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Smart Monitoring and Power Factor Correction of Distribution Transformer using IOT

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Abstract

Transformers are important elements in the process of transmission and distribution of electricity. Transformer is one of the vital and costliest components of electrical industry. As large number of distribution transformers are installed over a wide area, monitoring and maintenance of these transformers is an important issue. Therefore this paper presents the system which monitor different parameters of distribution transformer and these data are continuously updated on to a webpage using IOT. If any abnormality occurs, the system sends alert messages to the concerned person and an electronic relay operates. As the inductive load increases there will be a decrease in power factor, therefore this system incorporates a power factor improvement mechanism by switching capacitor banks. The main objective of this project is to develop a system which will help the utilities in the protection of transformer and identify problems before any catastrophic failure.
Keyword- Distribution Transformer, IOT, Monitoring, Power Factor, Capacitor Banks

I. INTRODUCTION

Distribution Transformers have a long lifespan if they are operated under rated conditions. But their life will significantly reduce if they are overloaded which results in unexpected failures and when a transformer fails, the continuity of transmission and distribution systems is affected resulting in increase of power system cost and decrease of reliability in electric delivery. Distribution system's network carries electricity by the transmission system and delivers its load centres. Thus the distribution transformer should have high efficiency, high reliability and high service quality. As transformer is a combination of many parts, all parts must be checked regularly to maintain the transformer in perfect operating conditions. Now days, a person visits the site and manually checks the distribution transformer for maintenance .Some power companies use Supervisory Control and Data Acquisition (SCADA) system for online monitoring of power transformers but SCADA system for online monitoring of distribution transformers is an quite expensive.

This paper will help to find problems before any abnormal condition, thus resulting in a long life service for transformers. In this proposed system the transformer parameters are analyzed using sensors and recorded in system memory through (ADC) analog to digital converter and continuously updated to a webpage using IOT. All monitoring parameters are compared with certain predetermined values and if any abnormality occurs, the system sends Alert messages to concerned person. As the inductive load increases there will be a decrease in power factor. As a result the value of current drawn increases, therefore this system incorporates a power factor improvement mechanism which switches capacitor banks based on the need.

