IoT Based Power Monitoring System for Diesel Generator

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Belen Septian
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IoT Based Power Monitoring System for Diesel Generator

Belen Septian
Department of ECE
Osmania University
Hyderabad, India
septianbelen@yahoo.com

Peddapuram Rakesh
Department of ECE
Osmania University
Hyderabad, India
rakeshpeddapuram0443@gmail.com

S. Rajiv Dhora
Department of ECE
Osmania University
Hyderabad, India
rajeevsuncha@gmail.com

Abstract—**Internet of Things is widely used to monitor and control electronic devices. It is technology combined embedded system and internet technology by which people can monitor devices throughout internet network anywhere in the world. A power monitoring system using IoT is an affordable solution to monitor power parameters of diesel generator such as voltage, current, running hours, and fuel status from external fuel tank. The system uses an Arduino Uno microcontroller as a processor and SIM900 GSM/GPRS module to send data into a web server. ZMPT101B and SCT-013-030 are used to monitor AC voltage and load current respectively. Whereas running hours parameter is taken based on status of measured voltage. The results showed that the system could display those parameters real-time on the website application. It also displayed running status of generator and online or offline status of the system. Furthermore, this system helped technicians to determine maintenance time appropriately.**

Keywords—**IoT, Power monitoring system, Arduino Uno, SIM900 GSM/GPRS module, Website application**

I. INTRODUCTION

Electrical power is the most important source for electronic devices. In industrial systems, electrical power is needed to keep control systems running for 24 hours. Stable power source should also be taken care to prevent devices from being damaged. Diesel generator is a fossil-fuel powered generator employed to supply electrical power [1]. It can be used as either main or backup energy. Generator needs to be maintained to get its maximum lifespan. Running hours can be used as an indicator by which operator can determine appropriate time for generator maintenance. Monitoring the current and voltage is also important to make sure it gives stable power source.

Development of IoT rises significantly as internet becomes common for many people. With the advancement of mobile phones, people can monitor electronic devices easily through their mobile phones. IoT starts with a sensor. A sensor needs to be connected with a controller or a processor so that it can constantly sense the parameters for which it is used for [2]. Internet of Things (IoT) links anything from anywhere in the universe. It communicates with almost everything around the world. The communication can be a control signal or identified data from this world. It is a common internet data communication and is communicated in different ways [3].

In [6], authors used SCT-013-030 and Arduino Uno to measure power consumption based on loads. ESP8266 was used to send data using IoT concept. Another study to measure power consumption was done in [7]. Energy meter was used along with Arduino Uno and RTC clock. RTC clock captured the time of energy usage and saved the data into EEPROM. Measured data would be sent in the form of SMS using GSM module. Further study in power monitoring system was done using ZMPT101B [4]. It was used to get voltage measurements. It was connected to analog input pin of Arduino microcontroller and calculation was done using polynomial regression.

A generator monitoring system that measures fuel level and power was done by [9]. In this study, fuel level was measured using buoy mechanism. When there was an increase in liquid level, it would move the buoy which would rotate the rheostat sensor so that it would give a different resistance value at each fuel level. To measure power, PZEM-004T sensor was used and the results were compared with CM3286-20 clamp meter.

Based on previous studies, a complete system that measures voltage, current, fuel level, and running hours has not yet been done. The objective of this paper is to monitor power parameters such as current, voltage, fuel level, as well as running hours which is taken from measured voltage using Arduino Uno. The Arduino microprocessor board is a single board microprocessor used in intelligent projects and prototyping [4]. Sensor parameters are to be sent throughout the internet and can be monitored via website application.

II. DESIGN METHOD

There are several methods of measuring fuel level sensors, including measurements with resistance, capacitance, and ultrasonic methods [9]. In this study, fuel level will be measured using ultrasonic sensor. Current will be measured using CT sensor, as for voltage and running hours will be measured concurrently using a single-phase voltage sensor.

