



Remote Monitoring System using Wireless Zigbee Technology and Image processing for a Switchable Distribution Transformer

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ABSTRACT: This paper proposes a wireless ZigBee technology to monitor the parameters of the transformer. The transformer parameters such as voltage, current, power factor and temperature can be monitored through wireless ZigBee technology. Embedded Ethernet is used to develop client and server applications. Acquisition of voltages, currents, temperatures, active and reactive power, controlling the switching devices and acquired data processing can be done by an embedded system. The modules in the embedded system are connected and the images of the transmission lines of the transformer during the power transmission will be noted and compared with the standard IR images by the use of image processing to observe the level of temperature passing through the transmission lines. Active power and the reactive power of the transformer which specifies the power usage and power wastage of the transformer respectively can be monitored. MATLAB simulations are carried out for the parameter monitoring.

KEYWORDS: Wireless ZigBee Technology, Image processing, Switchable distribution transformer, Embedded Ethernet.

I. INTRODUCTION

Remote monitoring of transformers is widely used nowadays and there are many techniques available in remote condition monitoring. Here we introduce a Wireless ZigBee Technology to monitor the parameters of the transformer. Transformer parameters such as current, voltage and temperature can be monitored. The remote monitoring system for the switchable transformer is however quite unique because it includes measurements of switching devices. Moreover, the system is useful not only in monitoring the parameters of the transformer such as voltages and currents but also in controlling the switching devices and performing switching at appropriate timings. There are a multitude of standards that address mid to high data rates for voice, PC LANs, video, etc. However, up till now there has not been a wireless network standard that meets the unique needs of sensors and control devices. Sensors and controls do not need high bandwidth but they do need low latency and very low energy consumption for long battery lives and for large device arrays. There are a multitude of proprietary wireless systems manufactured today to solve a multitude of problems that also do not require high data rates but do require low cost and very low current drain. These proprietary systems were designed because there were no standards that met their requirements. These legacy systems are creating significant interoperability problems with each other and with newer technologies. The ZigBee Alliance is not pushing a technology rather it is providing a standardized base set of solutions for sensor and control systems. ZigBee is poised to become the global control/sensor network standard. It has been designed to provide the features such as low power consumption, low cost, high density of nodes per network, global implementation and simple protocol.

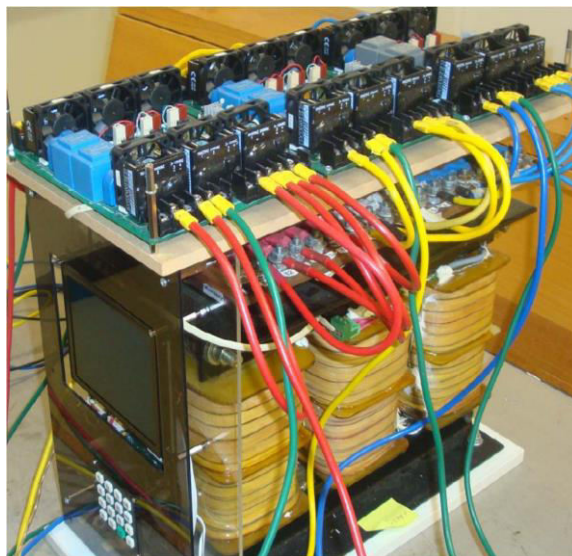


Fig1 Three-phase 10-kVA switchable transformer

In relation to this project, remote condition monitoring was applied to a three-phase 10-kVA energy-efficient switchable distribution transformer. This transformer has been previously developed to show an increase in the efficiency through the use of special configurations of windings, called series and parallel. The series and parallel configurations consecutively reduce losses of the transformer in low and high loads. The configurations were made by the use of 18 switching devices and controlled by three microcontrollers (AT90CAN128). The monitoring is done by the use of wireless ZigBee technology which is intended to reduce signal loss. IR camera is used to capture the images of the transmission lines to observe the temperature level passing through it.

