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Design and Construction of Internet of Things (IoT) Based Generator Monitoring System

[1]Oladoyin, A. E
[1]Olaleye, O.O
[1]Ikueyemi D
[1]Adeleke, A.E
[1]Etoh, H
[1]Ogunsola, T
[1]Department of Marine Engineering Maritime Academy of Nigeria Oron, Akwa Ibom State

[2]Adeyi, A.A
[2]Department of Electrical Electronics Engineering, Maritime Academy of Nigeria, Oron, Akwa Ibom State. Nigeria

Abstract:- This project presents an internet of things (IoT) based generator monitoring system of engine performance, stability, oil level and battery level equipped with mobile app control. An Internet of Things is an interconnected system of distinctively addressable physical items with various degrees of processing, sensing, and actuation capabilities that share the ability to interoperate and communicate through the Internet as their joint platform. On board a ship power supply is essential as such even ashore. At shore, generators are manually monitored by site operators and the process of monitoring engine performance are not sufficient enough which has led to frequent engine break down, and excess cost of maintenance. There have been cases of power outage for days and weeks because of unprofessional practices and carelessness of engine operators there by impacting huge loses. This problem has lingered and caused serious concerns. Therefore, this work introduced Wi-Fi enable internet of things (IoT) based remote monitoring process to address the unprofessional practices of engine operators. The system uses Gyroscope sensor, Magnetic field instrument sensor (MGF), MG-Oil quality sensor and DS18B20 for the effective monitoring of the generators parameters being mentioned above. However, low power and low cost microcontroller ESP32 board and i2C module also provide a very flexible pattern for sharing operational data through Wi-Fi. Advance C++ programming language was also used to establish a stable communication cycle. The system transmitter was carefully designed and tested. The result shows that the developed system perfectly starts the generator and monitored the oil level, battery health, stability, engine performance and transmitted the status via wireless connection to the operator's mobile phone. With this, generators can be monitored remotely with a high working efficiency.

Keywords:- *Internet of Things, Mobile App Control, Transmitter, Wi-fi Enabled IoT.*

I. INTRODUCTION

The traditional method of checking generator's working parameters such as determining the fuel level using dipstick or fuel gauge, ascertaining oil and jacket water pressure, and temperature by looking at the gauge do not only take time but also lead to stress of being in the working area at all time. Manual systems like this are prone to incessant failures which may hinder operations because of inadequacy. Although most generator sets now have their operation parameters displayed on a screen for easy access for the person in charge but with the introduction of Internet of things (IoT) based monitoring system, a person may never have to visit the generator room except during maintenance or repair as the system will not only reduce incessant checks and perform the same function but also send the information wirelessly including diagnosis to the operator's device for necessary actions.

However, in engineering or science, the role of internet cannot be overemphasized since most of the work being done revolve around it. The Internet of things (IoT) describes exactly the network of physical objects **-** "things" that are embedded with sensor components, software, and other technologies to connect and exchange data with other devices and systems over the Internet (Emodi et al, 2015). Thus, the main objective of the Internet of Things is to make it possible for objects to be connected with other objects, individuals, at any time or anywhere using any network, path or service. The Internet of Things (IoT) is gradually being regarded as the subsequent phase in the Internet evolution. IoT will make it possible for ordinary devices to be linked to the internet in order to achieve countless disparate goals.

According to (Yusuf, Bedine, Mahmoud, Hani, 2019), estimates of 28 billion IoT devices were connected since the birth of the internet in 1983. This means that there are more IoT devices in the world than there are non-IoT devices. As the internet continues to evolve, it has become more than a simple network of computers, but rather a network of various devices, while IoT serves as a network of various

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"connected" devices (Miraz H. M, Ali M., Excell P.S and Picking R, 2018).

In this dawn of technological age, information can now be shared over the Internet among devices like vehicles, smartphones, cameras, toys, buildings, home appliances, industrial systems and countless others regardless of their sizes and functions, they are capable of accomplishing smart reorganizations, tracing, positioning, control, real-time monitoring and process control. The Internet of Things has components ranging in complexity, from simple identification tags to complex machine-machine communication, cameras, smart watches as well as electronic identification tagging of cargoes (Jeremy, 2013).

The Internet of Things (IoT) is expected to continue expanding its reach as regards the number of devices and functions, which it can run. This is evident from the ambiguity in the expression of "Things" which makes it difficult to outline the ever-growing limits of the IoT. While commercial success continues to materialize, the IoT constantly offers a virtually limitless supply of opportunities, not just in businesses but also in research. Accordingly, the understudy addresses the potential of IoT on generator as a monitoring system.

Generally, generator sets or Genset, both diesel and gasoline fuel, have been widely used both as main or backup power generation or main and auxiliary power supply as regards on-board ships. In Engineering, the working principle of the generator to produce electricity is based on the work of the combustion engine, which generates electric power as the generator rotates. In locations that are unreached by National electricity supply like in ships during voyage, network masts or field area without electricity, generators are used as the primary source of electricity generation. In urban areas, especially in commercial buildings such as banks, shopping malls and so on; generators are used as backup power, when there is no electricity from National electricity supply.

In addition, generators are equipped with electrical indicators, like the output voltage, current and frequency but despite all these, human beings are prone to errors, they may contribute to failures of engines due to delays in response time, inadequate fueling of tanks, inability to spot leakages in tanks and so on (Edem and Ezeofor, 2018). The IoT system will be more efficient in this aspect as it is system of various indicators that give some information about the current performance of the generator or time into the next periodic maintenance. If the generator is used as the main power to support field operations, the generator must be in good condition, so it can be assured that there will be no problem.

Moreover, if the generator set develops fault when it is already under operation, it undoubtedly hinders the work significantly. To solve these problems, a monitoring system of generator operation is needed. The system can record the historical data of the generator parameters, starting from the measurement of fuel level, engine temperature and also total energy (kWh) generated. The measurement data can then be used for offline analysis of the performance condition of the generator or to determine the length of time to the next periodic maintenance. Furthermore, if there are more recording of data or parameters of operation of the generator set, it can be used for failure analysis and this give rise to this project.