The system consists of two major parts which are hardware and software. Hardware part consists of a schematic diagram and components. While software part consists of IoT architecture and I/O connections.

A. Architecture of Hardware

Fig. 1. shows the schematic diagram used for building this system. It consists of Arduino Uno, SIM900 GSM/GPRS module, US-100 ultrasonic sensor, ZMPT101B voltage sensor, SCT-013-030 current sensor, and LCD interface. ZMPT101B is used to measure voltage by connecting which to the power source. According to [5], The ZMPT101B operates on 5V DC and it contains two AC input (Phase and Neutral) pins and four DC output pins (Vcc, Out and two Gnd.). The output of ZMPT101B is given to the analog pin [5] of Arduino Uno. While SCT-013-030 will be clamped upon the cable to get load current measurements. As per the datasheet, this current sensor gives 1V output for 30A current sensed [6]. As the current value is lower, the CT output accuracy also falls [6]. To measure running hours, 220 VAC is calculated periodically when generator running and is to be saved temporarily in EEPROM microcontroller. According to

[7], The data on which will not be deleted even when the power breakout because EEPROM is non-volatile memory.

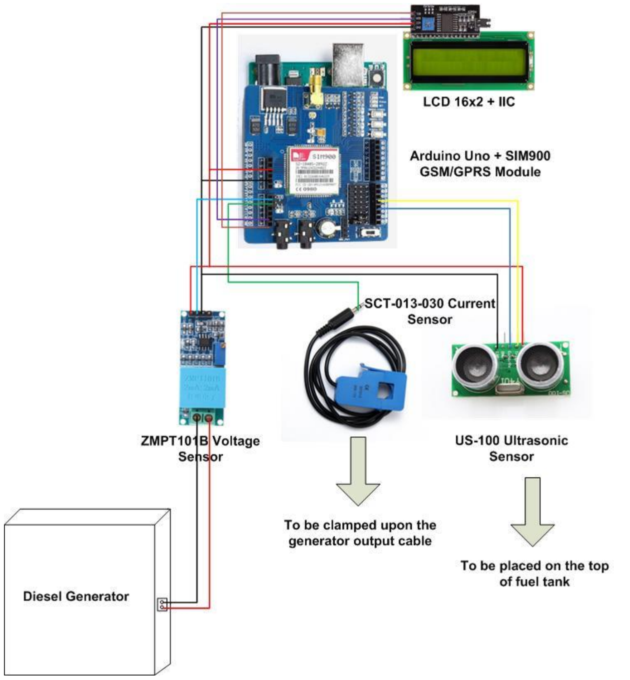

Fig. 1. Schematic Diagram of Hardware

US-100 ultrasonic sensor is placed over the fuel tank to measure fuel level. Ultrasonic transmits signal to the object and bounces back its signal to get the distance. This distance is calculated along with height and length of the tank to get the fuel capacity in percentage format.

B. Architecture of IoT

There are many methods to send data of sensors throughout internet network. Based on [8] study, SIM900 GSM/GPRS module was used for transferring data into a server. In this paper, raw data from microcontroller will be sent into a web server using SIM900 GSM/GPRS module. Fig. 2. shows architecture of IoT used in this system.

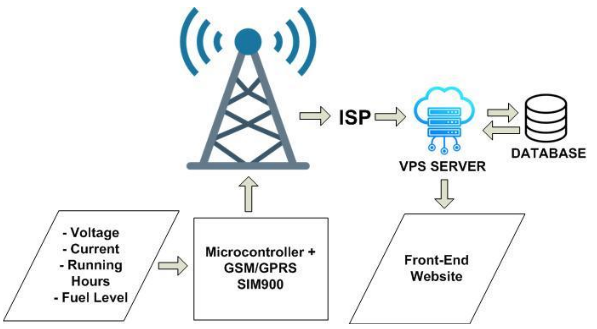

Fig. 2. Architecture of IoT

Microcontroller collects voltage, current, running hours, and fuel level data. GPRS module sends those parameters into a VPS server via GPRS network. In VPS server data will be processed using PHP script and are to be sent into MySQL database along with timestamp. Saved data can be accessed anytime by end-user through website application.