II. EXISTING SYSTEM

In the existing system the parameters of the transformer were monitored and the modules of the embedded system were connected and communicated through the CAN bus which is wired communication. Wired communication has some drawbacks when they carry data such as loss of data and lack of effective communication. Another thing in this system is the parameters of the transformer such as voltage current temperature and power factor were measured but active power and the reactive power was not measured. Since the communication is wired there will be considerable power loss and also data loss. Efficient data transmission is so much important in transformer monitoring. But there will be loss of data in the CAN bus. Active power and reactive power was not measured. By the use of active and reactive power measurement we can analyze the level of temperature passing on the transmission lines.

III. PROPOSED SYSTEM

The Fig.2 represents the block diagram of the proposed system. Three phase supply is given to the load. During the supply, the parameters such as current, voltages and temperature are measured using the current, voltage and temperature sensors respectively. Atmega8 microcontroller is used and the communication between the controllers taken place with the help of RS232 serial communication protocol. The embedded Ethernet unit contains a microcontroller ATMEGA128 which was programmed to execute client/server applications. The embedded Ethernet unit which is functioned as a server is connected to the embedded system through the remote terminal module using an RS232 interface. Connections to the LAN were done through the use of LAN controllers (RTL8019AS). The computer in this system is used for experimentation purposes and eliminated when the most compact remote monitoring system is needed. IR camera is fixed in the building nearer to the transformer to capture the images of the transmission line. Images at various temperature levels are captured and compared with the standard IR images to observe the temperature level.

IV.SYSTEM ARCHITECTURE

IR camera is fixed nearer t

o the transmission lines which capture the images of the transformer at various voltage levels such as normal, high and low. The captured images are then compared with the standard IR images and the result of the voltage and temperature levels passing on the transmission lines is displayed in PC. Fig.3 shows the temperature measurement of the switchable distribution transformer. The power supply provides voltages of 415 V on the primary terminals of the transformer while the load draws currents of up to a maximum rating (24 A) on the secondary sides of the transformer. Voltages and currents on each of the primary and secondary sides of the transformer are acquired by using some D3600 voltage transformers and LTS 25-NP current transducers. Temperatures of the transformer as well as of the switching devices are acquired by using digital temperature sensors (DS18S20). Wireless ZigBee is used to enable exchange of information or parameters between the modules. The power factor of an AC electrical power system is defined as the ratio of the real power flowing to the load to the apparent power in the circuit, and is a dimensionless number between 0 and 1. Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the current and voltage of the circuit. Due to energy stored in the load and returned to the source, or due to a non-linear load that distorts the wave shape of the current drawn from the source, the apparent power will be greater than the real power.

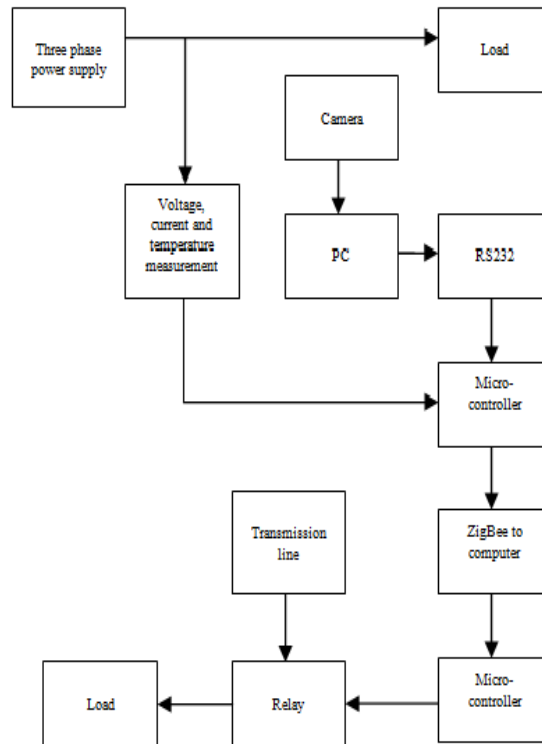


Fig.2 Block diagram of proposed system

In an electric power system, a load with a low power factor draws more current than a load with a high power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system, and require larger wires and other equipment. Because of the costs of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is a low power factor.