Therefore, this project is stipulated to tackle the problem of generator set failure during operation due to delay in response by the person in charge of running physical checks on the generator set and to prevent corrective maintenance and poor use of generator set which contributes to continual repair and also limit physical checkup of the system especially when the generator set is installed in a tight space or contaminated with poisonous fumes or gases.

This project will develop an operation monitoring system of the generator set by measuring several generator operating parameters such as fuel level, temperature and output power. So that the performance of the generator can be analyzed to determine if it is still following the operating standards or there is a decline in performance.

➢ *The aim of this project is to design and construct an internet of things-based generator monitoring system. The objectives of this project are:*

- To design and construct an IoT-based generator monitoring system using Gyroscope sensor, Magnetic field instrument sensor (MGF), MG-Oil quality sensor, DS18B20 for the effective monitoring of the generators.
- To develop a modern controlling system in a generator engine that will use sophisticated communication modules, such as low cost highly efficient ESP32 board and i2C module which will provide a very flexible pattern of use by sharing operational data through Wi-Fi.
- To make use of advance C++ programming language so as to establish a stable communication cycle.

II. HISTORY OF INTERNET OF THINGS (IOT)

The term "internet of things' also known as "cyber-physical systems" at the macro level, was first coined by Kevin Ashton in his presentation made to Procter and Gamble (P&G) in 1999 (Kevin, 2009). Kevin was working in Massachusetts' Institute of Technology (MIT) AutoID Laboratory to improve P&G business by linking its supply chain with Radio-Frequency Identification (RFID) information to the internet (Yusuf, Bedine, Mahmoud, Hani, 2019). Internet of things extensively, is a system consisting of networks of actuators, sensors, and smart objects whose purpose is to interconnect 'all' things, including day-to-day and industrial objects, in such a way as to make them intelligent, programmable, and more competent of interacting with humans and each other. (Institute of Electrical and Electronics Engineers Standards Association (IEEE-SA), 2015). The concept of IoT is not new. Because programable Logic Controller (PLC) in 1970s is a micro-

ISSN No:-2456-2165

model of the IoT system that was widely used to control machines and processes within a factory. A PLC consists of output (example for digital or analog data), inputs (examples for sensors, actuators, and on & off switches), Central Processing Unit (CPU), and communication between components. The PLC systems were within a factory, not connected to the internet and cloud. There is no unique definition available for IoT that is admissible by the world community of users. The optimal definition for the IoT would be an open and comprehensive networks of intelligent objects that have the capacity to auto organize, share information, data and transformation in the environment". The internet of things has components that range in complexity, from simple identification tags to complex machine-to-machine communication, cameras and radio frequency identification tagging of shipments in the supply chain are examples (Jeremy, 2013).

➢ *Review of Related Works*

Several studies related to the development of a fuel monitoring system have been carried out, among others. The ESP-8266 control module, which has Wi-Fi communication facilities and ease of making internet connections, was used. The system built was intended to monitor the condition of the fuel level and operation status of the generator, whether it is in an on or off condition. The test results obtained from the design is to get a system that provides continuous data to the operation of the generator and to provide ease of delivery and displaying of data of all the activities of the system as a whole through the internet (Firdaus., Murti and Nugraha, 2017).

Obikoya (2014) developed a fuel level monitoring system. In his study, the measurement of the fuel level used a resistance method from the fuel float sensor. However, (Edem and Ezeofor, 2018) also researched on the development of a generator fuel monitoring system and battery level using Global System for Mobile Communications GSM infrastructure. In this study, the Atmega328 microcontroller is used as a controller and the HC-SR04 sensor as a level gauge, through ultrasonic method. The monitoring system sends information related to fuel and battery level conditions of the generator using the SMS feature via the AT command.

(Ghulam, Syed, Shoaib, Muhammed, Muhammad and Abdul, 2021) Proposed architecture-based on an IoT solution-consists of different sensors, namely a current transformer for measuring load, fuel gauge for fuel level monitoring and temperature measurement with the energy module to determine the power factor of the system. The Arduino Mega controller and ESP 8266 Module for sending data to the i-cloud were used.

Several other studies have shown that the development of a generator operation monitoring system is used to conduct maintenance planning based on running time to detect damage of the generator by analyzing the quality of the generated power, detect the generator failure based on measurements of working temperature and generator oil level. (Boopathi, Jagadeeshraja, Manivannan, Dhanasu and Smart, 2015) developed a smart generator monitoring system using micro-controller and relay to detect the power failure, communicate to microcontroller which makes decision and finally alert the authorized person which enable the observer to keep track of the system and address any problem that arise.

In the field of agriculture, a based monitoring and controlling system to gather information on the farmland such as humidity and luminance so as to guide the farmers on their farming activities was designed by (BulliBabu, Jonathan, Cherishma, Lakshmi and Keshav, 2015)

Mohammad, Musse, Bishwajeet, Hardik, Shayla and Izzul (2021) worked on the internet of things based smart electricity monitoring and control system using usage data. Their work presented an integration of both hardware and software. The software is used to monitor power usage and the consumption of household appliances and control system through overcurrent relay and notification of any mis-matches. The developed systems consist of Arduino UNO, a WiFi module (ESP8266), a relay, a low current sensor breakout (ACS712), and a liquid crystal display (LCD). The proposed system displayed the voltage, current, and power consumption where the web or mobile application is used to visualize the data and trigger alarm, when necessary. They were able to measure overcurrent or circuit overloading earlier based on advanced IoT applications where consumers' alarm triggers.

In their system configuration, "Thing- Speak", an open source IoT application was used to store and retrieve data via Hypertext Transfer Protocol (HTTP) over the internet or Local Area Network (LAN). Their work explains the compatibility of Thin-Speaks with the ESP8266 Wi-Fi module for analysis and storage of data from the sensor based on IoT.

