Design and Construction of Condition Reporting System Based on GSM Technology for Power Station

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Abstract- This paper describes a condition reporting system of Power plant components using GSM technology. Most of the reporting systems commonly used in Myanmar are manual. The objective of this paper is to transform manual system to automated reporting system with the help of GSM technology. There are three portions in automated reporting system. They are GSM modem system, microcontroller system and sensing system. A dedicated microcontroller based hardware unit (DHU) has been developed to continuously measure the parameters of the viz. voltage, current and temperature of generation of the alternator to monitor the running condition of it also. Other than the generator there are subsystems which also need continuous monitoring. In this monitoring system equipment is connected with one such DHU which is also connected to a Global System for Mobile Communication (GSM) modem. The preliminary level of fault or abnormality in operation of component is diagnosed by the DHU and the fault or abnormalities details are reported to the pre-assigned operator through an SMS service. In extreme case, the provision of equipment shut down by a return SMS is also provided. The circuit model has been set up and is working satisfactorily.

Keywords- Microcontroller, GSM modem, SMS service, reporting system, wireless communication

I. INTRODUCTION

Wireless Communication is now-a-days playing a significant role in modernization of Power system. Wireless communication can be used to deploy different sensors in different Power system equipments where wired sensor deployment is difficult. Electrical equipments including alternator, transformer, circuit breakers etc. installed in different locations in a power system, are needed to be monitored and controlled for healthy operation and smooth running of the system. The convergence of wireless communication technology and the embedded controller technology with the different transducers makes these supervisory systems more reliable, flexible, and much efficient as well as cost effective than wire line deployment. Among different parameters of alternator, monitoring of output voltage, load current and temperature are most important for early detection of any incipient fault. In this context, real time condition monitoring and control has become an essential issue.

Due to this motivation, real time GSM based condition reporting system for power station equipment is developed in this research.

II. RELATED WORK

In [1], the author presented the methodology for monitoring patients remotely using GSM network & Very large scale integration (VLSI) technique. Patient monitoring systems consist of equipment, devices and supplies that measure, display and record human physiological characteristics, including blood pressure, body temperature, heart activity, various bodily substances (e.g. cholesterol, glucose, etc.), pulse rate, respiration rate and other health-related criteria. A patient monitoring system for providing continuous monitoring of a patient includes a data acquisition and processing module receiving physiological data from the patient This unit may be inserted in a bedside display unit to display the physiological condition of the patient. The major reason for the development of the said system is to reduce the product size, power consumption & cost of the system. The remote monitoring & control of the physiological parameters can be obtained by interfacing GSM mobile unit with the patient monitoring system. The system architecture is described. Patient monitoring systems measure physiological characteristics either continuously or at regular intervals over time. The embedded system is developed using libero IDE. An application of this method in Biomedical includes better accuracy, design security, productivity, speed and flexibility.

In [2],the author explained the systems based on existing technologies and also proposes a GSM-Bluetooth based light controller and remote monitoring system. This system has simple features designed with the objective of minimum power consumption using infrared sensor for controlling lights, fans and other appliances which are controlled via SMS using a GSM module. A Bluetooth module is also interfaced with the main microcontroller chip. This Bluetooth module eliminates the usage charges by communicating with the appliances via Bluetooth when the application is in a limited range of few meters. The system informs user about any abnormal conditions like intrusion detection and temperature rise via SMS from the GSM module or by Bluetooth module to the user's mobile and actions are taken accordingly by the user.

In [4],the author mentioned the performance of the sensors of a low cost Short Message System (SMS) based home security system equipped with motion sensor, smoke detector, temperature sensor, humidity sensor and light sensors has been studied. The sensors are controlled by a microprocessor PIC 18F4520 through the SMS having password. The operation of the home security has been tested on Vodafone- Fiji network for emergency and feedback responses for 25 samples. The GSM experiment showed that

it takes about 8-10s for the security system to respond the occupant and relevant civil authorities in case of emergency. It takes about 18-22s for the occupant to switch and monitor lights and appliances and then get feedback from home depending upon the network traffic.