IV. EXPERIMENT RESULTS

MATLAB model is used to simulate the proposed model. The Fig.3 represents the simulation diagram of proposed system. The simulation result shows the monitoring of current, voltage, temperature, active and reactive power. Fig.4 shows the measurement of three phase voltage with respect to time.

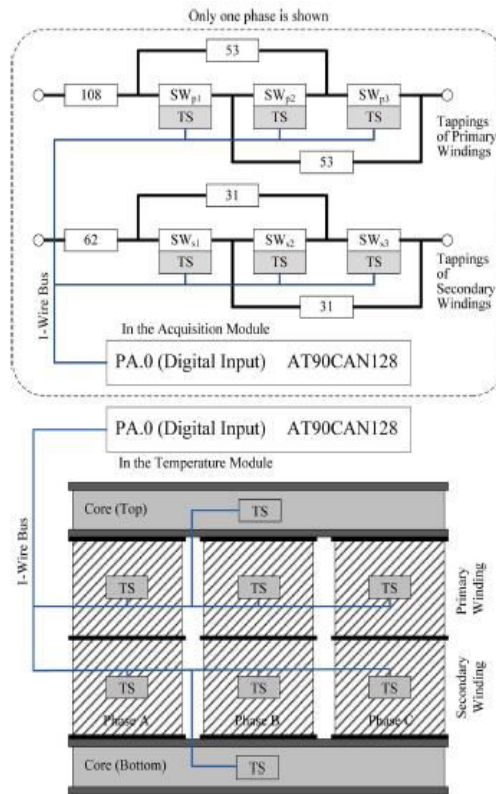


Fig.3 Three phase switchable distribution transformer. TS: Digital Temperature Sensor (DS18S20)

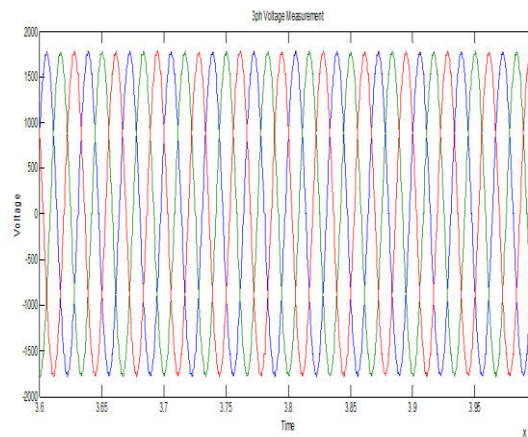


Fig.4 Waveform of Three Phase Voltage

Fig.5 shows the measurement of three phase current with respect to time. Active and reactive power of the transformer also be monitored to observe the power usage and power wastage respectively as shown in Fig.6. Fig.7 shows the measurement of power factor. The value of power factor should be 1. We can obtain 0.8 power factor. Fig.8 shows the waveform of output voltage with respect to time. During the simulation we can monitor and measure all these parameters effectively. Fig.9 shows transmission line fault indicator where image processing is used.

