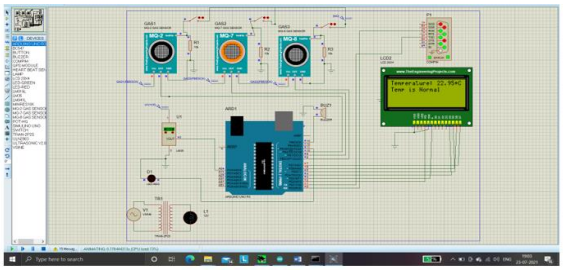

Fig. 6.1 When temperature is normal

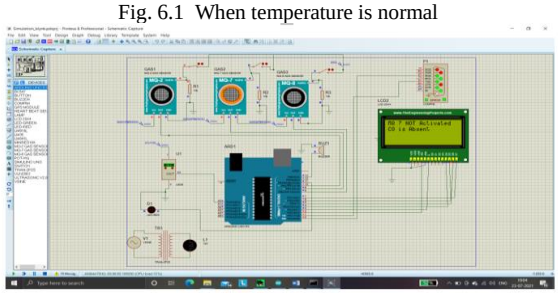

Fig. 6.2 When MQ2 Sensor is not activated

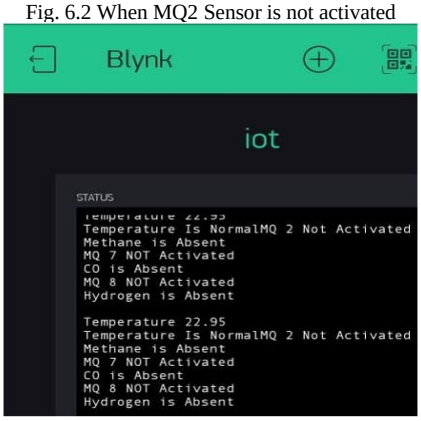

Fig. 6.3 Meassage displayed in Blynk app for case 1

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Case 2: When the temperature was raised beyond the permissible values and When gases such as methane, carbon monoxide and hydrogen are detected by sensors. Results are displayed as shown below .

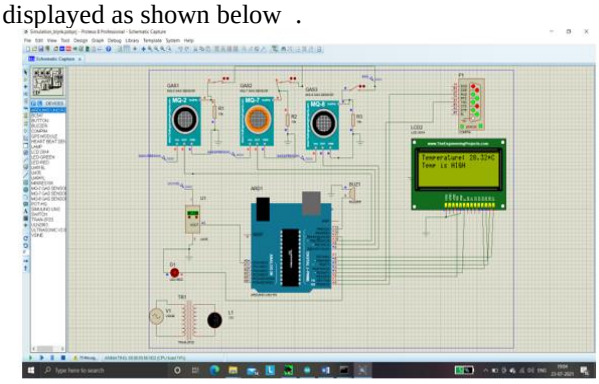

Fig. 6.4. When Temperature is high

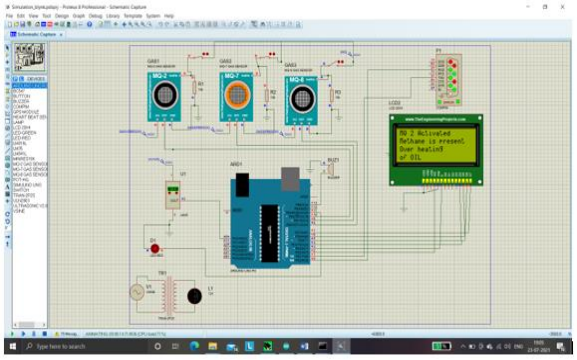

Fig. 6.5. When MQ2 Sensor is activated

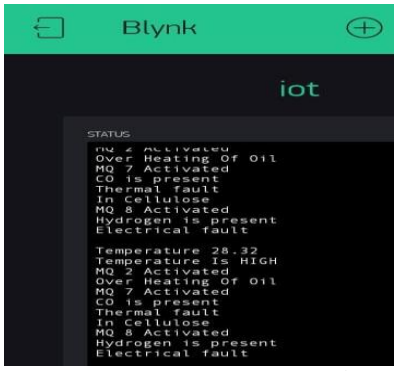

Fig. 6.6. Message displayed in Blynk app for case 2

CONCLUSION

This study gives remedies from difficulties of determining fault occurring causes in transformer and it overcomes the drawbacks 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 Transformer Monitoring System which can display real time states in transformer. After the construction of the device, the system was tested successfully. That is the device can monitor the condition of transformer and send data accumulated from the sensors through the Wi-Fi and displayed over the IoT platform. All parameters that are critical and have exceeded their threshold limit can be sent through SMS 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 trip the circuit breaker automatically in case of fault before the SMS reaches the mobile operator which makes the operation even faster.

This system finds a big scope in transmission lines by using other communication protocols like Laura, rf 434 MHz etc.

Using genetic algorithm in determining best sensor readings or faulty sensor 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 help in reducing post-fault clearing time in distribution network.

This system can be expanded to 3-phase transformer, which will display more accuratehealth indices.

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