III. PROPOSED SYSTEM

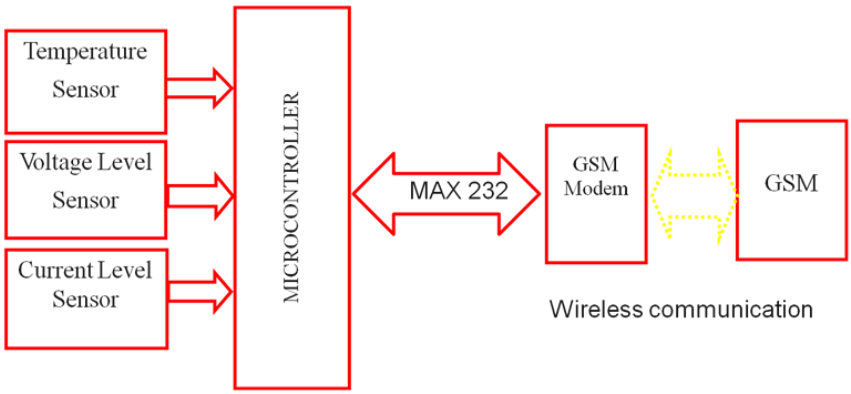


Figure 1. Block diagram of GSM based condition reporting system using microcontroller

This system is the GSM Based Condition reporting system using microcontroller in power station equipments. This system is mainly constructed with PIC 16F877A and GSM modem. PIC 16F877A is mainly used as control unit. Three sensors are mounted in power station and its surrounding. The three sensors sense the voltage, current and temperature and the sensing data are sent to PIC. PIC receives the sending data and checks overload or not according to the programmable. The three sensors are Voltage Level sensor, current level sensors and Temperature sensor. Initialization the microcontroller is operated and the sensors sense the data. If the over voltage or under voltage are occurred in the operating time, the microcontroller close the circuit and then one message is sent to the user mobile phone from the GSM modem. The user receives "voltage= V, current= A, temp= F" message. If the station temperature is over (250ºC), the engine can burn. So the temperature sensor is used to protect the station burn. The temperature sensor senses and the sensing data is report to the microcontroller. If the temperature is over, the microcontroller sent a message to the user. The user receives the message "The station is stop because of overheating!". If the power does not flow during the sensors, the modem sends the message "The station is stop because of lack of power!". The microcontroller and the GSM modem are connected with RS232 serial interface.

Block diagram of GSM based condition reporting system using microcontroller is shown in figure 1.

This design can be divided into several units or modules. They are sensor unit, processing unit and power unit. There are some devices and components used in the in the design to implement each unit. These devices used in this system are as follows;

- Power Supply Unit
- Current sensor
- Temperature sensor
- Voltage divider
- PIC16F877A microcontroller
- MAX232 level shifter
- GSM Modem
- Display Unit

A. Power Supply Unit

The DC power supply unit is vital component in modern electronic devices as they need a wide range of DC voltages for their operations. The purpose of a power supply is to provide the required amount of power specified voltage from primary source.

B. Current sensor

The Allegro ACS756 shown in figure 2, family of current sensor ICs provides economical and precise solutions for AC or DC current sensing in industrial, automotive, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, power supplies, and over current fault protection. The device consists of a precision, low-offset linear Hall circuit with a copper conduction path located near the die.

Features and Benefits of ACS756

- Industry-leading noise performance through proprietary amplifier and filter design techniques
- Total output error 0.8% at T_A = 25°C
- Small package size, with easy mounting capability
- Monolithic Hall IC for high reliability
- Ultra-low power loss: 130 μΩ internal conductor resistance

- 3 kV_{RMS} minimum isolation voltage from pins 1-3 to pins 4-5
- 3.0 to 5.0 V, single supply operation
- 3 µs output rise time in response to step input current
- 20 or 40 mV/A output sensitivity
- Output voltage proportional to AC or DC currents
- Factory-trimmed for accuracy
- Extremely stable output offset voltage
- Nearly zero magnetic hysteresis

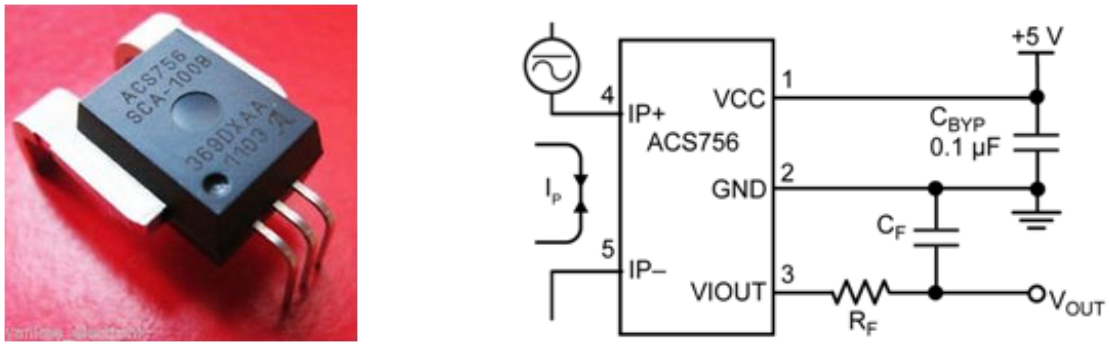


Figure 2. (a)ACS756 sensor (b) General block diagram of ACS 756 sensor

C. Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in °Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1/4°C at room temperature and ±3/4°C over a full -55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 mA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a -55° to +150°C temperature range, while the LM35C is rated for a -40° to +110°C range (-10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-202 package.