II. METHODOLOGY

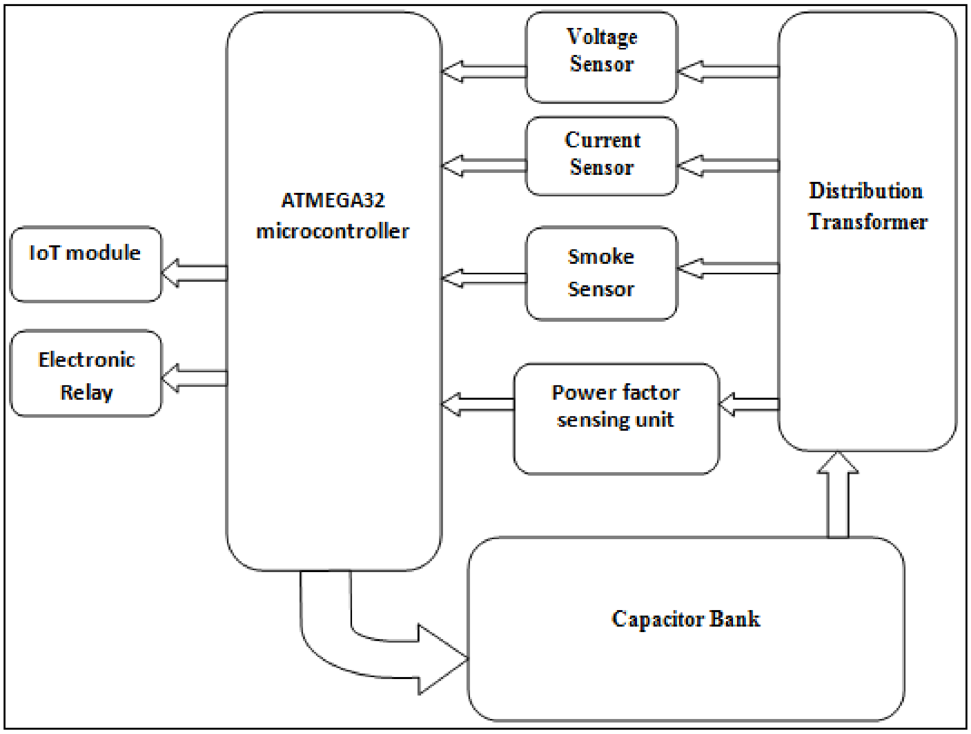


Fig. 1: Block diagram

Atmega 32 microcontroller is programmed to read the parameters of distribution transformer. Real time voltage, current and power factor is uploaded to a webpage and checked whether these values are within the range or not. If the values are not within the specified range then corresponding action takes place. If real time voltage or current is not in the range relay will be switched off and message will be sent to the concerned person using IOT module. If power factor is not within the range then capacitor banks are switched accordingly to correct it. Power input to the microcontroller and all other components are given with the help of solar panels.

III. HARDWARE

Continuous monitoring of distribution transformer and updation of parameters on internet is the major importance of this project. The above block diagram shows distribution transformer condition monitoring hardware setup of computer aided design using ATMEGA32 Microcontroller using different sensors such as current sensor, voltage sensor etc. Password is needed for accessing data and to change the cutoff values. During abnormal condition information like voltage, current and transformer name are sent to the concerned person. After the initialization data's are measured from current and voltage sensors simultaneously.

Then the microcontroller starts to compare the incoming values with the preset values in the EEPROM memory. If at least one parameter value is denied when compared with the pre-set value, then the microcontroller takes action to send alert message to the concerned person.

The power factor correction on the load side can also be controlled using this scheme. When the inductive load increases the power factor value reduces. This can be eliminated by adding capacitors along with the circuit. Capacitor switching circuit helps in maintaining a good power factor at load side.

1) Atemega32 Microcontroller: It is a 40 pin IC and 256 bytes of EEPROM memory.32k bytes of flash program memory. Its speed of program execution is about to 1 microsecond or 10 MIPS (10 Million Instructions per second). The micro-controller is programmed to take actions accordingly.
2) LCD Module: It is a flat panel display that uses the light modulating properties of liquid crystal. It displays the various measurements like real time voltage and current measured using sensors.
3) IOT: using IOT module the object to be sensed can be controlled. An IOT module is a small electronic device embedded in objects, machines and things that connect to wireless networks and sends and receives data.
4) Sensors: Here three types of sensors are used. They are current, voltage and smoke sensors. They sense these parameters from the distribution transformer and generate a physical signal corresponding to the change. These signals are then given to the microcontroller for further actions.

5) Solar Panel: Power needed for microcontrollers and other hardware components are given from solar panels. There is a backup battery for the usage of power at night time. Using of solar panels helps not to consume form the distribution transformer.
6) Capacitor Bank: They are used to correct the power factor at the load side of transformer. By sensing the power factor accordingly capacitors are switched simultaneously.

