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IoT based Distribution Transformer Health Monitoring System using Arduino, Nodemcu and Thingspeak

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***Abstract*— Transformers are the main building block in a power system. Any damages in transformers adversely affects the balance of a power system. The damages are mainly occurring due to overloading and inefficient cooling. The main objective of the is real time monitoring of the health conditions of the distribution transformer using IOT technology. The parameters such as temperature, voltage and current of a transformer are monitored, processed and recorded in servers. For this purpose, we use three sensors interfaced with Arduino. The recorded data can be send using Wi-Fi module and accessed from anywhere around the world using IOT technology using HTTP protocol. This helps in identifying without human dependency. This helps in identifying and solving a problem before a failure without human dependency.**

Keywords—IoT technology, cloud, server

I. INTRODUCTION

The distribution transformer directly provides the low voltage users with power supply. Thus, the working condition of the transformer plays an important role in distribution network. The transformers must be operated in rated condition for their long life. This is not possible during entire working periods. Overloading and deficient cooling of transformers can cause unexpected failure in transformers which can disturb delivering of electricity over many consumers. The manual checkup of rise in voltage, rise in ambient temperature, load current etc. tends to be more complex as incidental parameters cannot be accessed[1].

In IoT, interaction between the physical and digital worlds using sensors and actuators are carried out. A sensor or a network of sensors are used to sense the physical parameters or the respective environment. These processed sensor output are then send to the main server or cloud with the help of various network devices. The data can be accessed over internet from anywhere around the world. Monitoring and controlling form the basic objective of IoT technology. Hence IoT based monitoring is preferred more than manual monitoring. The system is a real time monitoring of transformer parameters such as voltage, current and temperature. This will help to identify the faults before a serious failure occurs.

II. FAULTS IN TRANSFORMERS

The major faults occurring in a transformer are overload, over / under voltage, temperature rise, oil level fault etc[2].

(A) Overload / Overcurrent: Overload / Overcurrent is the flow of fault current occurring in the power system through the transformer. These condition last for a short duration of about or less than 2 seconds as protection relays isolate the power system.

(B) Over / Under voltage: Over voltage results when voltage to frequency ratio exceeds 1.05 pu at full load and 1.10 pu during no load condition.

(C) Temperature Rise: Transformers are generally designed to work for 24 hours with an average ambient temperature of 30^0 C. Over voltage and over current causes an increase of oil temperature which induce failure of insulation of transformer winding.

(D) Oil level fault: Oil present in transformers provides cooling and insulation. Temperature could reduce the oil level and its reduction beyond a required level affects cooling and insulation.

III. PROPOSED SYSTEM

The proposed project is about acquiring real time status of transformer health parameters. Temperature, voltage and current of transformers are monitored and send over internet The live tracking of these parameters can be done using IOT technology from anywhere around the world .This is cost effective in nature. Thus the responsible authority can access information on any power failure or maintenance.

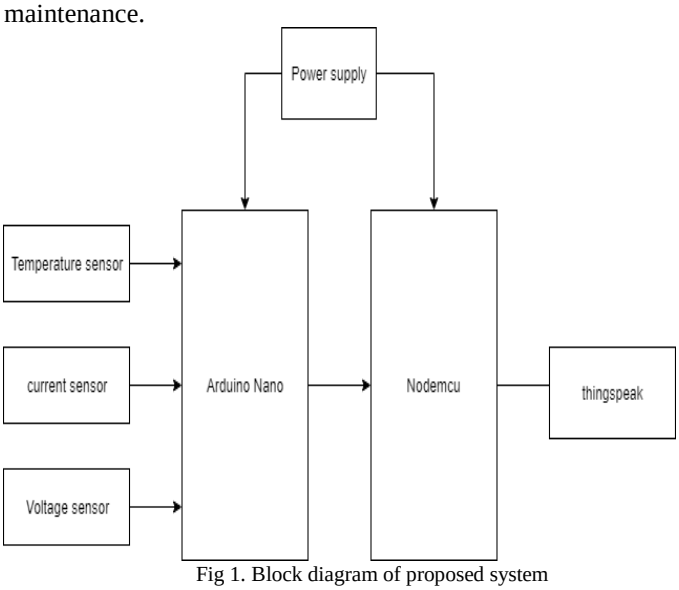

Fig 1. Block diagram of proposed system

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It consists of arduino board, node mcu, voltage sensor, temperature sensor, current sensor and power supply as shown in the fig 1. The sensors sense the parameters and send this to arduino nano. It processes it and send to WiFi module.

IV. HARDWARE COMPONENTS

The project is designed to emit a reduced size and maximum efficiency. The components used are Arduino, temperature sensor, current sensor, voltage sensor circuit and Node MCU [3].

A. TEMPERATURE SENSOR- LM 35

Temperature sensor is used to sense the current temperature status of a transformer or generator. It has three pins as shown in fig 2.The output obtained from the temperature sensor is proportionally dependent on the temperature in degree Celsius sensed. The operating temperature ranges from -55^0 C to 150^0 C. It draws about 60 micro ampere from the supply and has reduced self heating .It does not tend to possess a temperature rise more than 0.1 ^{0}C in still air. For every ^{0} C rise or fall in temperature the output response will be 10mV variation. This LM35 operates from 4V to 30V. It has + 1 / 4^0 C of typical nonlinearity. Pin description is as shown in the table.1.