Features of LM35

a) Calibrated directly in°Celsius (Centigrade)
b) Linear a 10.0 mV/°C scale factor
c) 0.5°C accuracy guaranteeable (at +25°C)
d) Rated for full -55° to +150°C range
e) Suitable for remote applications
f) Low cost due to wafer-level trimming
g) Operates from 4 to 30 volts
h) Less than 60 mA current drain
i) Low self-heating, 0.08§C in still air
j) Nonlinearity only ±1/4°C typical
k) Low impedance output, 0.1 Ω for 1 mA load

E. PIC16F877A Microcontroller

PIC 16F877 is 40/44 pin device and is one of the popular microcontroller used in complex applications. The device offers 8K X 14 word of Flash program memory, 368 bytes of RAM, 256 bytes of nonvolatile EEPROM memory, 33 input/output pins, 8 multiplexed A/D converters with 10 bits of resolution, PWM generator, three timers, an analog capture and comparator circuit, USART, and internal and external interrupt facilities.

F. MAX232 Level Shifter

Almost all digital device use either TTL or CMOS logic levels. Therefore, the first step to connecting a device to the RS232 port is to transform the RS232 levels back into 0 and 5 Volts. A MAX232 chip provides the TTL to RS232 (and vice versa) level conversions for the project.

The MAX232 provides two incoming ports and two outgoing ports. To create this interface, it mainly used the TTL outputs of the PIC in combination with a MAX232 serial driver chip. The MAX232 simply converts the TTL outputs to RS232 outputs.

This IC also includes two receiver and two transmitters in the same package. Two common RS232 level converters are the 1488 RS232 Driver and the 1489 RS 232 Receiver. Each package contains 4 inverters of the one type, either Drivers or Receivers. The driver requires two supply rails, +7.5 to +15v and -7.5 to -15V.

It may have a problem in many instances where only a single supply of +5V is used. However, the advantages of these IC's are cheap and also can be available in many places.

The MAX232 contains four sections:

(1) Dual Charge-pump DC-DC Voltage Converters
(2) RS232 driver
(3) RS 232 receivers
(4) Receiver and Transmitter enable control

G. GSM Modem(GM28)

The GSM modem communicates with the user cell phone to intimate the condition obtained for the microcontroller. Serial Port Adapter works in data and AT modes and needs to be properly configured. In AT mode, series of commands are sent for proper configuration. If match is found, it starts data communication between micro-controller system and GSM. AT commands are sent by sending text strings 'A', 'T', along with specified command strings through serial port to cell phone and are executed on receipt of carriage return. The result codes are sent by cell phone to system (TE) to indicate the status after execution of command.The GSM modem operates with SIM card as mobile phone.

Main features	**Parameters**
Power supply voltage	DC: 5~18V
Frequency band	Support four frequency: GSM850,GSM900,DCS1800,PCS1900 , Frequency automatic search , Frequency can be set by AT command
AT command	other extended AT command
Transmitting power	Class4 (2W): GSM850 and GSM900 , Class2 (1W): DCS1800 and PCS1900
Message	Text and PDU mode , Message storage equipment: SIM card
RS232 characteristic	Global function serial port, Used for AT command, Adaptive baud rate: 4800 bps-115200 bps, Character format: data bit 8, stop bit 1, no parity bit
Temperature range	Working temperature: -35 to 80 degree, Storage temperature: -40 to 80 degree
RS232 interface	A RS232 standard interface (device is female)
SIM card interface	a SIM card interface

V. SIMULATION RESULTS

Firstly, the system is simulated by using Proteus software. As shown in figure 5, the system can successfully read the data from sensors using microcontroller. Since the Modem is not available in Proteus, data transmitting and receiving functions are tested in Virtual terminals.

Principle of operation

The complete circuit diagram of the proposed system is shown in figure 3.