Hyun, Ryu and Jun, (2016) designed and constructed a smart emergency generator monitoring system through IoT using IEC 61850 to provide emergency generator status to the user. The IEC 61850 gateways receive the data from sensors (temperature, pressure, fuel flow) in the emergency generator. The hardware of the system includes 4 to 20mA sensors, Controller, IEC 61850 gateway which has ARM Cortex M5 series 500MHz CPU, 512MB Ram, Flash memory, it supported IEC 61840 Group 1 MMS protocol and RS 485 based 2 Channel communications (Half Duplex Mode) and an Ethernet Modem wireless router is used for LAN connection that supports 4G LTE gateway and 802.11b/g/n standard. In further researches, Jawad et.al (2020) designed and operation and fault monitoring system of electric generator using IoT. Aduino controller board, ADC converter, esp8266Wifi module were used. The instruction was programmed using IDE (Integrated Development Environment).

Based on this review, the project will focus on IoT based generator monitoring system which is software and hardware based, providing ease in the operation and monitoring of generators. The operating information will be

ISSN No:-2456-2165

shared over Wi-Fi connection. The user will be provided with a mobile application installed in a smartphone which will always display a simulation of the generator's internal combustion, engine performance graph, engine temperature, fuel consumption, engine frequency, total energy produced, voltage and current bar. An amazing feature is its ability to turn ON and switch OFF the genset remotely through the mobile application, whenever the generator develops an issue, an alarm will be sent to the user through the Wi-Fi which covers the range of 500m from the generator, indicating areas of error and corrective measures. This offers a user-friendly and flexible mode of operation.

Moreover, operating history of the generator will be saved in the phone application for references, which will be useful during surveys in case of sales, repairs, and maintenance as well as to ascertain possible deviation from the historical pattern of operation.

III. MATERIALS

The device being used consists of active and passive electronic components, coupled with a microcontroller system and a few sensors, which are further, systematize to provide a real-time status of an engine using internet communication.

A. The Materials Selected for this Project Work:

- ESP32 board
- i2C module
- Boost converter module
- 3.7v lithium battery
- Gyroscope sensor
- DS18b sensor
- MGF sensor
- MG-Oil quality sensor
- HC-SRO4 Ultrasonic Sensor
- Buzzer
- Resistors
- Capacitors
- 12v relays

B. This is Grouped into the following:

- Power Supply Module
- 2430 watts single phase Gasoline Generator set
- Sensor Module
- System Control Module
- Wi-Fi Module
- System Display Module

C. Each Module is Explained below Including how they Interact to Achieve the Desired System Objectives for More Understanding:

➢ *Power Supply Module:*

The +3.7v Lithium battery direct current (DC) power supply for the system was designed based on the voltage required to power each component as specified in the manufacturer's data book. Transformer was used to step down the 240V alternating current (AC) mains voltage of the genset to about 12V AC. The rectifying diodes were used to converts the AC voltage to DC voltage. Electrolytic capacitor of 1000µF/35V was used to filter ripples and regulator of 7805 used to capture exactly +5V DC needed.

➢ *Generator Engine*

In this study, a Single phase 2430watts Firman Gasoline generator is monitored with a special transducer installed on it, to generate the electrical characteristics as well as the signal which will further be analyzed using microcontroller.

Fig 1 3-Dimensional Design of the Generator set.

The various parameters being monitored on the generator are features which contribute to the optimal functioning of the system.

- *Generator Output*

This part of the assembly incorporates the alternating current line which is fed to the house or for use. The lines are connected in a way such that the automatic changeover system will properly switch into available lines once the generator is running.

- *Automatic Changeover*

This is a simple electronic gadget that provides an automatic switch over between the gridline and generator or the switch inverter.

➢ *Sensor Module*

In order to monitor the vital health statues of a generator, various physical and electrical parameters are needed to be monitored which will be compared to their quantity in order to adequately state the health statues of an engine system.

ISSN No:-2456-2165

These Parameters Include;

- *Physical Quantity:*

✓ Temperature
✓ Fuel level
✓ Oil quality
✓ Gyration /acceleration

- *Electrical Quantity*

✓ Voltage
✓ Current
✓ Running frequency
✓ Power/energy

These and many more parameters, which are so essential that once we can easily measure them correctly, we can actually state using a well refine predative analysis to state the health statues of the generator.

To monitor these given quantities, we are using these set out sensors.

- *Digital Temperature Sensor (DS18B20):*

This is 1-Wire digital temperature sensor from Maxim IC. Reports degrees in Celsius with 9 to 12-bit precision, from -55 to 125 (+/-0.5). Each sensor has a unique 64-Bit Serial number etched into it - allows for a huge number of sensors to be used on one data bus.

Fig 2 Digital Temperature Sensor (DS18B20)
(Source: Pinterest.com).

- *Fuel Level Sensor (HC-SRO4 Ultrasonic Distance Sensor):*

This is a distance sensor incorporated in the monitoring system of this project to monitor fuel level as it can report the range of objects from 2cm to 400cm (about an inch to 13 feet) away. It can operate using a low power (suitable for battery operated devices), affordable, easy to interface and extremely popular with Arduino. The sensor is composed of two ultrasonic transducers. One is transmitter which outputs ultrasonic sound pulses and the other is receiver which listens for reflected waves.

Fig 3 Pinout of the HC-SRO4 Sensor

Table 1 Main Specifications of the HC-SRO4 Ultrasonic distance sensor

Parameter	Value
Operating Voltage	5V DC
Operating Current	15mA
Min. Range	2.54cm/1 inch
Max Range	400cm/13 feet
Operating frequency	40 kHz
Accuracy	3mm
Measuring Angle	<15°
Dimension	45 x 20 x 15mm

- *Gyroscope Sensor (MPU6050):*

The project is designed to showcase at all times, the angle of rotation of the generator's crankshaft. MPU6050 sensor module with complete 6-axis Motion Tracking Device were used. It combines 3-axis Gyroscope, 3-axis accelerometer and digital motion processor, all in a small package. It also has additional features of on-chip Temperature sensor and I2C bus interface to communicate with the microcontrollers. If 3-axis Magnetometer is connected to auxiliary I2C bus, then MPU6050 can provide complete 9-axis Motion Fusion output.