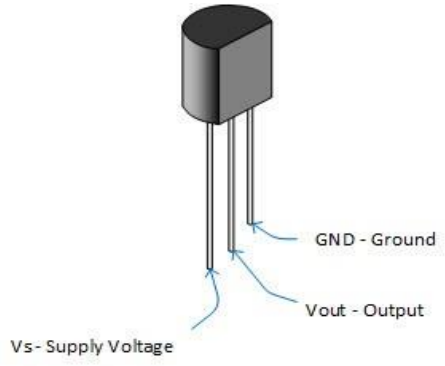

Fig 2. LM 35 temperature sensor

Table.1: pin description of temperature sensor lm35

Pin no	Pin name	Description
1	Vcc	Input supply voltage: +5V
2	Analog output Voltage	Usually +6 V to -1 V.
3	Ground	Ground: 0V

B. CURRENT SENSOR ACS 712

ACS712 current sensor produces an analog output voltage proportional to the current sensed by the terminals. The current sensor can operate from an voltage of 5V. Even high AC mains current can be measured. The sensors are based on the Allegro ACS712ELC chip. These sensors are available full scale reading of 5A, 20A and 30A. For a 30A sensor the output sensitivity s 66mV/A and it can measure a current from 30A to -30A range.

ACS712 consists of a low offset, precise linear Hall effect sensor circuit having a copper conduction path around the die surface. The hall effect circuit convert the electromagnetic field produced during current flow through the copper part to output voltage.

C. VOLTAGE SENSOR CIRCUIT

Fig 3. Voltage measurement circuit.

It is a combination of IN4007 diode, a step-down transformer, variable resistor 47K Ω, capacitor 1microF 25V, 5V Zennor diode. Usually 5V output is obtained during 250V. variable resistance is adjusted to get the output.

AC Voltage = (230/1024) * ADC_ Value

D. NODE MCU V3

Node MCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP -12 module. This is a single board microcontroller. The operating system is XTOS.This is version 3 and it is based on ESP - 12E. Multiple GPIO pins on the board allow us to connect the board with other peripherals and are capable of generating PWM, I2C, SPI, and UART serial communications. USB to UART converter is added on the module that helps in converting USB data to UART data which mainly understands the language of serial communication. Instead of the regular USB port, MicroUSB port is included in the module that connects it with the computer for programming and powering up the board as shown in fig 5 . LED blinks giving the current status of the module if it is running properly when connected with the computer. The power voltage for USB be kept around 5 V. It has a memory of about 128kBytes. Storage is about 4Mbytes.

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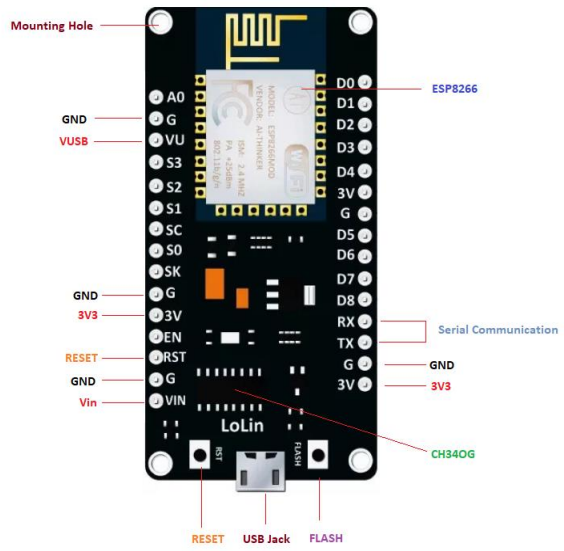

Fig 4. Node MCU v3

The arduino nano and Node MCU exchange data through serial communication. The Node MCU will be treated as master and arduino nano act as slave during this communication. Arduino acts according to the instructions given by Node MCU.

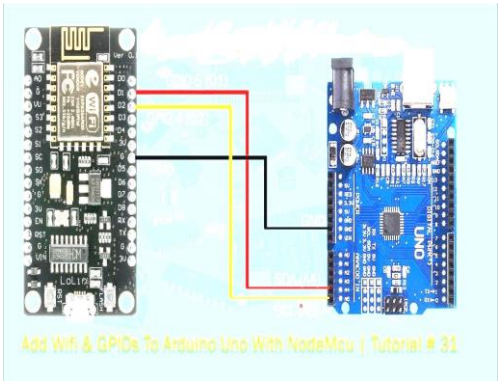

Fig 5. Interconnection of arduino nano and Node MCU

E ARDUINO NANO

It is based on ATMEGA328P microcontroller. It works with a mini-USB cable. It is a small sized one. operating voltage is 5V, with an input voltage variation of 7 to 12V. it has 14 digital pins, 8 analog pins, 2 reset pins and 6 power pins. Arduino nano is provided with a crystal oscillator of frequency 16MHz. It cannot be supplied power with an external source. Flash memory is16KB or 32KB. This is programmed using arduino IDE.the serial communication is achieved by digital pins like pin0 (Rx0) and pin 1 (Tx).
Specifications

