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Real Time Monitoring and Control of Electrical Diesel Generator through Internet of Things

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Abstract- **The advancement in the Internet of Things (IoT) has made an application in all areas. Presently, IoT is causing ripples in the automation of devices. The rampant energy crisis made it necessary to control alternative electricity sources such as electrical generators. An electrical generator is a piece of handy equipment when it comes to power shortages. They are reliable but require human intervention to keep them from opportunity to time. The framework presented in this work changes the manual Monitoring of generators to auto-monitoring. An embedded system monitors various activities when the generator is up and running, including status and alarms for multiple scenarios. This paper addresses issues recently raised that only hint at greater challenges in this domain. To make things easier to handle in operating and Monitoring of generator, an IoT-based android application is designed that provides status update information about the generator when it is operational. The embedded system uses sensors that provide up-to-date information on fuel, oil, temperature, flow, and voltage and delivers that information to the person responsible for handling these issues. The embedded system is based on a small, scaled Arduino controller, which generates results in its propelled condition and then sends the information to an android device to monitor the generator status in real-time.**

Index Terms-- **Automation, Electrical generators, Internet of Things (IoT), Monitoring and controlling**

I. INTRODUCTION

Electrical generators are used in various domains where an uninterrupted power supply is needed. With the importance of the usage of generators, the issues faced by the generator operators and business owners are fuel burglary, fire alarm, temperature, oil and fuel threshold levels, voltage and current, etc. [1] The network of the Internet of Things (IoT) is termed as the complex network of environment, the interconnectivity of the IoT components and the number of networks [2], [3]. IoT-based solutions are gaining popularity, and some of the popular application domains are healthcare, including patient care, fitness care, home automation, and environmental Monitoring [4], [5]. IoT applications are gaining popularity due to their availability, ubiquitous nature, connectivity, and role in real-time decision-making [6].

Electrical generators are the principal components of businesses, and they play a vital role in financial growth [7]. Since the past holds the plan for the 21st century, innovative reliance is to a great degree significant. Observing this generator is a substantial and vital issue that each processing plant must consider [8]. The electrical generator is an important organ in the life of people in developing countries, where power resources are scarce [9]. They not only fulfill industrial needs but, in some situations, are used for domestic needs [10], [11]. With the demand and importance generators play in the economy and people's life in any region, proper maintenance and management are necessary. The major concerns in the improvement are remote Monitoring of the fuel tank, overall load, and generator battery voltage [12]. With the availability of technology and the demands of the industrial and financial sector, it is crucial to monitor the generator's status while in use. That not only reliably and precisely provides real-time data of the machine but also reports if it experiences any fault, which helps take corrective measures at the earliest [13].

Because effective online Monitoring can help prevent unforeseen trips and maximize outages [14]. A solution is demonstrated by creating an Android application that evaluates the generator's live state and captures fuel level data, temperature, current, and voltage esteems [15]. The system is divided into two sections, hardware and software. The software module optimizes the data and errors in the hardware component and provides information to the mobile device via Esp. The system's sensors are required to carry out our projections. The software uses a programmed PIC controller to compare the data values and notifies the appropriate party via IoT. The hardware comprises a diesel generator, relay, current transformer, and potential transformer. The PIC controller establishes sensors for each electrical parameter and instantly displays the generator's status [16]. The principal challenges in operating the generator can be minimized by implementing a Microcontroller with a programmable chip. This system becomes invaluable when power outages, interruptions in power supply, and other issues arise. Sensors and other measurement tools can offer useful data about the operation of the machine. The vital factors that need to be constantly checked can be sensed using a variety of sensors. To prevent damage to the load in the event of a malfunction, a delayed circuit is utilized to trip the process on supply to the load. All streaming data from the generator is sent to an electronic device via messaging services thanks to GSM, a delayed circuit, and a designated individual will handle the information. The system uses remotely controlled benefits to provide a solution to a complex wired network.

Additionally, suppose the controller detects a fault. In that case, an alarm is immediately sent to the staff member's mobile phone, allowing them to act quickly to fix the issue and keep the generator running steadily. Finally, an alert framework is also built that warns the person in control if any of the qualities are exceeded as far as possible. This program can remotely turn ON/OFF the generator through an Android mobile. This undertaking is another application in the space of installing different frameworks, going for the progression, and commitment to the innovative world present, and lastly, giving a brilliant and inventive arrangement that can help and start a lift the field of remote observing. The main goal of the suggested system is to track power usage at the device level, upload data to a server, and manage equipment remotely. Using a home energy monitoring website, the energy monitoring system computes and shows the power usage of various electrical devices.

