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Transformer Monitoring and Controlling with GSM Based System

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Abstract: ***Distribution transformer is an important part for electrical energy transfer in electrical power systems. So to protect the distribution transformer from damage the overloading currents, over-heating of transformers oil and high voltage spikes. So, relevant protection of transformer is very important for continuity of power supply. In this protective strategy is implemented by using of Arduino controller that is not so costly and massive high speed with high accuracy. The controller sense the temperature of transformer and current of load continuously. The rating of voltage and current reaches from its pre-set values; protection scheme operates and trips the load in abnormal condition. As temperature reaches to threshold value set in system, a fan would turn on for the cooling of the heated transformer. To occur the over current fault we increase load by using bulbs. If any emergency or abnormal conditions occur the system sends information through SMS to the mobile phones, by using GSM Modem. At the end, successful results have been justifying the proposed technique and identify problems before any failure.***

Keywords: Distribution transformer, Current transformer, Arduino, GSM, Relay

1. Introduction

Distribution transformer is electrical equipment which is utilized to step down the voltage without change in frequency and distribute to the consumer. In this paper a protection system has been design in such a way that system is monitoring the real time based, operating flexible of the transformer continuously and these parameters are display on the LCD display. LCD display views the continuous parametric information of transformer. In this research work a current transformer is acting as a current sensor. The C.T. place in series to the transformer .Thermistor is utilized to measure the temperature of transformer oil. Relays are used to carry out the tripping mechanism. Voltage and currents is measured using A/D converter i.e. analog to digital converter of microcontroller. A/D converter converts the values of analog current and voltage value to the digital value .Then according to the code; values are compared with the preset values in the controller if error in any parameters value occurs a relay would trip the transformer upon exceeding the limit of

current and voltage. If temperature increases from preset value, a fan would be turn on using relay1. The voltage, temperature and current values are displayed on the LCD. It is also has the advantages of significant cost savings, power consumption and greater reliability. In this system, Arduino microcontroller is used to monitor cases of electrical faults and communicate to a switch to isolate transformer from the system.

A. Necessity

The monitoring devices or systems which are presently used for monitoring distribution transformers have some problems and difficulties. As mentioned below.

1) Ordinary transformer measurement system generally detects a single transformer parameter, such as power, current, voltage. While some ways could detect multi-parameter, the time of acquisition and operation parameters is too long, and testing speed is not fast enough.
2) Detection system itself is not reliable. The main performance is the device itself instability, poor antijamming capability, low measurement accuracy of the data, or even state monitoring system should is no effect.
3) Timely detection data will not be sent to monitoring centers in time, which cannot judge distribution transformers three-phase equilibrium
4) A monitoring system can only monitor the operation state or guard.
5) Against steal the power, and is not able to monitor all useful data of distribution transformers to reduce costs.

B. Objective

1) To develop embedded system for transformer protection using Arduino-uno controller.
2) To set up communication between sensor and Arduino controller using SPI protocol.
3) To take corrective action for inappropriate condition using fan.
4) To send corrective action information to authorise person using GSM.
5) To implement extreme condition emergency cut-off conduction

2. Literature Survey

The literature survey is carried out by different E-medias, IEEE journals, national and international conference paper-paper, research journals etc. A paper named as" A Review of Transformer Protection by Using PLC System" authored by Satya Kumar Behera published in International Journal of Digital Application & Contemporary research states that"

Distribution transformers of substation are one of the most important equipment in power system network. Because of, the large number of transformers and various components over a wide area in power systems, the data acquisition, condition monitoring, automatic controlling are the important issues. This paper presents design and implementation of automatic control circuits which is used in PLC automation to monitor as well as diagnose condition of transformers, like load currents, transformer temperatures and voltages. The proposed on-line monitoring system integrates a solid state device named PLC (programmable logic controllers) and sensor packages. The suggested plc monitoring system will help to detect the internal fault as well as external fault of transformer and also diagnose these faults with the help of desired range of parameters which is setting by programmer."[1]

3. System Development

In this system "Transformer safety and monitoring using GSM" not only provides safety & monitoring of transformer but also takes corrective action to avoid further damage of transformer. The embedded system in proposed system is integrated with temperature sensor and humidity sensor to sense transformer status in terms of its temperature and humidity around its surrounding. Two threshold levels are chosen, at first threshold of temperature fan & alarm will get ON automatically while at threshold level 2 which is greater than threshold level 1 it will be considered that transformer is overheated and there is a need of isolate transformer from the supply. At threshold 2 powers will be cut off considering emergency LCD is used to show current sensor values.