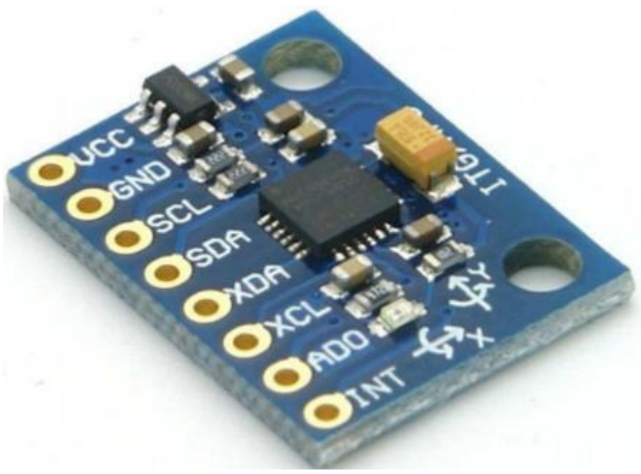

Fig 4 MPU6050 Sensor
(Source: GY-521 Accelerometer Gyroscope Module. (eitkw.com))

ISSN No:-2456-2165

The MPU6050 consist of 3-axis Gyroscope with Micro Electro Mechanical System (MEMS) technology. It is used to detect rotational velocity along the X, Y, Z axes as shown in below figure.

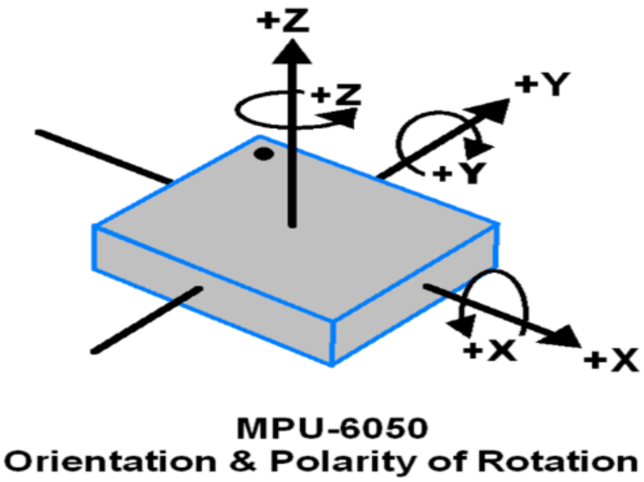

Fig 5 Rotational velocity along the X, Y, Z axes.
Source: Sensors Modules Mpu6050 Gyroscope Accelerometer Temperature Sensor (electronicwings.com)

- ✓ When the gyros are rotated about any of the sense axes, the Coriolis effect causes a vibration that is detected by a MEM inside MPU6050.
- ✓ The resulting signal is amplified, demodulated, and filtered to produce a voltage that is proportional to the angular rate.
- ✓ This voltage is digitized using 16-bit ADC to sample each axis.
- ✓ The full-scale ranges of output are +/- 250, +/- 500, +/- 1000, +/- 2000.
- ✓ This measures the angular velocity along each axis in degree per second unit.
- ✓ The MPU6050 consist 3-axis Accelerometer with Micro Electro Mechanical (MEMs) technology. It was used to detect angle of tilt or inclination along the X, Y and Z axes as shown in the figure below:

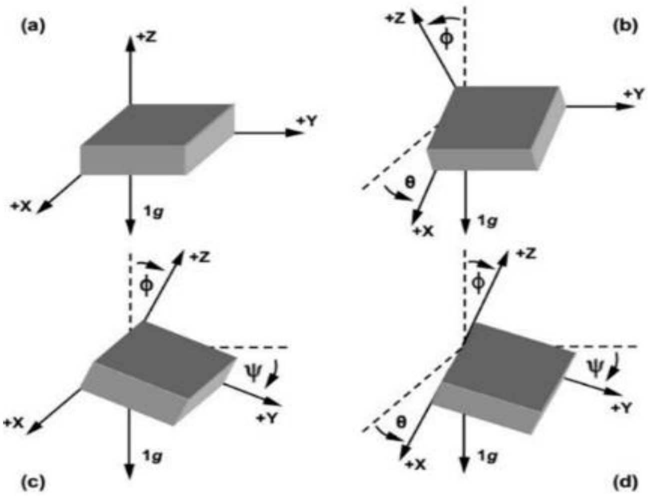

Fig 6 Angle of inclination along X, Y and Z axes for the 3-axes accelerometer.
(Source: MPU6050 (Gyroscope + Accelerometer + Temperature) Sensor Module |... (electronicwings.com).

Acceleration along the axes deflects the movable mass.

This displacement of moving plate (mass) unbalances the differential capacitor which results in sensor output. Output amplitude is proportional to acceleration.

16-bit ADC is used to get digitized output.

The full-scale ranges of acceleration are +/- 2g, +/- 4g, +/- 8g, +/- 16g.

When the device is placed on a flat surface it will measure 0g on X and Y axis and +1g on Z axis.

- *MG-Oil Quality Sensor (OQS):*

The sensor is a live, highly flexible, and cost-effective condition-based monitoring solution, designed to be permanently installed within any lubrication system on any type of machine. Over 60 times more sensitive to oil contamination than any other dielectric constant measuring sensor, it provides real-time monitoring of water ingress and oxidation levels.

- *Electrical Sensor (PZEM-004T) Multifunction Power Monitoring*:

The PZEM-004T circuit is used for measuring AC Root Mean Square (RMS) voltage, current and power (single phase). The unit easily interfaces with Arduino and other hardware using the code. The circuit comes with a TTL to USB adapter wire for easy connection to a computer or microcontroller.