IV. SIMULATION

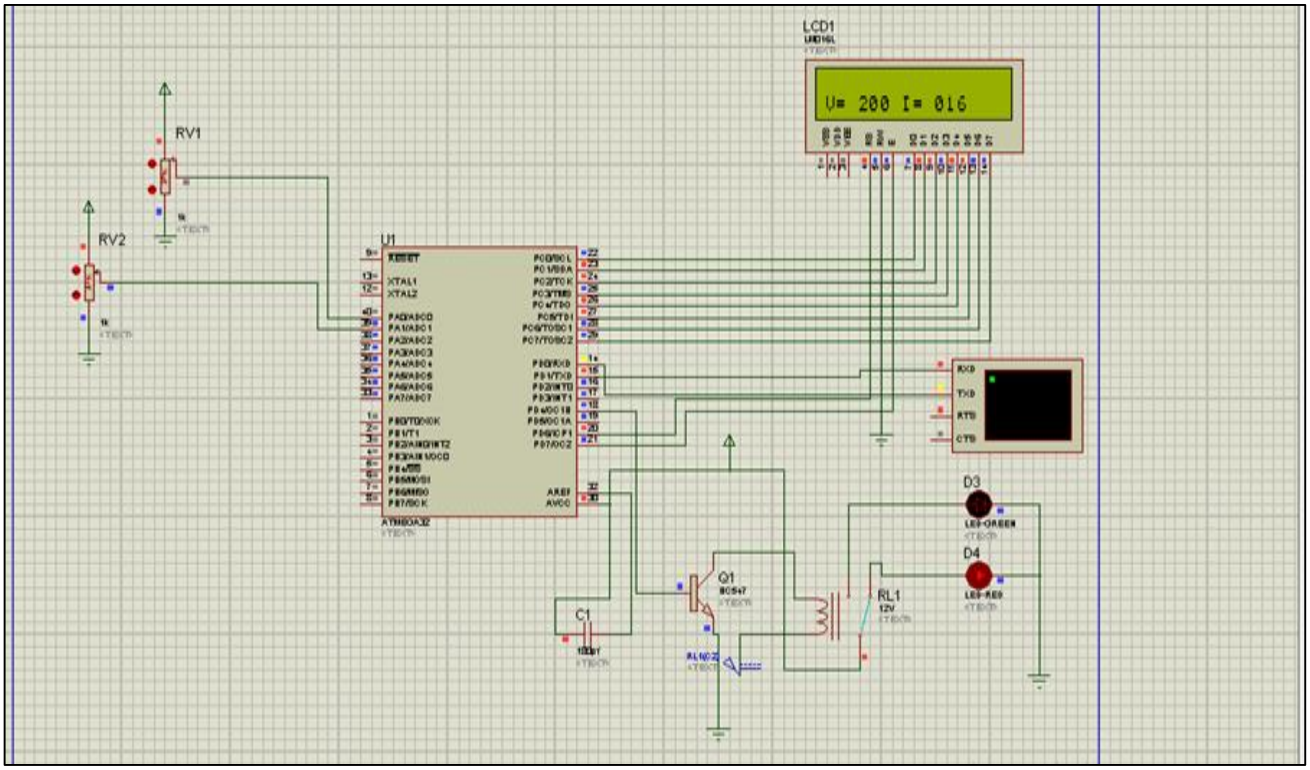


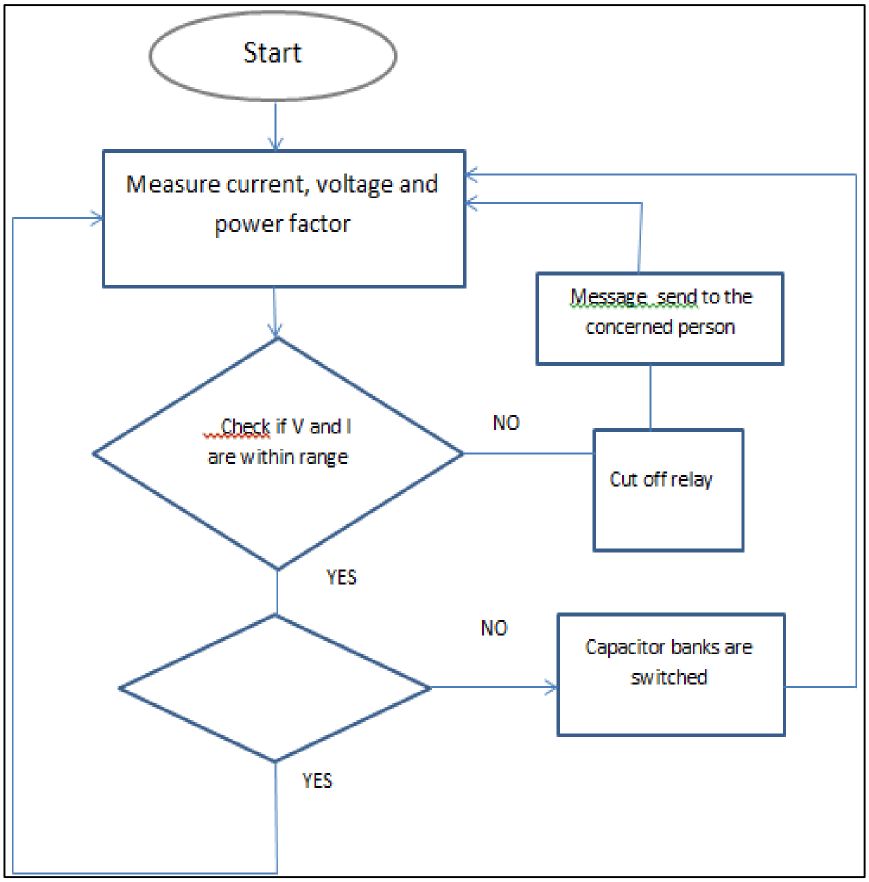
Fig. 2: Simulation when the relay is off

