Development of a Remote Timing and Monitoring System for GSM Base Station Generators

Dauda A. Shaibu, Joseph M. Mom, David O. Agbo

Abstract--Global System for Mobile Communication (GSM) base stations encounters several challenges when trying to provide power to run their equipment. Generators are used as backup power supply in some stations while other stations rely completely on these generators to run the station. The system in the base station requires proper generators synchronization. GSM operators usually find it difficult to time and monitor the state of power supply at the base stations in remote locations, leading to poor quality of services for subscribers if there are any power related issues. In this paper, an application for timing the operation of generators and monitoring the basic parameters of the generator (Temperature, Starter status, battery voltage level and Fuel level) was developed. The design has two units; the remote controller unit and the generator controller unit. The remote controller unit consists of a GSM module, a keypad, a microcontroller, and a Liquid Crystal Display (LCD) while the Generator controller unit consists of sensors (Temperature, Battery voltage and fuel), a relay, a microcontroller, and a GSM module. The information from the generator (temperature, Battery voltage and fuel level) is obtained from the sensors and transmitted to the remote controller unit using GSM module. The remote controller unit receives information from its own GSM module. The LCD displays the status of all the parameters obtained from the sensors connected to the operational generator. If the conditions of generator is not according to the minimum set conditions (based on feedback via SMS), another generator will come on while notice will be sent to the operator. The device was tested and the LCD displayed the temperature, battery level and fuel level of the specified generator. A Short Messaging Service (SMS) Message was sent to the programmed number. From the test results, it shows that the design shows can be used in GSM base stations in Nigeria.

Keyword: Battery voltage level, Fuel level, GSM, LCD, Monitoring, Remote controlled and Temperature status

1 INTRODUCTION

There are several challenges encountered by Global System for Mobile Communication (GSM) companies to provide power to their Base Transceiver Stations (BTS) that are in Nigeria, especially in areas where there are frequent public power outages. While several companies are exploiting renewable power sources to power their BTS, majority are powered their Base stations with generators. This has increased the cost of GSM firms in provide quality communication services to the ever-growing telecommunication subscribers in the country. In many instances where generators are used, most of the GSM companies do not have accurate information on how many hours each generator runs at a Base station or theses generators break down. Hence, they rely on the information provided by those who operate these generators. This research focuses on the development of a remote system, which can provide information on the generator(s) status at the Base stations. The system will also help communication companies to choose how long one generator can run before the next generator, when there is public power outage.

This application will provide feedback on the state of power at a Base station at any location where there is GSM communication network. It will also help base station passive maintenance vendors to respond to early warning signs of the generators, thereby avert total breakdown.

Several studies have been carried out on the control of generators. The review of some related past works are as follow:

Baraneetharan and Selvakumar (2015) [1] implemented a GSM based change over system for generators. The power failure detection system is connected to the microcontroller which finds out the power failure through the output of that system. The generator output control is connected to the microcontroller through relay and driver circuit. The system turns ON the relay when it receives a message.

Boopathi *et al.* (2015) [2] presented a smart generator monitoring system that detects power failure. The power failure is detected by relay and communicates to the microcontroller to alert the authorized person through GSM module. The system also monitors fuel level, oil level, temperature and battery status of the generator that are communicated to an authorized person. These generator parameters are processed and recorded in the system memory.

Cotta and Naik (2016) [3] proposed a wireless communication system which involves the transfer of information between two or more points that are not connected by an electrical conductor. The work uses the HC-05 Bluetooth module and interfaces it with Arduino microcontroller.

Patil *et al.* (2013) [4] discussed the design of BTS safety and fault management system and the measures to be taken to rectify these problems. The method makes use of GSM

modem which gives the instant message about each activity (temperature) happening in the site.

Some of the works implemented are changeover system for generators using GSM for communication. The power failure detection system is connected to the microcontroller which finds out the power failure through the output of that system. The generator output control is connected to the microcontroller through relay and driver circuit. Similarly, a smart generator monitoring system that detects power failure and gives feedback using GSM communication is implemented. The system monitors fuel level, oil level, temperature and battery status of the generator, then communicates to authorized person. In all these systems, they switch from one generator to the other when there is power failure from a particular generator but the systems do not have the capability to set the time for the running of each generator.