Fig 7 PZEM-004T Multifunction Power Monitoring
(Source: AC Multifunction Meter Watt Power Volt Amp Current Test Module PZEM-004T New | eBay)

- *Specifications:*

- ✓ Working voltage: 80 ~ 260VAC
- ✓ Test Voltage: 80 ~ 260VAC
- ✓ Rated power: 100A / 22000W
- ✓ Operating frequency: 45-65Hz
- ✓ Measurement accuracy: 1.0.

This module serves all these basic requirements of measurement PZEM-004T as a separate board. The physical dimensions of the PZEM-004T board is 3.1×7.4 cm. The PZEM-004T module is bundled with 33mm diameter current transformer coil.

The main part of the PZEM-004T module is the SD3004 chip from the SDIC Microelectronics Co., Ltd. In addition, the board having the EEPROM from Atmel (now microchip) 24C02C which is a 2K bit Serial Electrically Erasable PROM with a voltage range of 4.5V to 5.5V with More than 1 million Erase/Write Cycles and 200+ Years Data Retention.

➢ *System Control Module (ESP32 Microcontroller):*
ESP32 is in the series of low power and low cost chip microcontroller. It comes up with already integrated dual mode Bluetooth and Wi-Fi. It is especially aimed to provide versatility, robustness and reliability in a large number of applications. Some applications in which this microcontroller is extensively used are MP3 decoding, voice encoding and music streaming. Best RF and power performance can be easily achieved using this microcontroller. ESP32 comes up with a USB port so we can say that it is plug and play devices i.e. plug in cable and your device is turned on and you are able to program it just like Arduino development boards.

Fig 8 ESP32 Microcontroller
(Source: Esp32 Esp-wroom-32 Esp32 Esp-32s Development Board Wi-fi Bluetooth Ultra-low Power Consumption Dual Cores Esp32 Board - Integrated Circuits - AliExpress)

Table 2 Specification of ESP32 Microcontroller

Component	Value
Number cores	2 (dual core)
Wi-Fi	2.4 GHz up to 150 Mbits/s
Bluetooth	BLE (Bluetooth Low Energy) and legacy Bluetooth
Architecture	32 bits
Clock frequency	up to 240 MHz
RAM	512 KB
Pins	30 or 36 (depends on the model)
Peripherals	Capacitive touch, ADC (analog to digital converter, DAC (digital to analog converter), I2C (Inter-Integrated Circuit), UART (universal asynchronous receiver/transmitter), CAN 2.0 (Controller Area Network), SPI (Serial Peripheral Interface), I2S (Integrated Inter-IC Sound), RMII (Reduced Media-Independent Interface), PWM (Pulse Width Modulation), and more.

The ESP32 board was programmed using Arduino IDE

➢ *System Display Module* (i2C module **(16 x 2 LCD)):**
A 16 x 2 LCD is used by the system to display the parameters being measured, some in percentage as it operates. Each character is displayed in 5x7 pixel matrix as the data is sent from the microcontroller.

➢ *System Design:*
In this design, the building block or working principle of the system is evidently presented using a simple block diagram below.

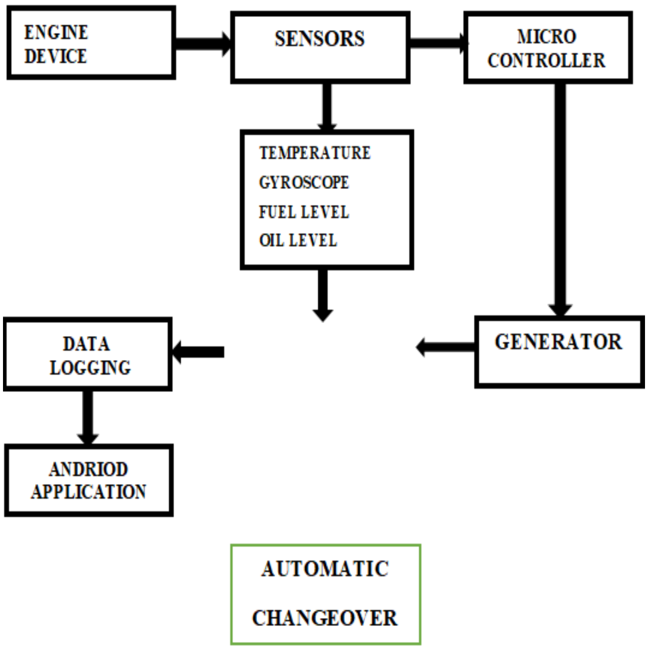

Fig 9 Block Diagram of the System

Figure 9 is further elaborated using the simple circuit diagram presented below.