In this system, PIC 16F877A microcontroller is used as control unit. PIC 16F877A microcontroller consists of 40 pin. It has 33 pins of input/output port. The input/output ports are PORTA, PORTB, PORTC, PORTD and PORTE. The next 7 pins are two pins for ground reference (V_{SS}), two pins for positive supply (V_{DD}), two clock input pins and master clear (RESET) input. In this system, PORTB is used as input pin and PORTC is used for output. The three sensor's data enter the PORTB pins. The voltage level sensor is RBO and the current sensor is RB1. The data of temperature low and high level enter RB3 and RB4 respectively.. The 5V power supply is connected to V_{DD} and V_{SS} is GROUND. The receive (R_X) and transmit (T_X) pins are connected to MAX232 IC. MAX232 has 16 pin and it converts 5V to 12V and 12V to 5V dc. The microcontroller receives the data from sensors and check overload or not according to programming. In programming design, transmit register and receive register is used to transmit and receive the data and then other registers are used in program. In this system, HI-TECH C program is used. To send the data from the microcontroller to modem, the serial data transmission system is used. The flow chart of the software implementation of the system is illustrated in figure 4.

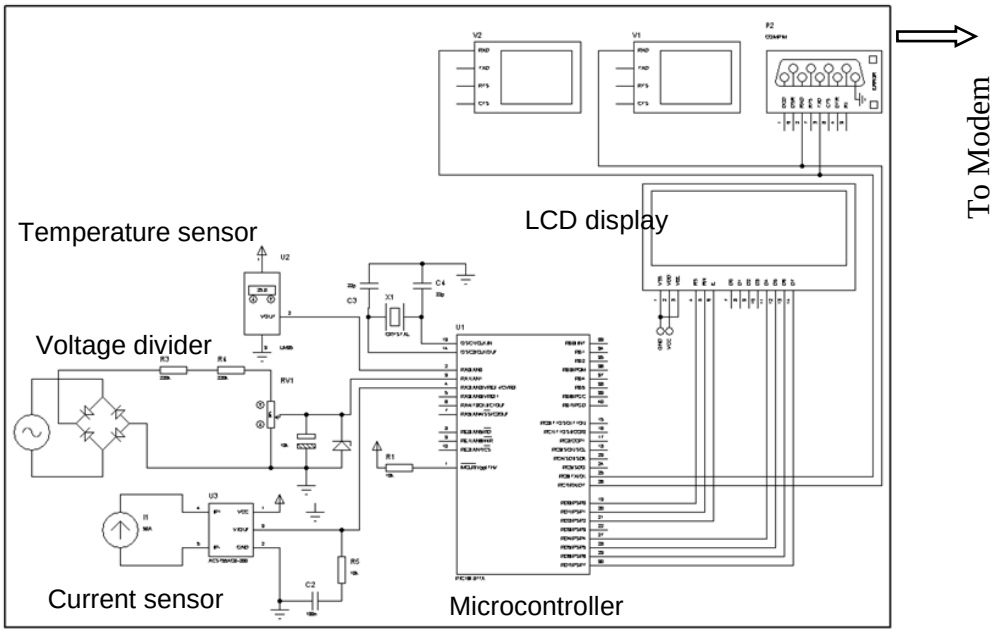


Figure 3. Complete circuit diagram

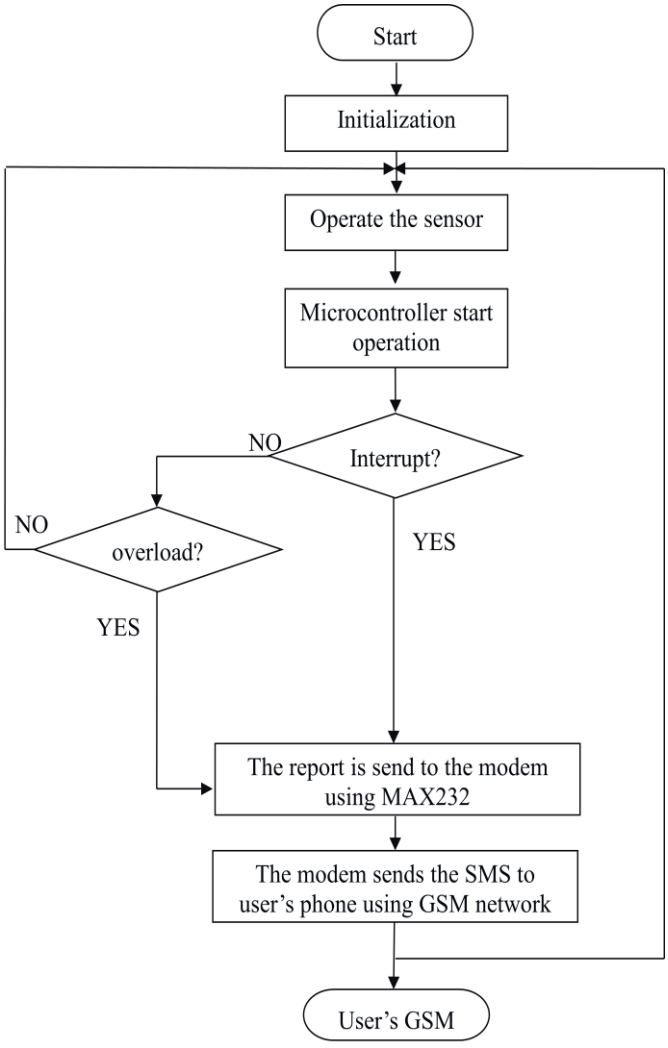


Figure 4. Flow chart of the software implementation