Finally, it can be seen that no work from the review has proposed, designed, simulated or implemented a real time system that presets the running of generators which will reduce the over running of one generator at GSM base station.

2 MATERIALS AND METHODS

The block diagram of the system consists of two units: the remote control unit and the generator controller unit. Figure 1 and 2 shows the block diagram of the system.

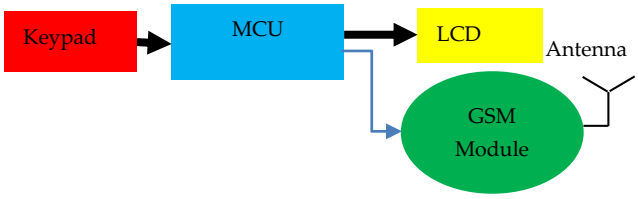


Figure 1: Remote Controller Unit

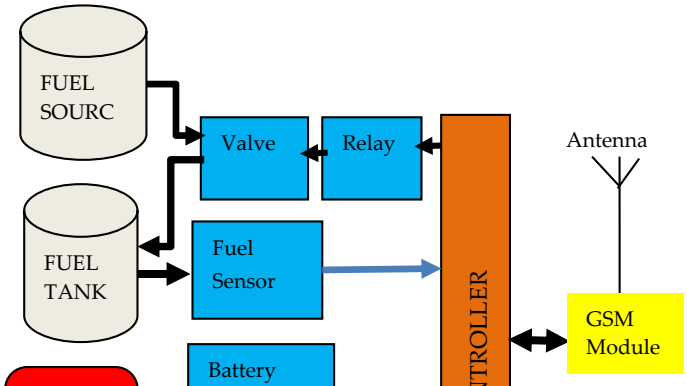


Figure 2: The Generator Control Unit

Figure 3 shows the keypad circuit diagram which is used in getting the status of any generator selected. The remote controller unit has three buttons connected to PIC18F2585 microcontroller [6] that can be used to select any of the generator and request for the status of the generator selected. To select a generator after the GSM module [8] initialization, there is a display of message on the LCD to press menu button. When the menu button is pressed, another command pops up on the LCD screen for the user to scroll either up or down to select any generator. When the operator reaches the desired generator the menu button is pressed again to select the generator and the status of that generator is automatically displayed on the LCD. Figure 4 shows the generator controller circuit diagram that is attached to each generator. The controller unit comprises of input sensors that takes readings of the generator temperature, fuel source level, generator fuel level and battery level that are all connected to PIC18F4585 microcontroller [6]. The temperature sensor LM35 [7] takes the temperature readings and sends it to the microcontroller, but if the generator temperature exceeds 95°C the buzzer comes on continuously. Ultrasonic sensor [5] is used to measure the fuel level and two ultrasonic sensors are used. One ultrasonic sensor is placed at the generator tank while the other is placed at fuel source supply tank. The generator fuel tank is measured in three levels: low, half, and full. When the fuel level is full and half, the valve for fuel to flow from the source to generator tank will be closed. However, when the fuel tank is low, the valve opens for the fuel to flow from source tank to the generator tank. When the source tank is empty, the buzzer turned ON and SMS is sent to the operator informing the operator of the status of the source tank through the GSM module. All information about the state of the generator is displayed on the 16 x 4 LCD. The status of the generator can be sent to the operator holding the remote control on request, all the status of the generators can be viewed by

the remote controller operator and time can be allocated to the generator by operator.

