

Transformer Fault Early Warning System Model Using GSM Network

M. A. M. Azmi
Department of Test Unit, TNB Repair and
Maintenance Sdn Bhd, Selangor, Malaysia
yanuar@utm.my

Z. Nawawi, M. I. Jambak, M. A. B. Sidik
Department of Electrical Engineering,
Faculty of Engineering, Universitas
Sriwijaya (UNSRI), 30662 Inderalaya
Ogan Ilir, South Sumatera, Indonesia

Y. Z. Arief, Z. Adzis, N. A. Muhamad
Institute of High Voltage & High Current
(IVAT), Faculty of Electrical Engineering,
Universiti Teknologi Malaysia (UTM),
81310 Johor Bahru, Johor, Malaysia

Abstract—This paper presents the design and implementation of a mobile embedded system using an Arduino microprocessor to monitor and record key operational indicators of a distribution transformer, such as transformer oil level, temperature and vibration of a distribution transformer in a substation. If there is any abnormality or an emergency situation, the system sends SMS (Short Message Service) messages to designated mobile telephones containing information about the abnormality of the mentioned parameters. Providing early warning of the abnormality of the distribution transformer can be accomplished by shutting down the entire unit with the aid on-line monitoring system integrates with Global Service Mobile (GSM) Modem. Furthermore, the design generally consist stand-alone single chip microcontroller, modem and sensor packages located on distribution transformer site. In general, the design is developed for the user to easily recognize the distribution transformer that is suffered by any high vibration and rise in temperatures and located in remote or suburban area which is rarely and hard to reach for manual monitoring. The ultimate objective is to monitor the transformer oil level and temperature of 24 hours, 7 days a week continuously besides the current and voltage parameter which included in basis monitoring system.

Keywords—Transformer fault; early warning system; GSM Network; Arduino; microcontroller

I. INTRODUCTION

A power transformer is a device which transfers electric power from one circuit to another without electric connection while maintaining the frequency of the power source as a result of the transfer of energy. In the distribution system, distribution transformer is used to convert electrical energy of higher voltage (usually 11, 22, 33kV) to a lower voltage (240 or 415V) with same frequency. Application of the product is mainly within the suburban areas, public supply authorities and industrial customers.

Distribution transformer is usually the last in the chain of electrical energy supply to households and industrial enterprises. There are three main parts in the distribution transformer which is consists coils or winding, magnetic core and tank which serving as a mechanical package to protect active parts as a

holding vessel for transformer oil used for cooling and insulation and bushing (plus auxiliary equipment where applicable).

Distribution transformers are currently monitored manually where a maintenance crew periodically visits a transformer site for maintenance and records parameters by performing tests such as infrared thermography, ultrasonic scanning, oil quality analysis (OQA) and visual check. Online monitoring of key operational parameters of distribution transformers can provide useful information about the health of transformers which will help the entities to optimize the use of their transformers and thus continue the operation for a longer period.

The main objective of this research work is to develop a transformer fault early warning system model using GSM network for distribution transformer application.

II. SYSTEM ARCHITECTURE

A. Hardware Architecture

This system consist three hardware modules which include processor, communication and sensors showed in Fig. 1.

A. 1 Microcontroller

The simplest computer processor is used as the "brain" of the future system which control and sense the surrounding electronics and environment. Depending on the manufacturer,

a bit of memory, a few A/D converters, timers, input/output lines are added. All is placed in some of the standard packages. A microcontroller also takes input from the device; controlling the device by sending signals to different components in the device. Arduino is a family of single-board microcontroller, aimed toward building interactive objects or environments in an easy way [1]. The hardware consists of open-source board designs based on various 8-bit Atmel AVR microcontrollers or 32-bit Atmel ARM processors. The systems provide sets of digital and analog I/O pins that can be interfaced to various

extension boards and other circuits. Some models also feature a USB interface for loading code from personal computers.

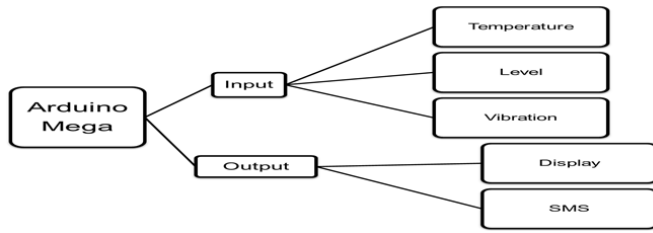


Fig. 1 Block Diagram of the system.

A. 2 Sensors

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically for reading or further processing. In this work, three types of sensor are used namely contact temperature, vibration, and ultrasonic level sensor.

A. 3 GSM Modem

A global service mobile (GSM) modem is a wireless modem that works with a GSM wireless network. A wireless modem is like a dial-up modem. The basic difference between them is the dial-up modem sends and receives data through a fixed telephone line while the wireless modem sends and receives data through waves. Like a GSM mobile phone, a GSM modem also requires a SIM card from a wireless carrier to operate. [4]. The GPRS/GSM shield provides a way to use the GSM cell phone network to receive data from a remote location. There are three methods of services can be used when connecting to the network such as short message service (SMS), audio and GPRS Service.

B. Software Architecture

The software is used to program the Arduino board to govern the operation of transformer monitoring. Besides that, this programming can also be used to monitor the operation of the system. A program or code written for the Arduino is called a sketch that is an integrated development environment (IDE) is a cross-platform application written in Java. A sketch is the name that Arduino uses for a program and the unit of code that is uploaded to and run on an Arduino board. This project involved five sketches which are run and tested individually before they combined to be one sketch. Arduino libraries are a convenient way to share code such as device drivers or commonly used utility functions. Standard library functionality includes basic

communication functions and support for some of the most common types of hardware like motor or sensors.

