Monitoring Temperature & Smoke for Substations using GSM Technology

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Abstract— **This paper is prepared as to introduced the GSM technology in the current substation monitoring, for wireless and data sending purposes. The purpose of this system is to remotely monitor and control the operational status of the substations by mobile monitors and control system. A remote monitoring is needed as to cut the maintenance cost and time. Maintenance is a key activity as for utilities as to assure the proper operation of their network [1]. Among effective maintenance characteristics is the low cost implementation, since it is known, that many small and medium sized corporations are hesitating to apply a wireless monitoring due to high investment reason[2]. Here, GSM technology helps to enhance the remote monitoring that requires constant updating status of a substation to the mobile operators and control centre. Its network is serves as a medium for transmitting the remote signal[3] and consist of monitoring part and monitoring centre. The computer and the monitoring device is attached via MAX232, along with GSM module for transmitting SMS to the mobile operator. The result shows that such monitoring that is based on GSM application can be realized.**

Keywords: *GSM module, substation monitoring, wireless packet system, mobile network*

1. INTRODUCTION

Generally, a remote monitoring of various devices distributed over wide area is strongly demanded to cut down the maintenance cost [4]. When choosing a system for such purpose several criteria need to be taken into consideration but what really matter most here is the total cost and the feasibility of applying such system. In term of industry, it is believed that there is an increase in requests for remote monitoring such as temperature and humidity management of biological waste disposal and periodic inspection of domestic switchboard [5]. For a substation, such requirement can be benefited in term of time taken for preventive measure to be executed particularly when a transformer is concern and the avoidance of having damage equipments along the way.

Basically, the proposed project is hoped to complement the existing goals of the maintenance such as cost reduction in maintenance and serious damage of a device, which for this paper will focus on a transformer since the demand for the electricity is keep on increasing day by day and the effective monitoring by the responsible personnel where her or she can quickly attend the required machine in short notice . This in return will enhance the equipment utilization for long term use and finally for the safety of the personnel who is responsible for the machines constant check up.

Current maintenance procedures consist principally corrective and preventive (time-based) [7],where the former is applicable for devices that are easy to be replaced, not so important to a system or network, and repairable. While the later one is for planned time assessment where a technician will come and make a periodic check up on the targeted devices at the substation. The monitoring will consists of getting the significant data which in return will be of a great use to as to support the decision making maintenance schedule and then, reducing failures and breakdowns[8].

During the process of building up the required monitoring system, the required factors were defined; namely type of parameters that need to be measured or tested, selection of equipment that need to be monitored and the location of a substation. Since, to enter a substation need a competent technician to enter, the verification of the proposed system is made at laboratory level 5. The parameters that will be taken into consideration are smoke and temperature.

It is known that the conventional method of monitoring the substations in UiTM is done by the said measures; corrective and preventive maintenance as stated earlier. But the downfalls of the usual maintenance is that the time taken for the technician to attend to the problematic devices in a substation, the safety of the personnel himself, and the possibility that the devices, which can be either switch breakers, transformers or even cables damaged even before the technician arrives.

The application is planned initially to be installed at a transformer, particularly the distribution transformer since the performance of it need to be checked from time to time as to avoid or reduce disruption due to sudden unexpected failure and helps to optimize the maintenance schedule. Therefore, the reliability of a distribution network can be assured with the application of this system. The rise in the temperature is checked and monitored 24 hours, and requires only one (1) personnel to see it through.