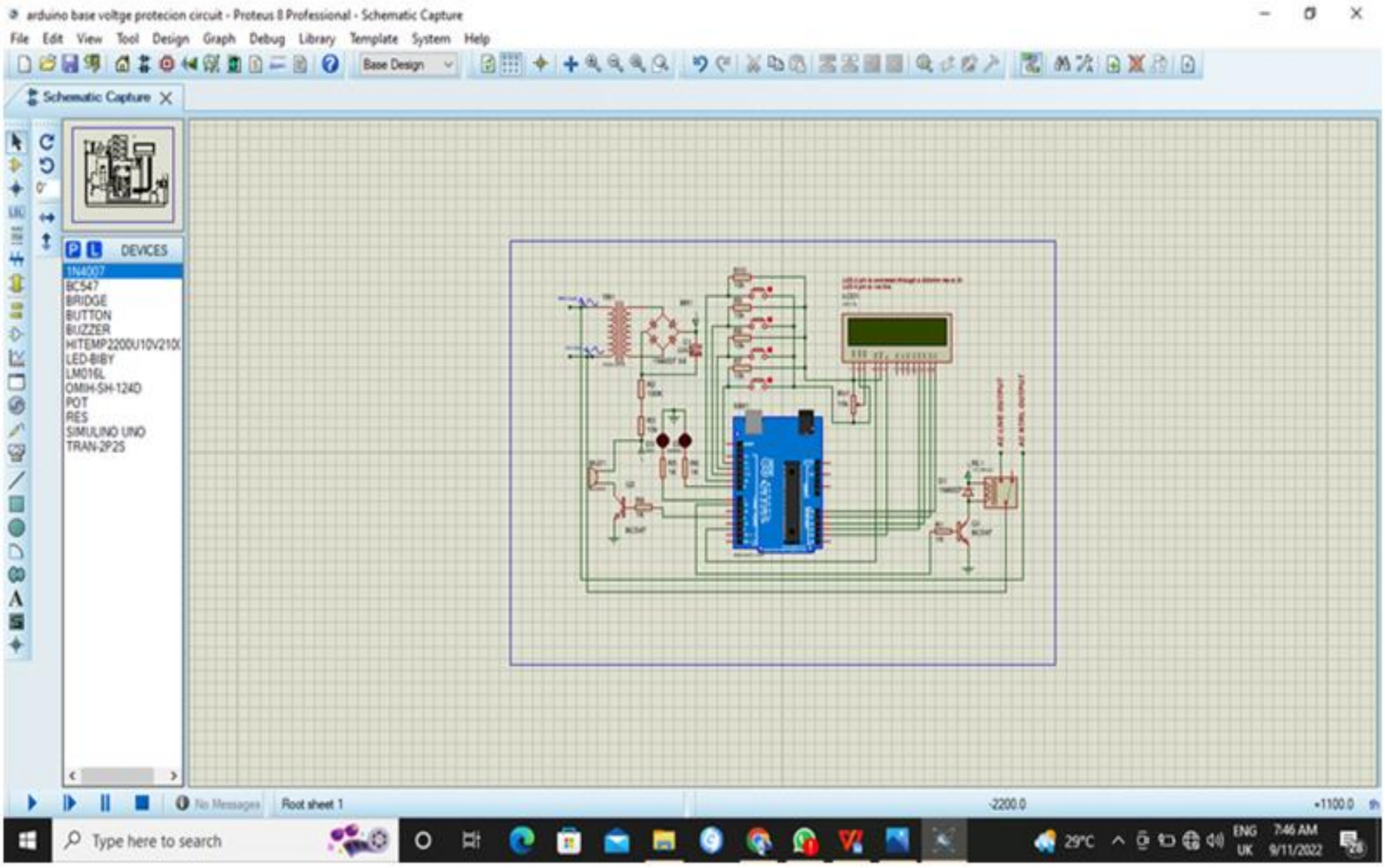

Fig 10 The Circuit Diagram

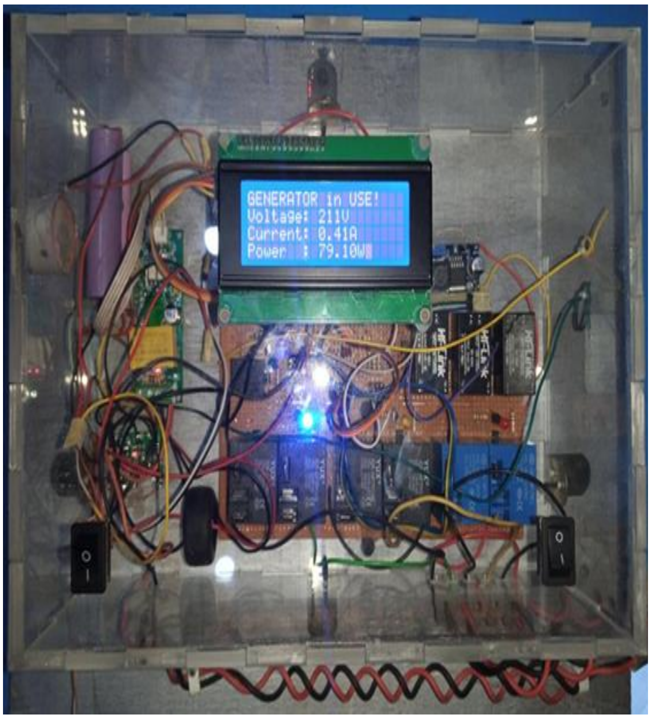

Fig 11 The interface of the designed Monitoring System

In the design process, all the sensors are embedded to the micro controller via its pin, as all the data are processed and analyzed for use as shown in Figure 12:

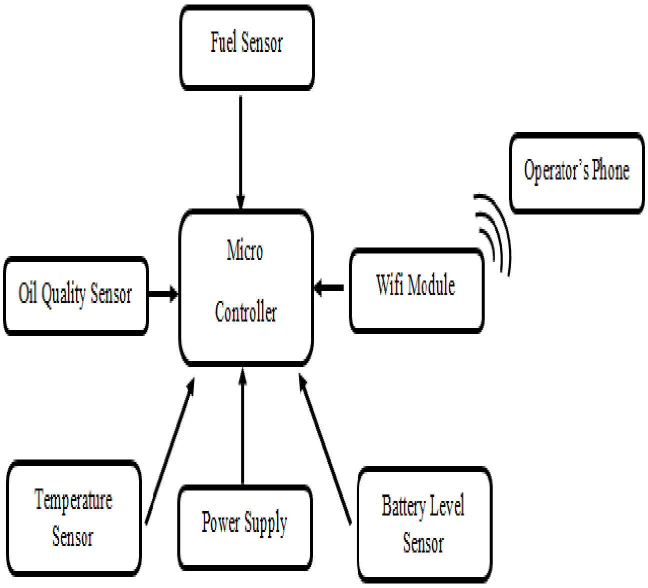

Fig 12Microcontroller Interactions with the Sensors

➢ *Software Component*

The software aspect of this project involves application development with friendly user interface using the advanced C++ for compiling set of commands necessary for the smooth operation of the monitoring system, used also as the system Algorithm for the microcontroller.

ISSN No:-2456-2165

➢ *Data Logging:*

Blynk is an IoT platform for iOS or Android smartphones that is used to control Arduino, Raspberry Pi and Node MCU via the Internet. This application is used to create a graphical interface or human machine interface (HMI) by compiling and providing the appropriate address on the available widgets.

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, store data, visualize and so on.