III. RESULT AND DISCUSSION

A. Hardware Result

No wiring required because the Arduino board provides female pins for plug and play for sensors, LED and GSM modem. Fig. 2 shows the wiring layout of the system which includes wiring for LCD, temperature sensor, level sensor, vibration sensor, and 5 LEDs for indication. The terminal expansion shield board not only expand the terminal of controller, but also can overlap other expansion boards to make connections more secure and reliable wiring connection.

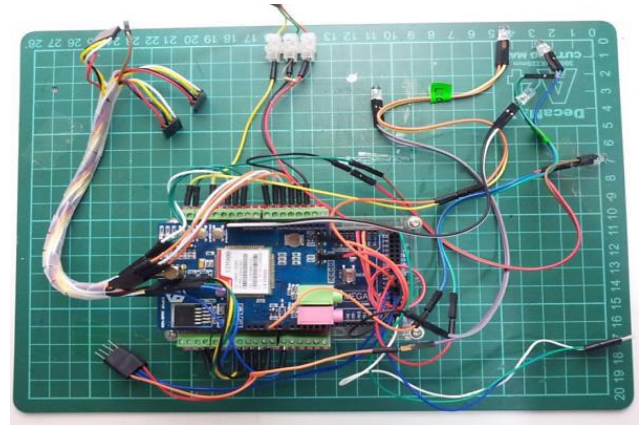


Fig. 2. Wiring layout with external expansion shield.

The system was tested and calibrated in the lab with controlled temperature 24oC using Reference Temperature Calibrator Model ATC115. The calibrator is highly portable and fast precision thermometers with dry-block and temperature ranges from -100° to 1205°C. The temperature is set as desired and temperature sensor is dipped into the multi hole insert for verification and function test. The procedure

required 10 minutes for the temperature of the calibrator to stabilize before proceed to the next reading.

For level sensing, the simple test runs by using a ruler as reference and a solid box for the sensor wave to bounce back. The angle for sensors is 90o as it will place on top of the transformer and facing inside of the body. The reading measured is acceptable because for oil level the requirement for precise reading is not crucial as temperature reading.

For vibration test, the sensor is being mounted on the shaker base plate securely and the sensitivity of the sensor is set to two modes, namely high and low. The test is run by increasing the

frequency and referring the indication of the sensor LED. PT520 shaker is a portable calibration device with the capability of calibrating accelerometers, velocity sensors, vibration transmitters, and proximity probes in the laboratory or in the field.

B. Software Result

GSM modem is tested by running the coding at the first place. The phone number is added to the coding the SMS is received about five seconds lagging due to area of networking. In this work, the DIGI SIM card was used as the modem. The next step is triggering the alarm and observe the system interact with a mobile phone by GSM modem. Fig. 3 shows an example of the respondent between Arduino and mobile phone by changing the coding.

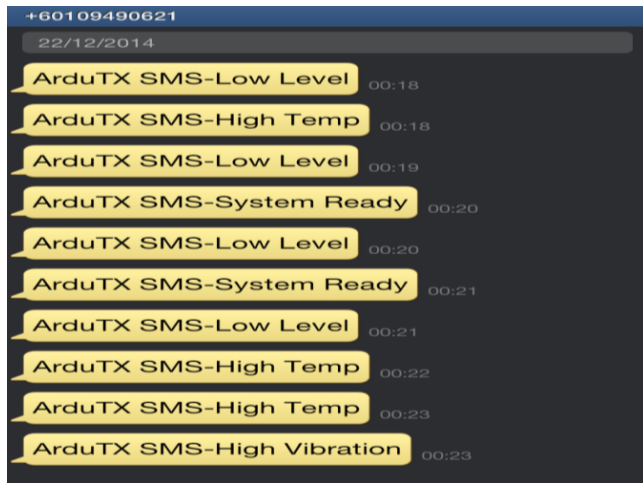


Fig. 3. SMS indication sent by Arduino with the specific alarm event.

IV. SUMMARY

GSM network-based transformer fault early warning system model for distribution transformer has been successfully developed with the capability to send a notification to the user mobile phone. Only authorized person has the notification of transformer condition for better and quick decision making. Lowest operating cost of the system will give advantages for entities that owned transformers where the location in remote areas. Time of event can be obtained through time of the SMS received in real time. Oil Level, oil temperature and vibration of transformers are monitored for 24 hours.

ACKNOWLEDGEMENTS

The authors would like to thank Universiti Teknologi Malaysia (UTM), TNB Remaco and Universitas Sriwijaya

(UNSRI) for facilitating and support in completing of this research work.

REFERENCES

- [1] Maik Schmidt (2011). Arduino A Quick-Start Guide (1st). Texas. The Pragmatic Bookshelf.
- [2] K. Latha, B.U. (2002). Supervisory Control of An Automated System With Ladder Logic Programming And Analysis Using Petri Nets, in System, Man and Cybernetics., . 5. International Conference
- [3] Wilson Pardi Junior (2003), Object-Oriented Real-Time Distributed Computing, 2003. A Supervisory Tool For Real-Time Industrial Automation System. 230 – 237. Sixth IEEE International Symposium.
- [4] Constantin Daniel Oancea (2011). GSM Infrastructure Used for Data Transmission. 12-14. 1 – 4. 7th International Symposium on Advanced Topics in Electrical Engineering (ATEE)