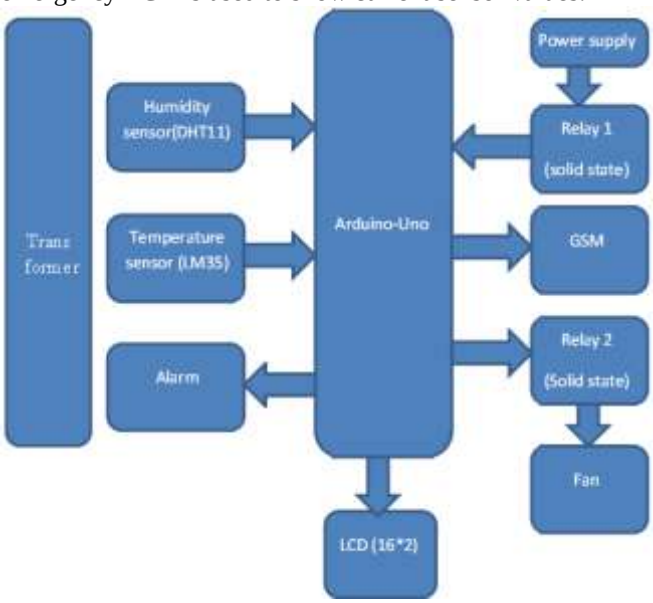


Figure 1: Block diagram of transformer protection system

4. Hardware Requirement

A. Arduino UNO Controller

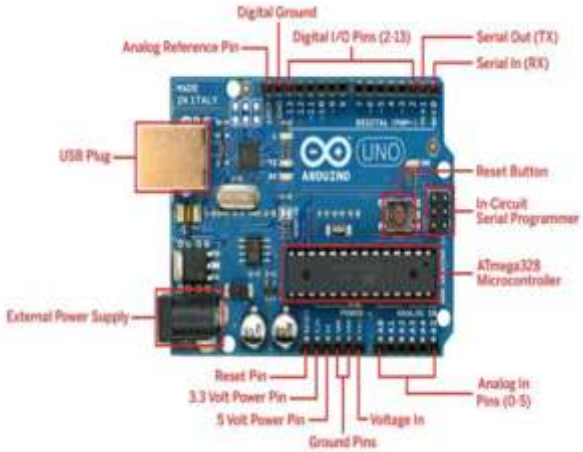


Figure 2: Arduino –UNO Controller

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable.The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

B. Relay

Figure 2: Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

C. GSM

Figure 3: GSM

GSM/GPRS Modem-RS232 is built with Dual Band GSM/GPRS engine- SIM900A, works on frequencies 900/ 180 M Hz. The Modem is coming with RS232 interface, which allows you connect PC as well as microcontroller with RS232 Chip (MAX232). The baud rate is configurable from 9600-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. The on board Regulated Power supply allows you to connect wide range unregulated power supply. Using this modem, you can make audio calls, SMS, Read SMS; attend the incoming calls and internet through simple AT commands.

D. Fan

Figure 4: Fan

Fan is used to down the temperature. After threshold level 1 Fan gets switched ON automatically while below threshold level 1 Fan get OFF automatically.

E. Alarm

Alarm is used to identify threshold level 1 of temperature has been reached. This alarm uses 5V/50mA power supply to blow.

F. Humidity sensor

Figure 5: DHT11

DHT11 digital temperature and humidity sensor is a composite Sensor contains a calibrated digital signal output of the temperature and humidity. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology is to ensure that the product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and NTC temperature measurement devices, and connected with a high-performance 8-bit microcontroller.

G. Temperature sensor

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾° Cover a full −55°C to 150°C temperature range. Lower cost is assured by trimming and calibration at the wafer level.

H. LCD

In proposed system 16*2 LCD is used to display current sensor values of humidity and temperature sensors. A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which be displayed or hidden, such as preset words, digits, and 7-segment displays, as in a digital clock.

5. Working

It consists of current transformer, power transformer, thermistor, oil sensor, Arduino, LCD display, GSM modem and relay. Normally in transformer failure occurs due to overload and current fluctuation, overheating, change in oil level etc. In this project, to sense these fault we have used different sensors like current and power transformer, temperature sensor, oil sensor respectively.