➢ *Android Application:*

With Blynk, you can create smartphone applications that allow you to easily interact with microcontrollers or even full computers such as the Raspberry Pi.

IV. SYSTEM SETUP

➢ *At the Completion of the Project Design and Construction, there were Two Independently Addressable Systems which are:*

- *Mechanical System and*
- *Electrical System*

- *Mechanical System*

This system was responsible for measuring and sharing the mechanical parameters of the single phase 2430 watts gasoline generator. These parameters are oil level, oil quality, gyroscopic orientation and running temperature.

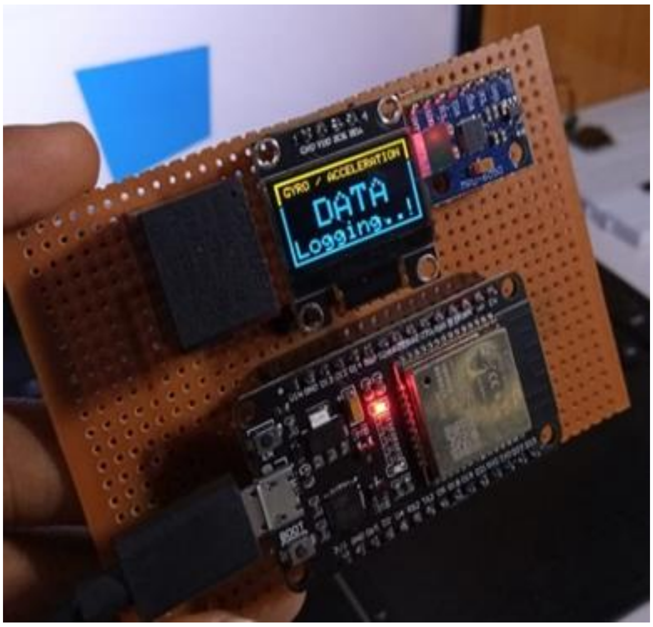

Fig 13 The Mechanical system loading for wi-fi connection during testing (Source: Author's work, 2022)

- *Electrical System*

The electrical system was responsible for measuring and sharing the electrical parameters of the single phase 2430 watts gasoline generator. These parameters are frequency, voltage, current, energy consumed, battery voltage and running hour. This system also served as an automatic change-over as it is fitted with inputs for generator, national grid supply for domestic consumption and solar panel with national grid supply as the primary reference. These two systems worked independently while their data were uploaded to the cloud through Wi-Fi and shared to the phone application via the same network.

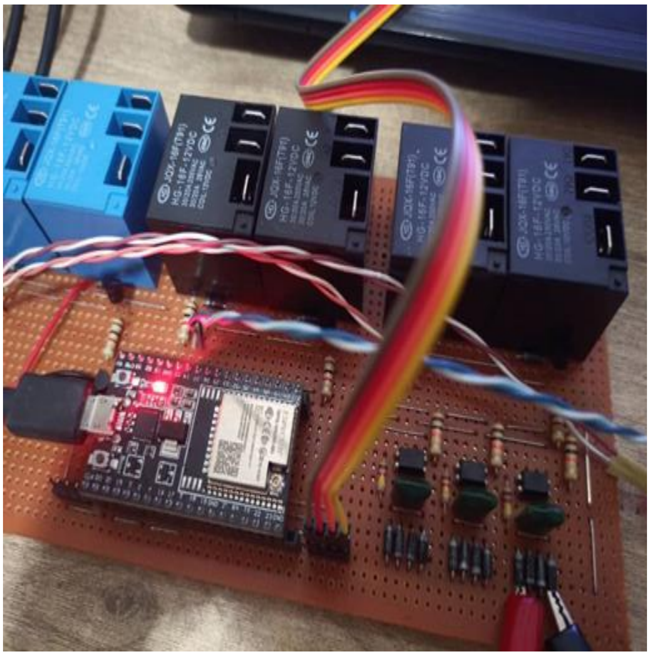

Fig 14 The Electrical System Circuit Board Plugged for Testing

Fig 15 The Gyroscope Sensor Showing the Position of the Generator Set During Testing