III. Results and Discussions

This system has been tested on 20 KVA diesel generators. Fig. 3. shows power monitoring system installed inside the power house.

Fig. 3. Power Monitoring System Installed Inside the Power House

Power monitoring system presented on this paper is equipped with LCD to ease technician or operator in monitoring generator status. Microcontroller is programmed to detect whether data is sent or not. In case data is sent successfully, LCD will display “NETSEND OK” else system will repeat process until it is successful. As shown in Fig. 3., LCD displays “NETSEND OK” which means data was sent successfully into a web server. To monitor status of the system as well as measured data, user needs to open website application and login prior to use. Login form consists of a username and password and should be inputted correctly. Input data will be compared by those which are saved on the database. If the inputs are not matched, error message will appear and user cannot access the monitoring page. Fig. 4. shows interface of website’s login portal.

Fig. 4. Login Portal of Power Monitoring System

When user inputs login's information correctly, user will be redirected to a monitoring interface.

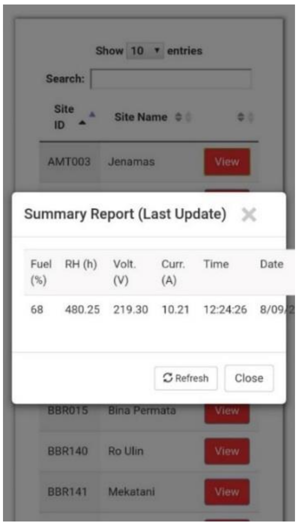

Fig. 5. Website Interface when Generator is ON

As shown in Fig. 5., sensor parameters are displayed along with date and time. These data will be updated periodically whenever database table is updated. Fig. 5. shown that ZMPT101B sensed 220 VAC. In which case, microcontroller would save "ON" state periodically in EEPROM and subsequently increment the running hours. SCT-013-030 detected load current that was drawn by the generator. Fig. 6., Fig. 7., Fig. 8., and Fig. 9. show measured parameters against time when generator is ON.