The structure of the paper is as follows, section II gives a literature review, the methodology is elaborated in section III, results in section IV results, and section V concludes the paper.

II. LITERATURE REVIEW

The author in [17] shows how to design and build an energy meter using an Arduino microcontroller that can track any electrical device's power consumption. An Automatic Power Factor Correction (APFC) Unit is described in [18], which can automatically monitor a system's energy consumption and optimize its power factor. The APFC device evaluates the reactive power consumed by a system's inductive load and uses capacitance from a capacitor bank to adjust for the trailing power factor. [19] represents the working of a smart energy system that controls and monitors the electricity through RaspberryPi. The system lets the user control the electricity usage hence, optimizing the use of electricity.

The authors of [20] used an Arduino microcontroller and a GSM (Global System for Mobile Communication) module to extend the design and execution of an energy monitoring system to incorporate power agenda pre-indication. Through an Android application, the monitoring system allows users to keep track of their expenses and electricity usage. They use an Arduino microcontroller, ZMPT101B voltage sensor, ACS712 current sensor, and NodeMCU. The authors of [21] designed and built a prototype with the basic function of Monitoring and managing the use of IoT-based electronic devices via the internet, where electricity consumption data is stored in the Firebase real-time database (V3). [22] combines the Internet of Things (IoT) with XBee to create a hardware and software solution. It combines a scalable and flexible platform with XBee technology and a built protocol for data sharing across the four modules that make up the system to allow remote Monitoring of electricity consumption in a home.

A system is proposed in [23] which controls and monitors the generator. The generator is controlled through an android application. The data is converted through an Arduino microcontroller, giving the user optimal comfort. In [24], a generator is proposed, controlled by a mobile phone. The system allows users to control and monitor the generator through Dual Tone Multi-Frequency (DTMF) technology. Authors in [25] have proposed a system that monitors the fuel level of an electric generator by IoT. The system uses Arduino controller ATMEGA328 to send the gathered information to the user over the internet. An IoT-based method is proposed in [26] to solve the existing issues in a diesel generator. The system aims to resolve the problems of quality management and Monitoring.

III. METHODOLOGY

In this section, the methodology of the system is discussed comprehensively. Various sensors are used in the implementation. These sensors are interconnected for better performance. Then, they are connected to the generator through Arduino Mega

A. EQUIPMENT USED

The control and monitoring components are combined to form the proposed system. While the control section explains how the program manages the electrical generator, the monitoring component provides a variety of indications to keep the user informed about the various factors that impact the generator's operation. The significance of this system is that it lets the user turn on and off the generator in case of failure. The need to be physically close to the generator has been eliminated as the user can perform the task above remotely. The user can keep an eye on the generator's most crucial requirements using the observation part. Smoke, flame, and RPM detectors, current and voltage sensors, DHT 11, jumpers, LCD 16x2 and Arduino Mega.

B. PROTOTYPE

In the proposed prototype, all the sensors are interconnected to Arduino Mega at one junction and then are connected to the microprocessor as visualized in Fig. 1.

1. ARDUINO MEGA MICROCONTROLLER

The gadget has an Arduino Mega as its CPU. This microprocessor was chosen because it possessed four essential qualities for system performance. All of the analog inputs from the transducers can be read by it. Eight single-ended analog inputs were needed in the proposed design for analog to digital conversion. as shown in Fig. 2.

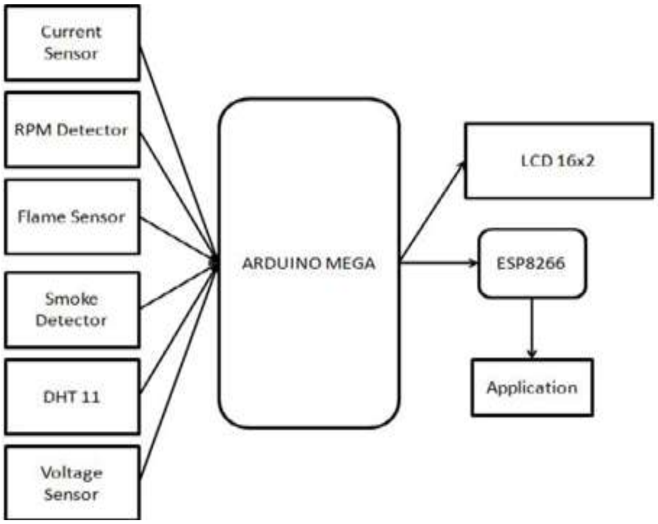

FIGURE 1: The Block Diagram of the Prototype [1]

Four digital interrupts were also required to interact with LCD and SD card. The Arduino Mega has a much larger flash memory than the Arduino Uno (128kB vs. 321(B) and 81d3 of SRAM to the Uno's 2kB. Without affecting performance, the expanded memory capacity enables increasingly complicated data processing. Additionally, it has a USB communication port, allowing laptop users who lack a serial / RS323 adapter to use it [27], 712V voltage requirement for power which is compatible with a standard 9V power source, and a preprogrammed bootloader to allow for uploading new code without an external hardware programmer [28].