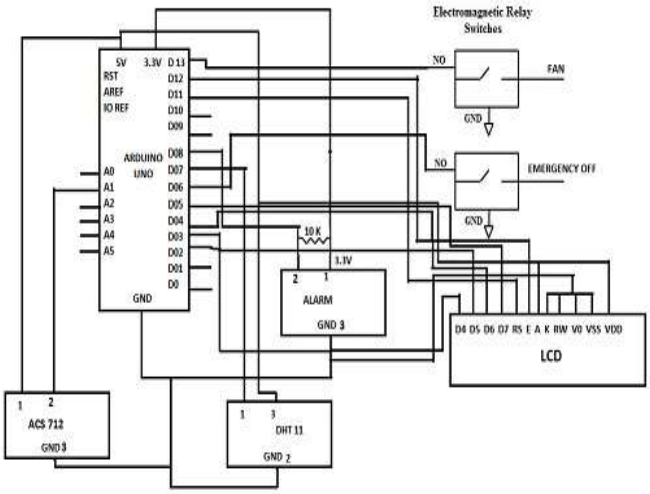
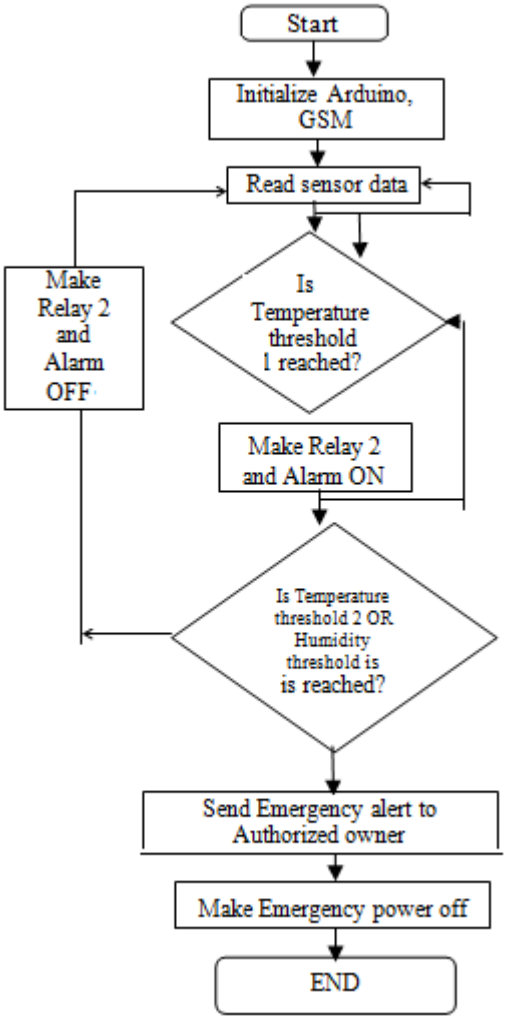


Figure 6: Circuit diagram

All these sensors are connected Arduino microcontroller, GSM model and LCD respectively.

6. Flow Chart



7. Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an .info file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer. A Software Serial library allows for serial communication on any of the Uno's digital pins.The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

Software requirement

ARDUINO 1.8.5:

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board.

Physical characteristic

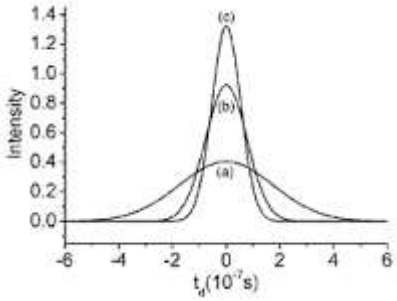
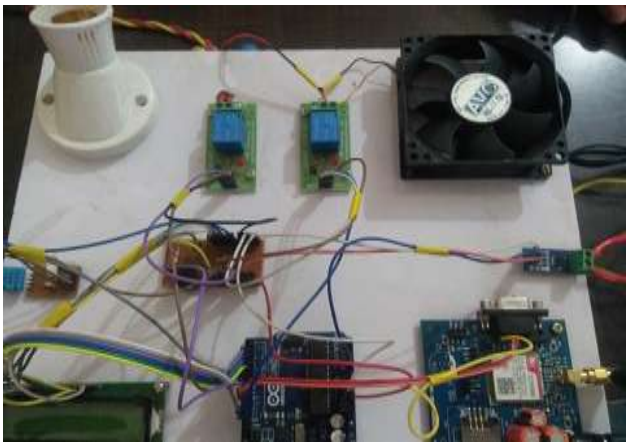


Figure 4: Intensity Characteristic of GSM

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

8. Result



9. Advantages

1) Useful as compare to manual monitoring.
2) Require less time to recover system.
3) It provides very cost effective product and solution.
4) Easily find out that which transformer is undergoing fault through message.
5) Advance version of GSM provides and high speed downloads and uploads data.

10. Disadvantages

1) In order to increase the coverage repeaters are required to be installed.
2) Receiving message may vary due to the public GSM network.
3) GSM provides limited data rate capability, for higher data rate GSM advanced version devices are used.

11. Conclusion

This project is simplified for self-clearing transitory faults by employing voltage injection at fault location. Another advantage is that it uses net fault quantities instead of overall fault quantities. It protects the system from damage by using relay which isolates the system from power supply when any fault occurs. This system provides an alternative and easy means of getting early information on status of distribution transformer for fault detection and for quick response and possible power response.

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