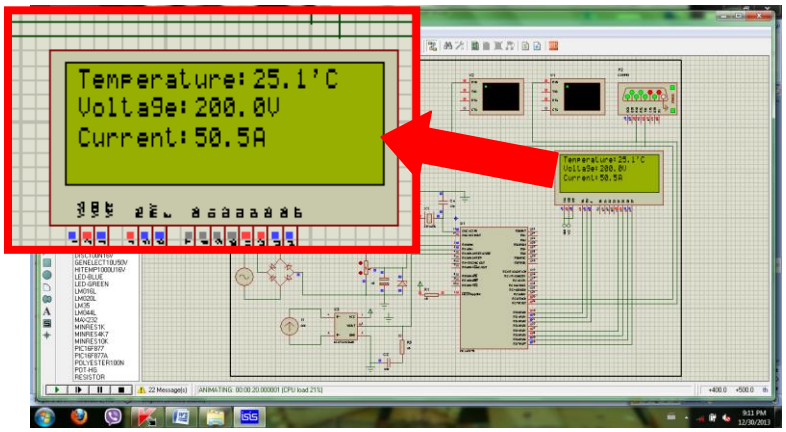


Figure 5. Simulation result for data reading from sensors in Proteus

3. Test and Results

The microcontroller based dedicated hardware unit (DHU) is constructed in this research as shown in figure 6. In this hardware construction, the temperature sensor, current sensor and voltage divider network sense the temperature, current and voltage of the AC mains line instead of the power station equipment. Then the sensed data are transmitted to the GSM modem via RS232. And then GSM modem transmits the data to the user's GSM mobile. As seen in figure 7, the constructed circuit can successfully transmit and receive the condition (temperature, current and voltage).

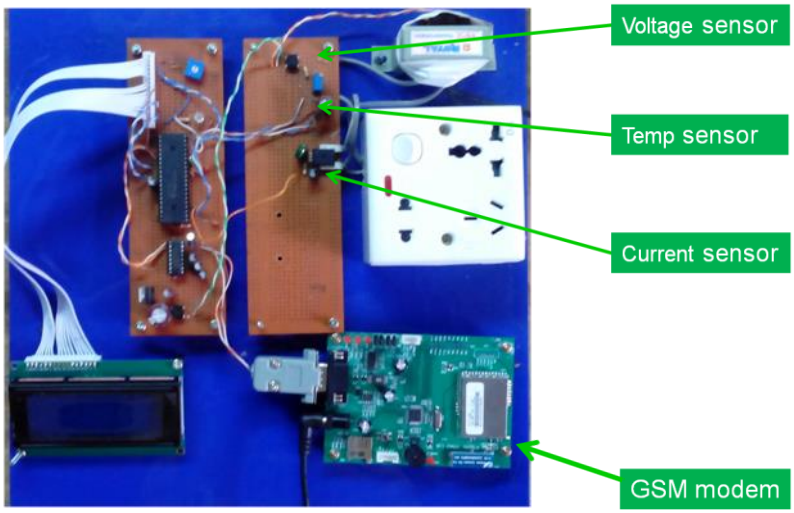
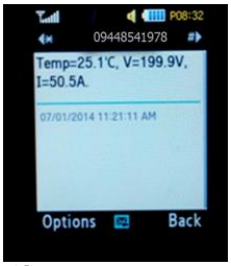


Figure 6. Constructed and tested microcontroller based DHU

(a) Checking Modem is connect or not

(b) Requesting data and sending data to user GSM

(c) Normal Running Condition



(d) Receiving sms on user GSM

Figure 7. Test Results of Hardware Unit

V. CONCLUSION

GSM based condition reporting system using microcontroller in power station equipment is implemented in this research work. The system is physically constructed and its performance is tested. The system operates successfully. Therefore this proposed system can be practically applied for the condition testing of the actual power station equipment.

VI. REFERENCES

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