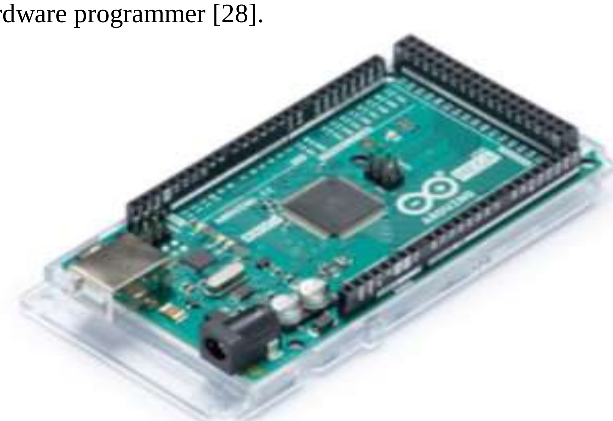
FIGURE 2: Arduino Mega Microcontroller [1]

1. ACS710 EMON CURRENT SENSOR

The stator current of the generator is measured through the ACS712 sensor, as seen in Fig. 3, for electrical investigation. This kind of sensor is usually referred to as a Hall Effect sensor because it operates on the Hall Effect principle. The creation of a voltage difference (the Hall voltage) across an electrical conductor that is orthogonal to an electric current in the conductor is referred to as the Hall effect. The current value is read, and a useful voltage value is produced. The ACS712 provides accurate and useful solutions [29]. The measurement sensitivity for the 20A model is 100mV/A. The sensor allows for the measurement of both positive and negative currents.


FIGURE 3: ACS710 Emon Current Sensor [1]

The specifications of the current sensors are listed in Table I below.

TABLE I. THE SPECIFICATIONS OF THE CURRENT SENSORS

	5A Module	20A Module	30A Module
Supply Voltage (VCC)	5V dc Nominal	5V dc Nominal	5V dc Nominal
Measurement Range	-5 to +5 AMPS	-20 to +20 AMPS	-30 to +30 AMPS
Voltage at 0A	VCC/2	VCC/2	VCC/2
Scale Factor	185 mV per AMP	100 mV per AMP	66 mV per Amp
Chip	ACS712ELC-05A	ACS712ELC-10A	ACS712ELC-30A

2. RPM DETECTOR

The RPM detector sensor, depicted in Figure 4, is a small board with a PCB size of 3.2 cm 1.4 cm and is used to track the generator motors' rotational speed. Depending on the engine speed, it has a set bolt hole and typical RPMs of 1800 and 3600 for a 4-pole and 2-pole generator, respectively. It has a 5mm wide groove optical coupling sensor that was imported. The sensor works on the voltage of 3.3V to 5V and produces an output in a digital switch, i.e., 0 and 1.


FIGURE 4: RPM Detector [1]

3. ESP8266 CHIP

The ESP8266 is a low-cost Wi-Fi microcontroller created by Espressif Systems, a Chinese company headquartered in Shanghai. A microcontroller and the complete TCP/IP stack are both included. Microcontrollers use this Chip to join a Wi-Fi network and transmit easy commands to attack TCP/IP connections in the Hayes fashion [30]. The ESP8285 is associated with one MB of intrinsic flash in nursing ESP8266, suitable for single-chip computers that can connect to Wi-Fi. The ESP8266 Chip is shown in Fig. 5.

FIGURE 5: ESP8266 Chip [1]

4. FLAME SENSOR

The device's flame sensor, type SEN02011F, can detect flames and other wavelengths between 760 and 1100 nm. High radiant power LEDs are employed. The flame sensor can function between -25 and 85 degrees Celsius. It is imperative to keep in mind that, to prevent harm, the probe's distance from the flame shouldn't be excessive [31]. Simply add a pull-up resistor to the Arduino analog pins, and they will get an analog value. It can also be used to generate digital values using our analog-to-digital module.