II HARDWARE SPECIFICATIONS

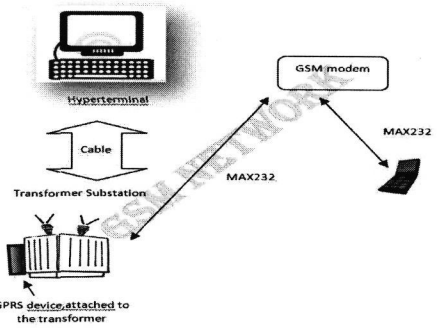

Fig 1 Overview of integrated system

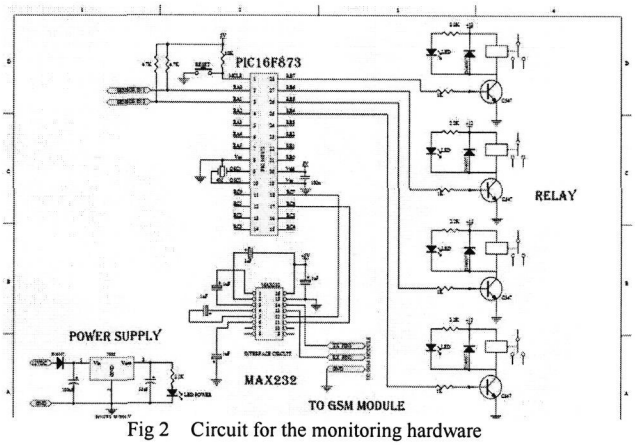

Fig 2 Circuit for the monitoring hardware

The figure above shows an overview of the monitoring system with GSM module being applied. The system mainly composed of a main monitoring station, which in this case the hyperterminal, remote monitoring device that is attached to the transformer inside the substation, a mobile phone and a GSM module for wireless application. The remote monitoring device attached to the transformer is equipped with the sensors, microcontroller and is connected to the hyperterminal via cable. Meanwhile, the hyperterminal & GPRS device is attached are connected to the GSM modem by MAX232 cables. Basically, in this system GSM modem is the main core for such system to be realized where the PC (hyperterminal), GPRS circuit inclusive of a microcontroller are attached to GSM modem via the serial cable. The mobile phone is for the operator or technician who will be responsible for decision making when there is a problem at the substation. It is connected to the system via GSM network.

The hardware of the circuit where the sensors are attached is the main core for monitoring and triggering the needed signal to the mobile operator should there be a problem at the substation. It consists of a microcontroller, a 28-pin 8-bit PIC16F873 that is used to control other devices based on the program that has being burned inside the chip, power supply with an IC regulator 7805 that responsible to change 12V DC voltage to 5V DC, relays that basically act as switches, sensors that comprise a temperature sensor LM35DZ which help to detect changes in the temperature at the transformer and a smoke detector. The hardware is connected to the hyperterminal via MX232 cable. The MAX232 is a serial communication cable between a microcontroller and any device. The main function is to convert the MAX232 level down to lower level, particularly either to 3V or 5.5V.

Integration of the above communication mode can help to build a reliable data transmission network [9]. Another important factor to realize the advantageous of this monitoring and controlling project is the ability to send warnings to the mobile operator via SMS.

Here is where GSM plays an important role, by providing a medium for the information to be sent wirelessly. GSM has some features such as two-way data transmission functions, strong network ability and the inspection cost can be cut extensively. Therefore it provides a strong platform for remote monitoring and data transmission [10]. The system is not only capable to receive warning from the substation to the mobile operator but also able to send instruction to the GPRS devices for immediate action.

III SOFTWARE SPECIFICATION

The methodology for this proposed project sees the implementation of Visual Basic 6.0, where among others, includes the controlling interface ,initialization program of monitoring center, accepting and sending the data through short messages, processing the given data and preserving the system. Another important factor when it comes to such matter is the serial communication between the central monitoring and GSM module. Therefore Visual Basic 6.0 can provide such needs to allow the serial communication to take place.

The software design on this purpose is based on several functions as to make the monitoring works effectively. Among others are to enable instructions to be sent to remote monitoring stations in the form of short messages, store the data and able to print the historical data for analysis. The advantages of using Visual Basic 6.0 are it has a good man machine interface, able to provide serial communication (which in this case establish a communication port COMM10 between the hardware and the GSM), the program that is created is simple and the data can even be saved in a database. Basically the software implementation is used to solve the remote wireless communication between the hyper terminal and the remote monitoring station. Also, the realization of such connection between the remote monitoring devices with a GSM can be realized by the help of AT commands, an instruction sets for modem command set.