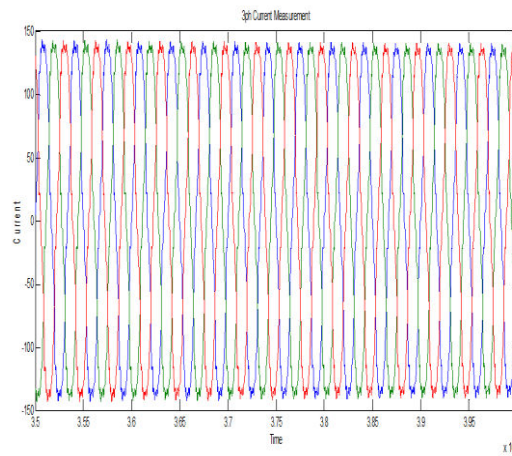


Fig.5 Waveform of Three Phase Current

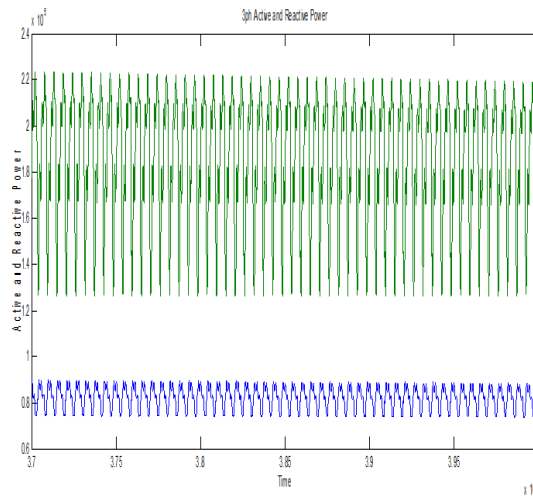


Fig.6 Waveform of Three Phase Active and Reactive Power

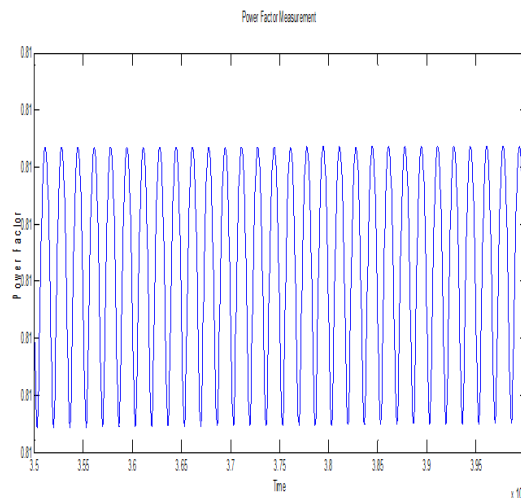


Fig.7 Waveform of Power Factor

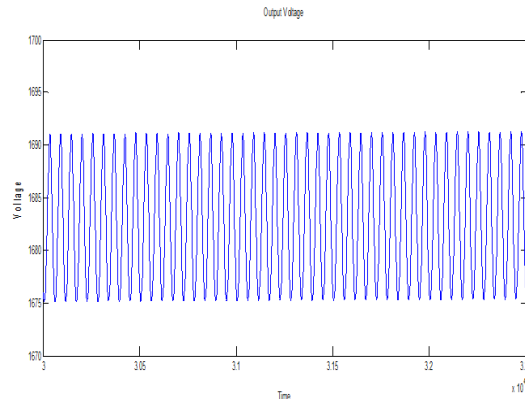


Fig.8 Waveform of Output Voltage

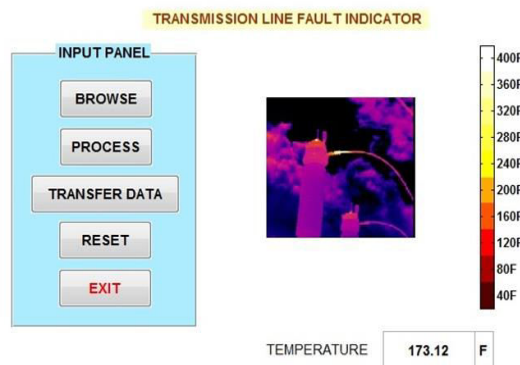


Fig.9 Transmission Line Fault Indicator

The input panel in the transmission fault indicator is used to browse the standard IR images and to compare the conventional images with the standard images. Threshold temperature level is set to 180F and the images below the temperature will be considered as low and the images above the temperature will be considered as high temperature.

VI. CONCLUSION

Remote monitoring of systems have been increased today. The parameters of the transformer are monitored with the help of wireless ZigBee technology. The temperature passing on the transmission lines is monitored and the images of the transmission lines are captured by IR camera and the images are compared with the standard IR images by the help of image processing which provides the condition of the transmission lines and the level of temperature passing through it. Additional parameters such as active and reactive power is measured to monitor the parameters effectively and to provide the proper precautions. The comparison of images is simulated using MATLAB software.

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