5. DHT-11 SENSOR

The system's humidity and temperature levels are managed by DHT 11. This sensor has high stability. The calibration function of this sensor is likewise fairly precise [32]. A resistive type wetness measurement element, an internal NTC temperature measurement component, and an internal high-performance 8-bit microcontroller are all components of the DHT11 system., as shown in Fig. 6, providing optimized digital signal output. Thanks to the exclusive digital signal acquisition it has high reliability and wonderful long stability technique and temperature sensing technology. The operating voltage of ranges from 3.5v to 5.5V. The temperature and humidity ranges of DHT11 are 0 C to 50 C and 20% to 90%, respectively.

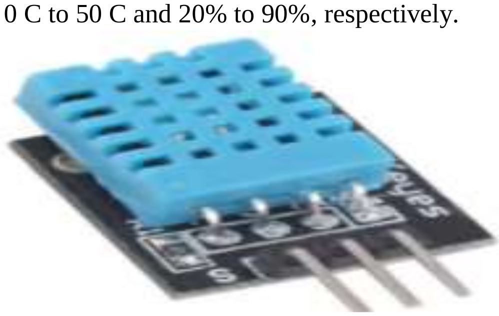

FIGURE 6: DHT-11 Sensor [1]

The pin configuration and identification of DHT11 is shown in Table II.

1. SMOKE DETECTOR

The Grove-Gas Sensor (MQ2) module is good for detecting gas leaks when sensing smoke emissions (home and industry). To detect H2, LPG, CH4, CO, alcohol, smoke, or propane is sufficient. Due to the sensitivity and short period of the measurements, they can be performed as quickly as is practical [33]. The device's sensitivity is balanced through a potentiometer, previewed in Fig. 7.

TABLE II. THE PIN CONFIGURATION AND IDENTIFICATION OF DHT-11

Pin No.	Pin Name	Description
For Sensor		
1	VCC	Power Supply 3.5V to 5.5V
2	Data	Outputs Temperature and Humidity through Serial data
3	NC	No Connection and hence not Found
4	Ground	Connected to the Ground of the Circuit.
For Module		
1	VCC	Power Supply 3.5V to 5.5V
2	Data	Outputs Temperature and Humidity through Serial Data
3	Ground	Connected to the Ground of the Circuit

FIGURE 7: Smoke Detector [1]

Table III shows the PIN configuration and identification of the Smoke Detector.

TABLE III. Pin configuration and identification of smoke sensor

Pin No.	Pin Name	Description
For Module		
1	VCC	The PIN Powers the Module
2	Ground	Used to Connect Module to System Ground
3	Digital Out	Used to get Digital Output from this PIN
4	Analog Out	This PIN outputs 0-5V Analog Voltage
For Module		
1	H-PIN	One PIN is connected to supply and another to Ground
2	A-PIN	A and B PINs are Interchangeable. These PINs will be tied to Supply Voltage
3	B-PIN	A and B PINs are Interchangeable. One PIN acts as Output and the Other will be Pulled to the Ground

C. ANDROID APPLICATION

Android devices are fantastic portable computers with an always-on internet connection and a slew of sensors [34]. The Android API is simple to start with; it is open, meaning that developers have access to practically all low-level capabilities and are not sandboxed. The Android API also makes it straightforward to access the equipment divisions. The different correspondence interfaces, such as Wi-Fi and Bluetooth, are fascinating for mechanical autonomous use.

D. DATA ANALYSIS

The software module optimizes the data and corrects any hardware component flaws before sending data to the mobile device through ESP8266. State monitoring in a generator tracks a machine's state parameter and identifies any substantial change. It is essential for preventive maintenance [35]. The use of conditional Monitoring makes it possible to do maintenance regularly or take various steps to stop failure and its effects. On important equipment conditions, control techniques are frequently employed. A hand and glove that transfer data to a central location over a wireless network of autonomous sensors that monitor environmental and physical elements, including temperature, current, fuel level, and other considerations. A few well-known networks are bidirectional and can control sensor activity.

V. RESULTS AND DISCUSSIONS

This project generates a lot of buzz because of its simplicity but valuable outcome; it gathered a variety of structures and applied them to a core issue that people in the business are facing; the pondering isn't huge on the world, but it will ensure more prominent production and make human existence less demanding but more right, especially since the current endeavor's notion of introducing separate systems can be fulfilled in many domains, current large-scale adventures, or for individual use; so, it is considered a clear natural module's structure. When the board is plugged into the computer's USB port, the green LED on the board should light up. When the power is given to the board, an orange LED flashes ON/OFF towards the middle (labeled 13 LED" in Fig. 8.)