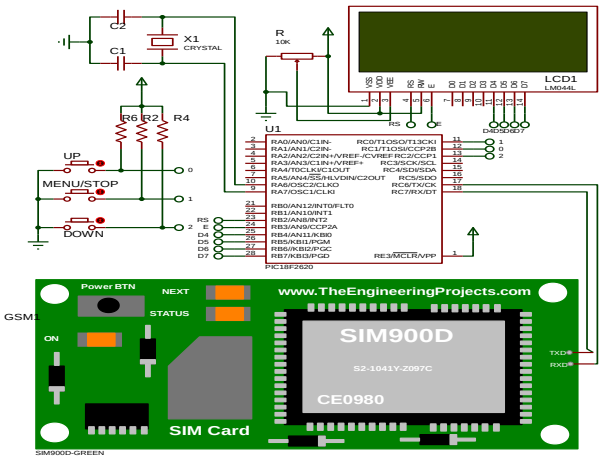


Figure 3: The Remote Controller Circuit Diagram

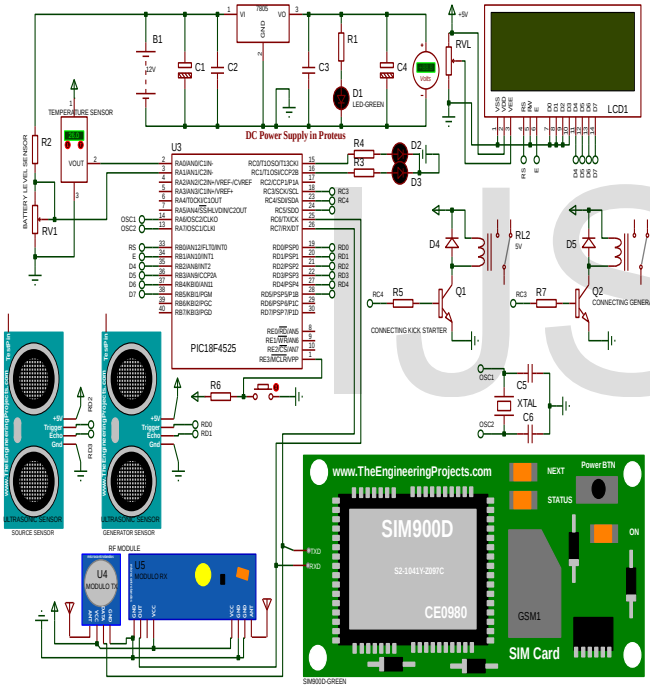
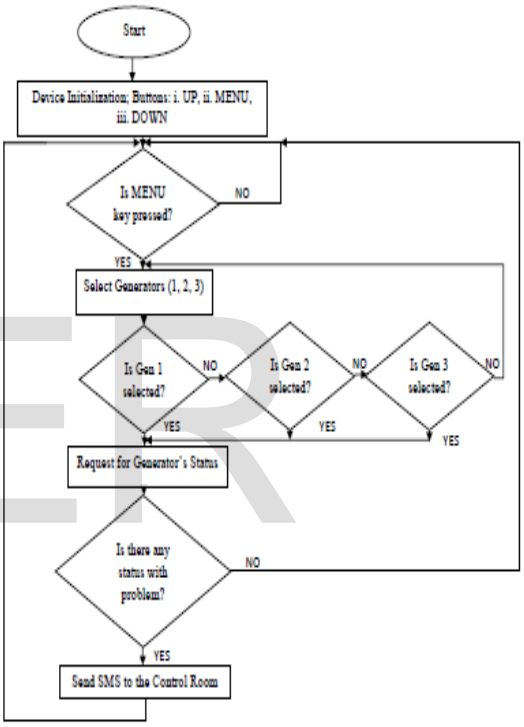


Figure 4: The Generator Controller Circuit Diagram

The Flow Chart of the system is divided into two namely: Remote Control Flow Chart and Receiver/Control Flow Chart. Figure 5 shows the Remote Control Flow Chart. When the device is turned ON, it starts and then proceeds for initialization and maintains the sleep mode to ensure proper synchronism. Whenever a button is pressed it proceeds to identify the key pressed else it will return to sleep mode if no key is pressed. After identifying the key that is pressed, it confirms its validation and update it status with LCD confirming to it, it then proceeds to check the timer and then validates the data if true. If the data isn't valid, the process returns to the decision mode that requires any key to be pressed. If device is left for a long time, it returns to sleep mode but still maintains its condition as last seen.

Figure 6 shows the Receiver/Control Flow Chart. When the device is turned ON, it starts and then proceeds to the initialization stage; and maintains the sleep mode to ensure proper synchronism. When the first synchronization is achieved, the reset button is pressed to ensure maximum uniform timing with remote control section else it will return.