Microcontroller used here is Atmega 32. LCD, relay, potentiometer and virtual terminals are connected to the microcontroller. It is programmed to read the real time voltage and current values and to check whether the values are within the limit or not. It also performs relay operation when needed i.e. in case of abnormal condition. There is an LCD to display real time voltage and current being measured on the load side. The relay used here is an electronic relay which opens and closes according to the predetermined values. Two potentiometers are used in order to vary the load. One of them represents the variation of voltage and the other represents the variation of current. When the relay is on, green led glows and when relay is off due to fault, red led glows which is shown in the figure 2. Virtual terminal is provided in order to show the real time monitoring. Figure 3 shows the real time monitoring of voltage and current it replaces IOT in the hardware.

V. ALGORITHM OF PROPOSED SYSTEM

1) Start
2) All sensors such as current sensor, voltage sensor and smoke sensor takes the reading from the transformer.
3) All analog values are sent to ADC to convert them into digital.
4) Digital values are passed to ATMEGA 32 micro-controller.
5) ATMEGA 32 sent these values to LCD and displays it.
6) Microcontroller sends these values on webpage having a particular IP address.
7) In case of an emergency case, then immediately SMS is sent to the concerned person through IOT.
8) If inductive load increases which in turn decrease the power factor beyond a specified value capacitor banks will be switched accordingly to correct the power factor.
9) All the data values are saved in database periodically.
10) End.

VI. FLOW CHART



VII. TEST RESULTS

After testing of proposed system, it provides following results:

1) If 5A>Current < 15A , then Current Fault
2) If 120v<Voltage>200v

Any abnormality condition occurred in the above rated condition is displayed on the LCD screen and sent to concerned engineers. Hence the transformer can be protected from faults. The same data monitored at monitoring side is sent via IOT and the webpage is continuously updated.

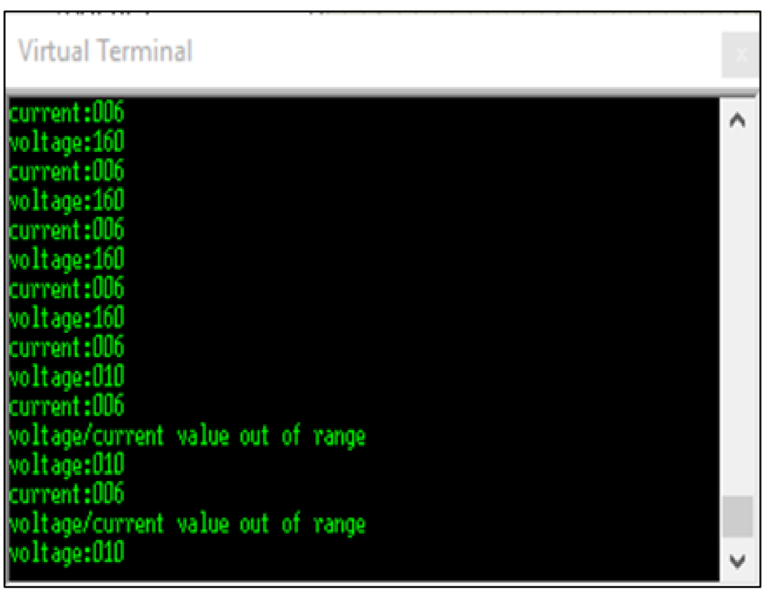


Fig. 3: Virtual terminal

VIII. CONCLUSION

All difficulties of manual monitoring of distribution transformer can be overcome by the proposed system. Here as IOT is used the transformer can be monitored from anywhere and its operation can be also controlled with the help of electronic relay.
The system hardware was constructed from the available components. The experimental results came out as expected.

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