ISSN No:-2456-2165

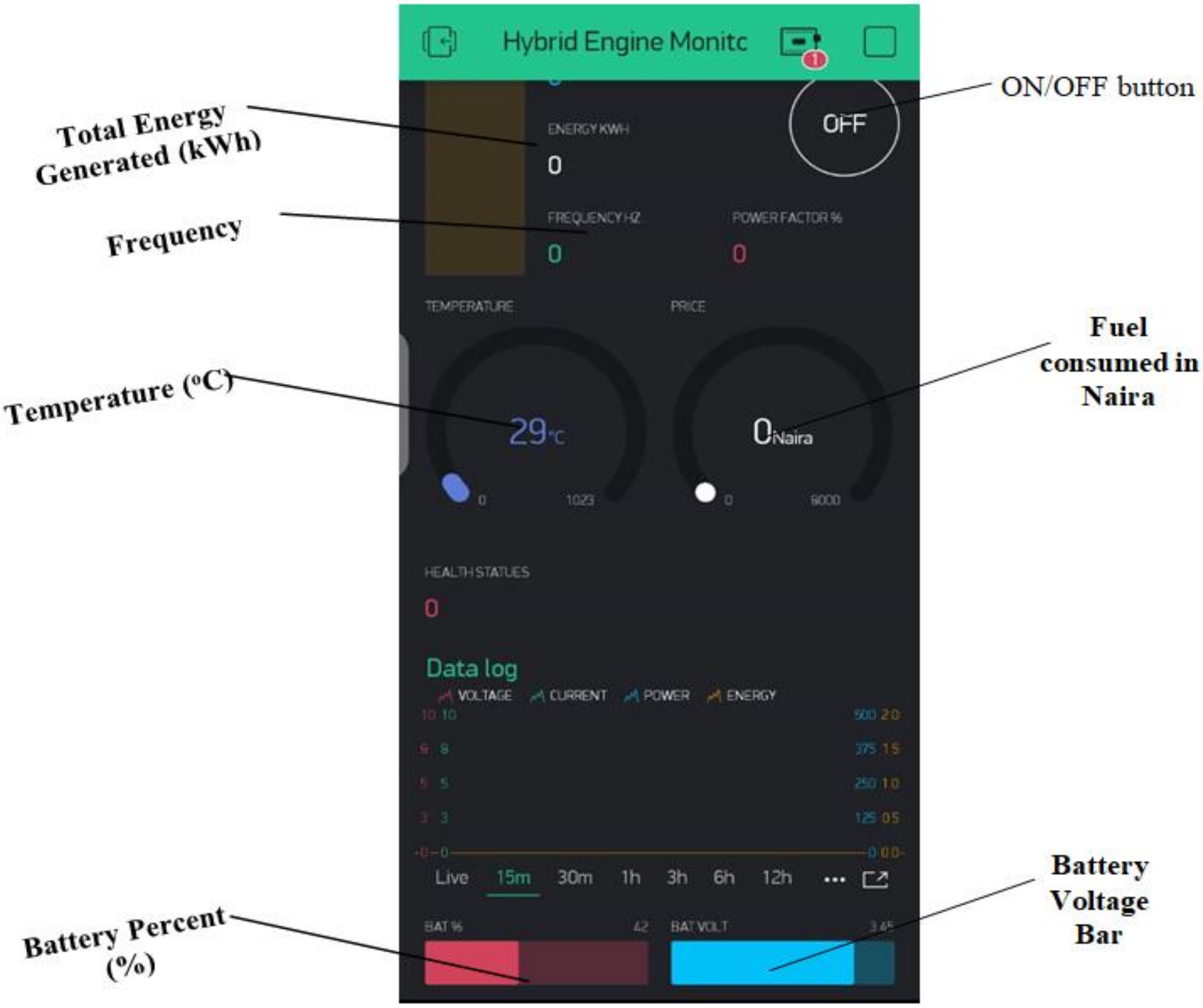

Fig 16 The Phone Application Interface before Testing

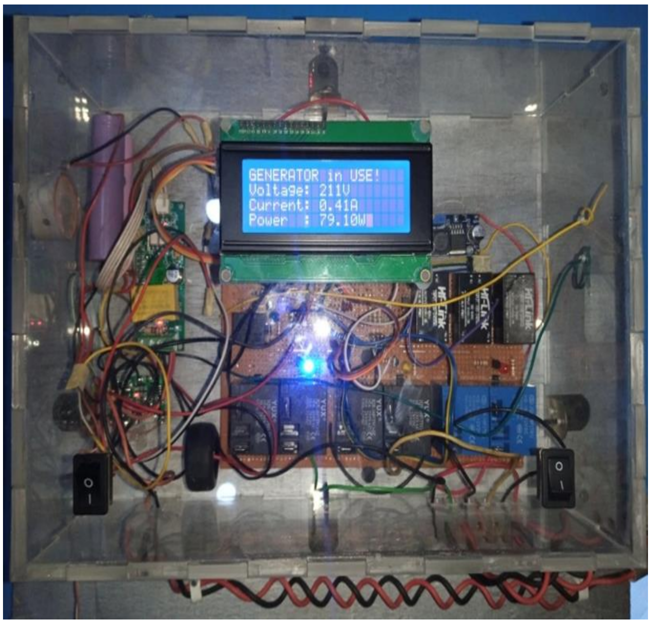

Fig 17 FThe Electrical System Circuit LCD Board Displaying Generator Operating Volts, Current and Power

V. RESULT AND DISCUSSION

The monitoring system was installed, turned on and tested. The application was installed on a smartphone and the Wi-Fi connection was established using ESP BOARD as the network name and esp12345 as the password immediately after which the internet connection was established between the system and the phone. The generator set was turned on from the smartphone and the intended measurable working parameters were clearly displayed on the mobile application while the buzzers, sensors, and modules interact efficiently, sending the right information for necessary action as expected without any discrepancy. The result was completely a successful one as the system was able to prove its efficiency. The time interval in switching the generator and the grid lines by the system was completely exceptional, due to the fact that its interval is not up to a second, rather in mili second without interruption.

The simulation of the IoT based generator monitoring system with mobile phone application was done to showcase the performance of the system. The parameters were monitored by reading the voltage variations in the generator set, mapped in digital form using the necessary sensors and modules where applicable. The data is sent to the microcontroller which processed it and sent it to the mobile application in discrete values.

VI. CONCLUSION

This project showed that management cannot be achieved without measuring, and measuring can only be achieved by monitoring. For ship managers, malls owner and other industrialist who want to keep a close eye on their generators, the internet of things (IoT) based generator monitoring system is a dream come true. This project reduces stress, decreases maintenance costs, and reduces the frequency and severity of breakdowns. It will enable site engineers to focus on other core tasks or sit back and monitor through their phones while taking actions only when required.

In simple terms, this project of internet of things connects physical objects to a network. Ashore, IoT devices can include smart light bulbs, moisture sensors to water your plants, and a growing range of health-tracking gadgets. IoT blurs the line between physical and digital objects by connecting the physical and digital worlds. By providing a continuous stream of data, IoT unlocks the power of big data, artificial intelligence (AI) and machine learning (ML).

This project thrived through a lot of limitations some of which still remained as constraints but these can be conquered.

RECOMMENDATION

The technological advancement of this era gave birth to this project but the limitations we had prevented us from unlocking its full potential. The initial plan for this project was to develop a monitoring system for a wide variety of marine diesel engine as applicable onboard vessel. Due to the global inflation, there is hike in prices of components and other materials which could have been used to fulfil the intended target but now limited the project to only the 2430watts single phase gasoline engine. This project can be upgraded to an impressive extent suitable for onboard application in the Nigeria Shipping industry and in the monitoring of generators in industries for efficiency, as it has been observed that so much is being spent on the repairs and maintenance of the gensets yet the output is poor as evident in the epileptic power supply that has crippled business in Nigeria.

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