IV METHODOLOGY

A. Hardware Design & Implementation

The hardware as explained earlier on will be responsible for data collection, analyzing and later is saved in a data base before to be sent to the mobile operator for further action. There are two parameters that are within the scope of testing; temperature and smoke. Both will be detected by sensors of each type respectively. The controlling device is placed on a transformer inside a substation. Initially, the setting temperature is set to 29.5^{0}C (the temperature can vary, depends on the sensitivity of the sensor)and the critical temperature is set to be 32^{0}C. As the temperature begin to reach the critical temperature, the sensor will detect and it will send a signal to the mobile operator through a GSM network as an SMS. For serious case, when the temperature is too high, a miscall is sent to the mobile operator and this will eventually encourage the technician to take immediate action.

The same concept applies to the smoke, but unlike temperature, the catalyst will be the smoke regardless the temperature. As the sensor sense the existence of the smoke, it will also send a signal to the mobile operator via GSM network and trigger a miscall to the handphone. The received signals are processed through PIC16F873 and is sent to the control centre via MAX232 serial communication port at the same time, an SMS is triggered.

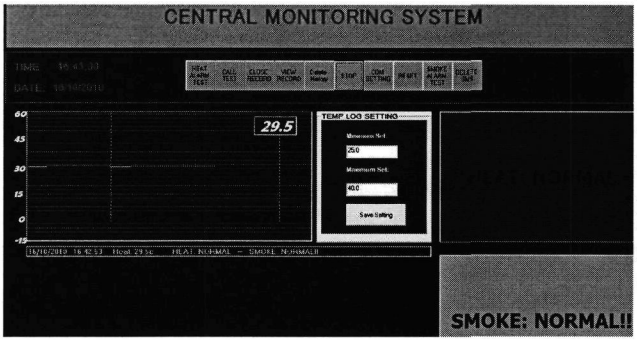

Fig 3 Panel, initial condition of temperature is set to 29.5^{0}C.

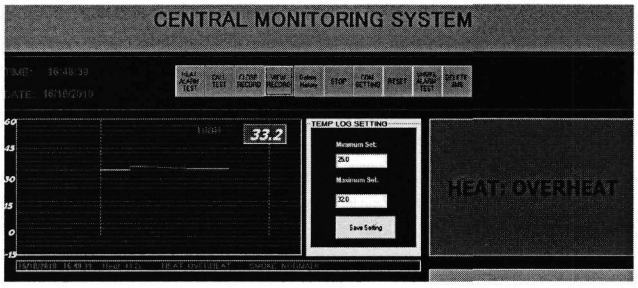

Fig 4 After the temperature sensor detect changes in temperature.

For temperature, the system will continue records any changes of it or in other words it is created to work continuously for 24 hours per day. The saved data will be used for analysis by the responsible technician.

B Software design & Implementation

The software design comprises of two set of programs; one for controller which is embedded in the PIC16F873. Another one is Visual Basic 6.0 for interfacing purpose between MAX232 and its serial devices. The important modules are ; the initialization serial port by providing communication control (COMM10) or go to the Device Manager of a PC, there is a path that is called Seral Bridge Comm Port, by AT Commands, the sending and accepting of short messages can be done. The procedure of sending short messages are as follows;

The number of short message centre is coded in PDU format,then the length of the short message is calculated, then press AT + CMGS = <length> <CR> <CR> representatives Return, that is 0 x0D of ASCII code. When the GSM modem return the character ">" of ASCII the PDU data can be input. PDU data is ended as data characterized by "Z". The module then will return <CRFL> OK <CRFL> when the process of sending short message is complete.

For accepting short message, timer is used to enquire for the serial port periodically. When the short message is complete the computer can accept it as <CRFL +CMTI : "SM",INDEX (storage location of the short message).The PDU data is read for the AT + CMGR = INDEX <CRLF>. After the instruction is implemented the module return the PDU format . The shor message is then coded, the phone number of the caller, sending time of message then finally thy are in the database.