- Microcontroller ATMEGA328P
- Operating voltage 5V
- Input voltage 7-12V
- Digital i/o pins 14
- PWM 6 out of 14 digital pins
- Max. current rating 40mA
- USB mini
- Analog pins 8
- Flash memory 16KB or 32KB
- SRAM 1KB OR 2KB
- Crystal oscillator 16MHz
- EEPROM 512 bytes or 1KB
- USART Yes

The important parts of a typical arduino nao board is depicted in fig 6. It has a dimension of about 4.5cm * 1.9cm * 1.5cm. It weighs about 29g.

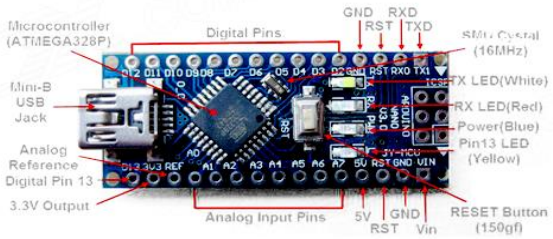

Fig 6 arduino nano

V. IoT TECHNOLOGY

IoT is an interconnection of many physical devices by using internet. The controlling and monitoring of any physical devices or parameters are possible with the help of IoT technology

A.ThingSpeak

It is an open – source internet of things applications. This provides with some apps that let analysing and visualising the data send by WiFi module. There is a ThingSpeak channel provided. These channels store the data. The channel provide provision for sending, processing and accessing the data when needed. The master device Node MCU sends the data using HTTP protocol.

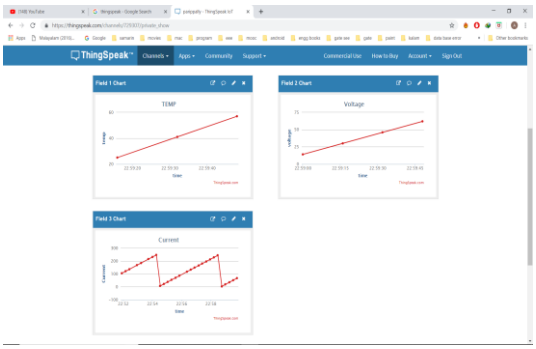

Fig 7. Thingspeak showing chart

VI. RESULT AND OBSERVATION

The system consisting of arduino and sensors senses the transformer health parameters. The data are collected and a node mcu unit communicates with ThingSpeak. The received real time data is processed by it. This data is send using HTTP protocol. The accessed readings can be visualized in ThingSpaek platform.

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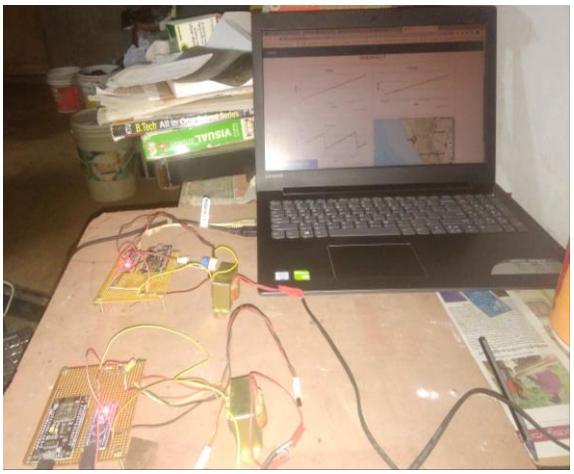

Fig 8 hardware components

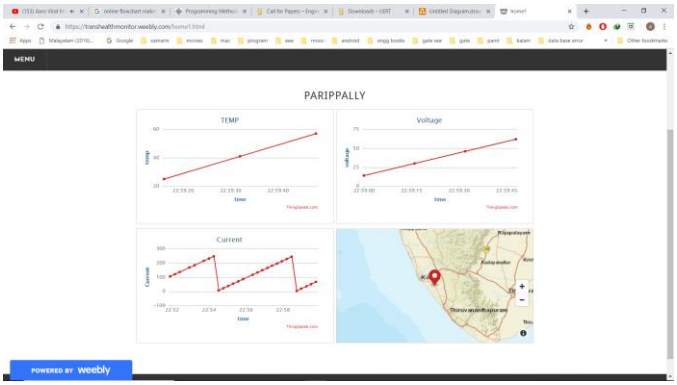

Fig 9 website view

VII. CONCLUSION

The transformers play a vital role in distribution part of power system. Therefore the monitoring and protection of transformer is very crucial. This system introduces a new and improved method of transformer health parameter monitoring using IoT. The sensors incorporated in the system collect the data of transformer health parameters such as voltage, temperature and current. These data arre send to an IoT platform, ThingSpeak using. These data can be sent and accessed using HTTP protocol. Thus the real time data collection, storage and monitoring of the transformer health parameters are possible with the system.

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