Figu

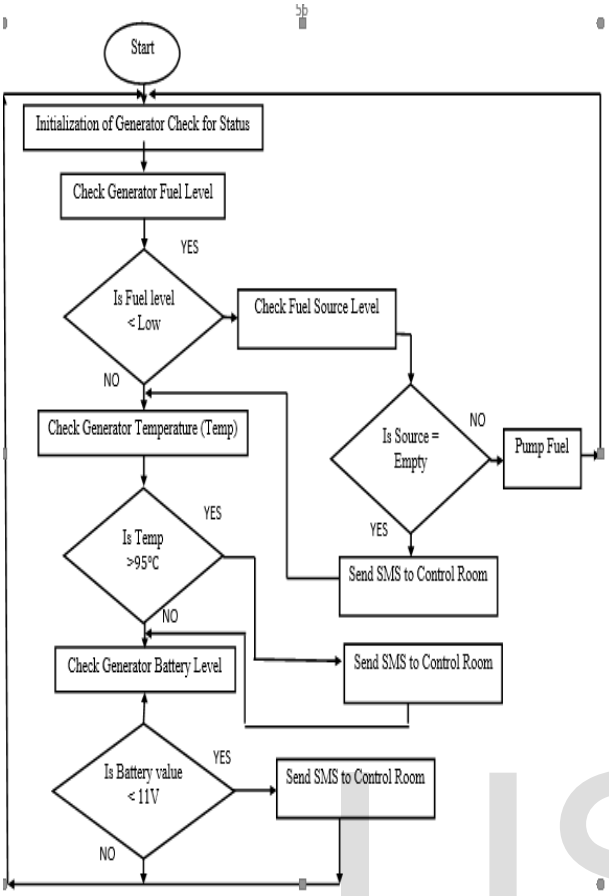


Figure 6: Generator Protector Unit

3 RESULTS

Figure 7 to 15 show the results of some stage of the system. After initialization of the remote controller hardware Figure 7 shows the accessing of generator by displaying a message for the user to press the MENU key and when the MENU key is pressed, "select command" is display as presented in Figure 8. Figure 9 to 13 shows the types of command to be selected. The command "ON generator" represented in Figure 9, remotely ON the selected generator, the command "OFF generator" represented in Figure 10, remotely OFF the selected generator, the command "Return" represented in Figure 11, takes the user of the keypad controller back to the last select command, while the command "Get status" represented in Figure 12, remotely get status of the selected generator (temperature level, fuel level and battery level). This get status command serves as feedback to know if the generator is working, Figure 13 presents the display of the generator status when temperature is 25.3 °C; battery level 8.4 V and fuel level is low. Figure 14 presents the display of the generator status when temperature is 25.3 °C, battery level 8.4 V and fuel level is middle and Figure 15 present the display of the generator status when temperature is 25.3 °C, battery level 8.4 V and fuel level is High.