For monitoring centre, the PIC16F873 is embedded with PIC program that can be obtained from the MPLAB website. Basically the control station serves as a place where the data received are collected, to show the short message and to send the real time data to the central main monitoring manager for next action.

The result of the testing is as follows;

Response

	Smoke (time)			Heat or Temperature (time)		
1	Triggered	Response	Reset/Normalizad	Triggered	Response	Reset/Normalized
2	10 second	15 second	15 second	15 second	5 second	10 second

MAX 232 to GSM (Pin 14 to GND)

	Smoke (Voltage)		Heat or Temperature (Voltage)	
1	Before triggered	After Triggered	Before triggered	After Triggered
2	200mv	7.2V	200mv	7.4V

PIC 16F873 (Pin 26 to GND)

	Smoke (Voltage)		Heat or Temperature (Voltage)	
1	Before triggered	After Triggered	Before triggered	After Triggered
2	8mv-0V	infiniti	8mv-0V	infiniti

Table 1 Result of testing

The table above shows the triggered condition and normal condition when a certain temperature is applied to the system. It can be seen that the time response is delayed by several seconds. For the first table, it required 10 seconds to detect after being triggered by a certain temperature and the response is 15 seconds to be received. On the second table, it is shown that before the triggered condition the excisting voltage is 8mV while after triggered it jumps to infinity.

Therefore it can be concluded that the response is slow. This will lead to, in real life a serious damage particularly at the substation where switchboard, transformers and cables might be destroyed.

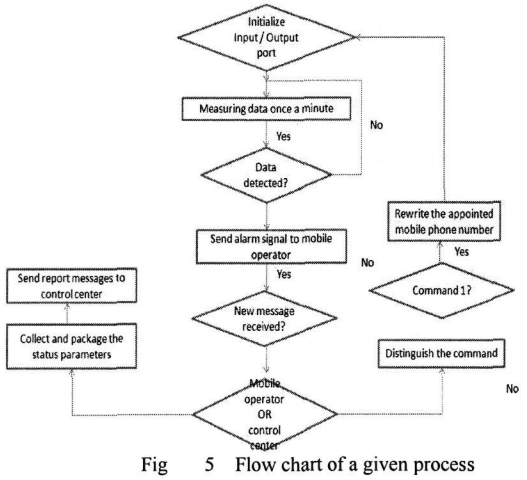

Fig 5 Flow chart of a given process

Figure above shows the flow diagram of the system, starting from the top after establishing the required connection between the serial ports, the monitoring will start, and based on the user's specification, the temperature is detected once the limitation of it is trespassed. Alarm is sent to the operator and SMS is received by the operator, Therefore the technician will do the necessary action and the data is recorded for control station. The process will repeat again. The system can also be altered if assuming that the technician responsible could not fix the problem then another operator can be called upon by simply changing the number from the program created.

V CONCLUSION

The system is aimed to establish a remote monitoring platform based on GSM short message mode that can monitor and control the remote communication between the central monitoring station and remote monitoring station. Basically the proposed project can be seen significantly to help the technician to monitor and expedite the required action should there be any problem at the substation. Since most of the SMEs are very reluctant to apply any wireless monitoring system due to its cost, therefore this can be applied. It is initially proposed after realizing the conventional way of monitoring substations inside the UiTM Shah Alam campus. Most or nearly all the substations are monitored as manually and when the problems arise, sometimes the devices are already damaged even before the technician can come to attend. Except for a GSM modem that can costseveral hundreds RM, it is economically effective and can give and excellent assistance for quick action should there be any problem arise at the substations.

VI FUTURE WORKS

There are several intelligent monitoring application for remote monitoring. One of them is SCADA which involves with real time checking through the internet. This can be very helpful in a sense that it can be done in wider scope with additional help from the internet. Other than that, the type of cable that is used to connect between the GPRS device and the monitoring station can be changed with the fiber. This to ensure the maximum data from one point to another and to avoid any losses that arise. Another enhancement that can be applied is Bluetooth Wireless Technique where it is proven effective for measurement purpose and monitoring as well.

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