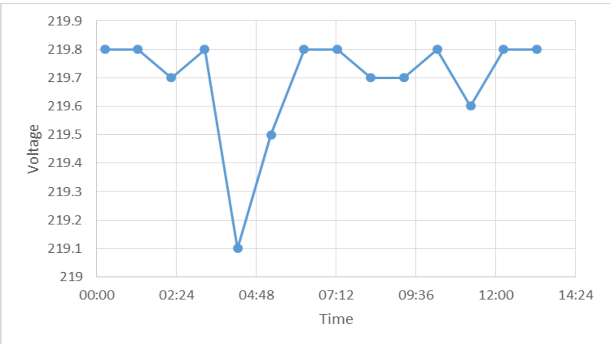

Fig. 6. Graph of Voltage vs Time

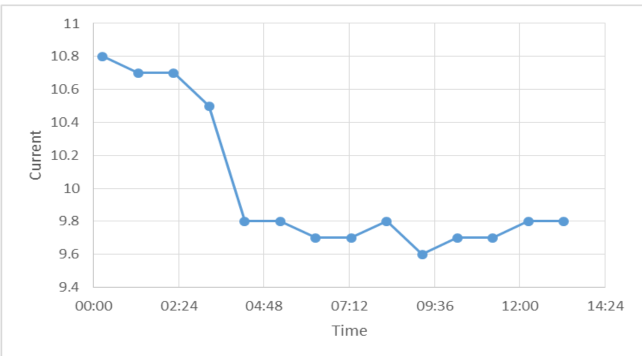

Fig. 7. Graph of Current vs Time

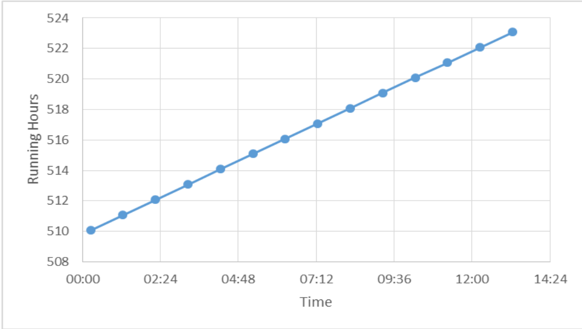

Fig. 8. Graph of Running Hours vs Time

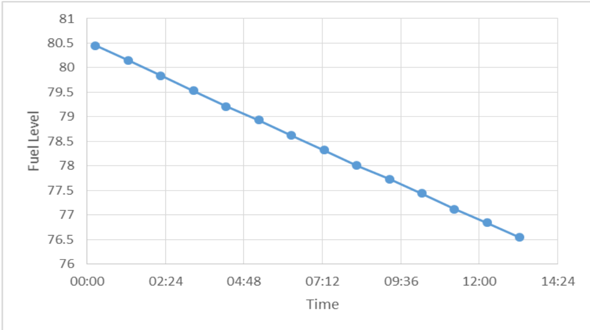

Fig. 9. Graph of Fuel Level vs Time

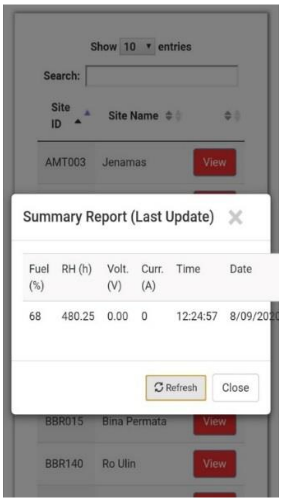

Fig. 10. Website Interface when Generator is OFF

When ZMPT101B did not sense AC voltage or generator state was "OFF" as shown in Fig. 10., microcontroller would send voltage data as "0" in floating-point format. EEPROM would not save anything and it would keep the existing value.

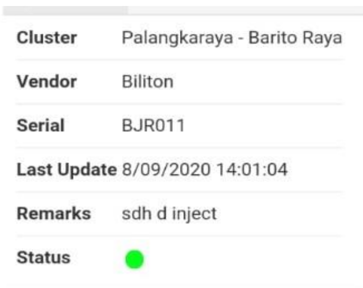

Fig. 11. Online Status of the System

Online status of the system is displayed by a green circle as shown in Fig. 11. by which it indicates that the system was actively sending sensor parameters into a web server. In contrast with that, a red circle is shown in Fig. 12. and indicates that the system was offline. Microcontroller did not send any data into a web server due to signal problem in GPRS module.

Fig. 12. Offline Status of the System

Fig. 13. shows the generators have been connected to this system. It contains information such as id, name, serial number, status, and latest update.

Fig. 13. Information of the Devices

As shown in Fig. 13. every device has different serial numbers. Each serial numbers indicate diesel generators that are connected to power monitoring system. All the parameters such as current, voltage, running hours, and fuel level will be sent to database according to device's serial number. When new parameters are received, database will overwrite previous data and update online status of the system.

IV. Conclusions

The system presented on this paper featured by Arduino Uno, SIM900 GSM/GPRS module, US-100 ultrasonic sensor, ZMPT101B voltage sensor, SCT-013-030 current sensor, and LCD interface. It has been implemented successfully using 20 KVA diesel generators. The results showed that the system could display sensor parameters on the website application. It also displayed running status of generator as well as online or offline status of the system. Moreover, this system helped operator to determine maintenance time appropriately.

For future work, this system can be integrated with a control system by which user can control generator remotely via mobile phone. Besides, abnormality detection can also be added to detect problems in diesel generator.

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