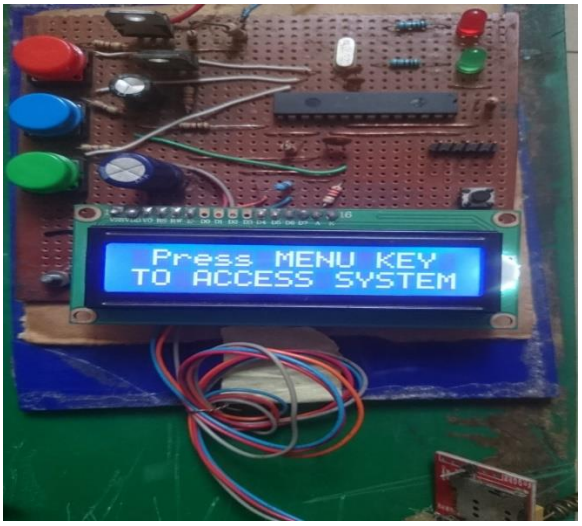


Figure 7: After Initializing the System, this Menu Appear

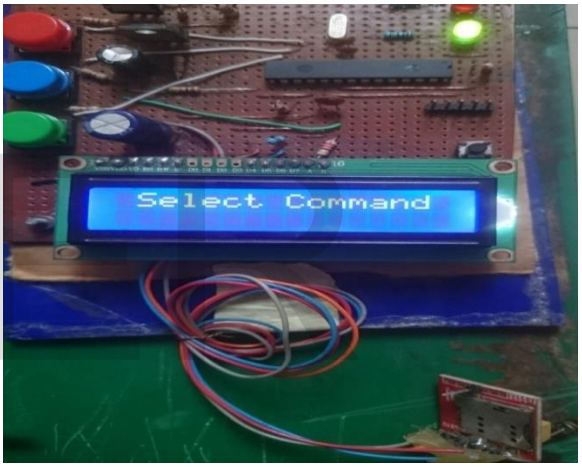


Figure 8: Menu displayed when "Menu" Button is Pressed

Figure 9: Menu to Switch ON the Generator

Figure 10: Menu to Return to the Beginning of the Menu

Figure 11: Menu to Switch OFF the Generator

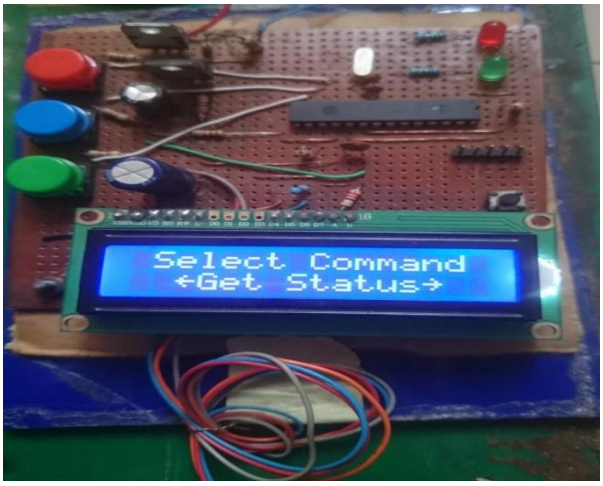


Figure 12: Menu to Get Status of the Generated

Figure 13: Status of Generator of when Temperature below Rated Maximum Value and Fuel Level is Low

Figure 14: Status of Generator of When Temperature below Rated Maximum Value and Fuel Level is Middle

Figure 15: Status of Generator of When Temperature above Rated Maximum Value and Fuel Level is Full

4 CONCLUSIONS

The aim of this research which is to develop and construct a keypad mobile application timing system for monitoring the operation of generators at the Base stations was met. This is a result of the achievement of objectives of this research earlier stated. A keypad application that timed the operation of generators and monitored the basic parameters of the generator (Temperature, battery voltage level and Fuel level) was simulated and constructed along with a PIC based controller that sent feedback to the application. The results obtained showed the design can be used in any base stations in the country.

REFERENCES

[1] E. Baraneetharan and G. Selvakumar, "Implementation of GSM Based Automatic Change over System for Electric Generators," ***International Journal of Innovative Research in Science, Engineering and Technology***, vol. 4, no. 6, pp. 1399-1403, 2015.

[2] S. Boopathi, M. Jagadeeshraja and L.D. Manivannan, "Smart Generator Monitoring System in Industry Using Microcontroller," ***American Journal of Electrical Power and Energy Systems,*** vol. 4, no. 4, pp. 45-50, 2015.

[3] A. Cotta and T.D. Naik, "Wireless Communication Using Hc-05 Bluetooth Module Interfaced With Arduino," ***International Journal of Science, Engineering and Technology Research,*** vol. 5, no. 4, pp. 869-872, 2016.

[4] C. Patil, and C. Baligar, "Base Transceiver Station (BTS) Safety and Fault Management", ***International Journal of Innovative Technology and Exploring Engineering,*** vol. 3, no. 7, pp. 23-28, 2013.

[5] "Ultrasonic Ranging Module HC - SR04 Datasheet", [Online]. Available from: www.services@elecfreaks.com, 2009

[6] "PIC18F2455/2550/4455/4550 Data Sheet," *Microchip Technology Inc. Corporate*. Available from: http://support.microchip.com, 2006.

[7]. "Temperature sensor LM35 datasheet", Texas Instruments Inc. Available: www.ti.com/sensors/lm35, 1995-2020.

[8]. "Sim900a GSM module datasheet-Components 101". Available: https://components 101.com>files