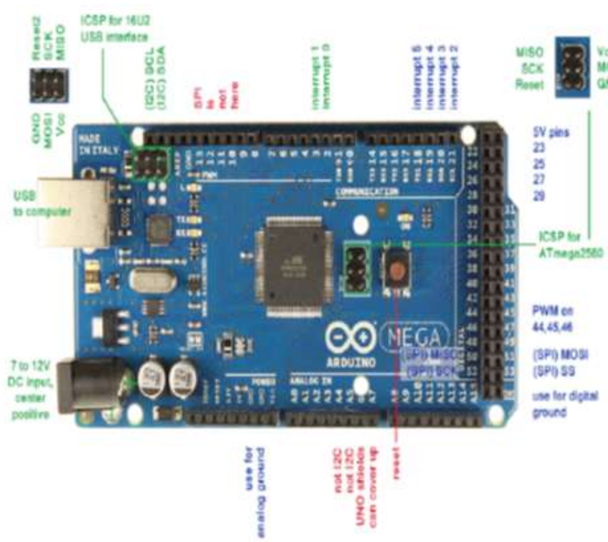

FIGURE 8: LED Power Indicator [1]

If the power LED on the board is not lighted, the board is most likely not receiving power. The Flashing LED, attached to digital output pin 13, is managed by code running on the board. (New boards come with the Blink sample sketch preinstalled.) The drawing works properly if the pin 13 LED turns on, indicating that the Chip on the board is functional. It is possible that the factory code isn't on the Chip if the green power LED is ON, but the pin 13 LED isn't blinking. If your board isn't a typical one, pin 13 usually doesn't have an integrated LED.

The DHT11 detects the electrical resistance between two electrodes to identify water vapor, as shown in Fig. 9. The humidity sensor consists of a moisture-holding substrate with electrodes attached to its surface. Ions are created when water vapor is absorbed by the substrate, improving the conductivity between the electrodes. T, or relative humidity, affects the change in resistance between the two electrodes. The resistance between the electrodes decreases as the relative humidity increases and increases as it decreases. The relationship between temperature and humidity is depicted in the graph in Fig. 10.

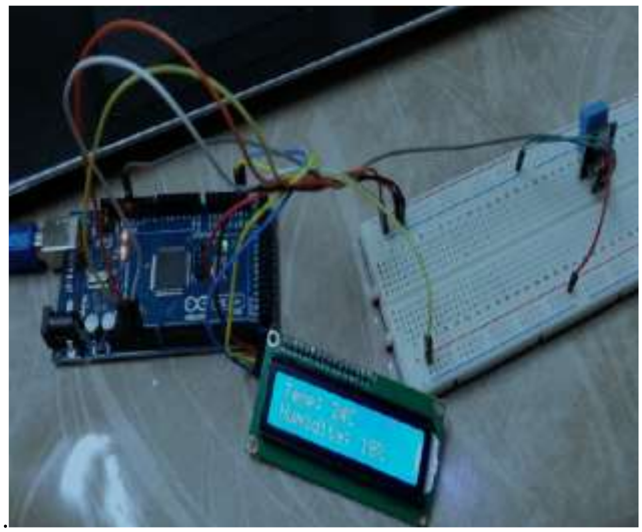

FIGURE 9: DHT-11 Sensor Test [1]

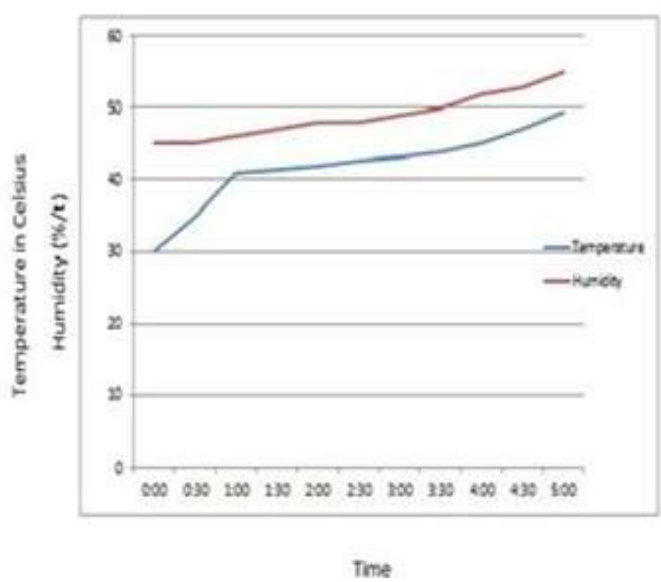

FIGURE 10: Relation between Humidity and Temperature [1]

A smoke detection test was also conducted, shown in Fig.11

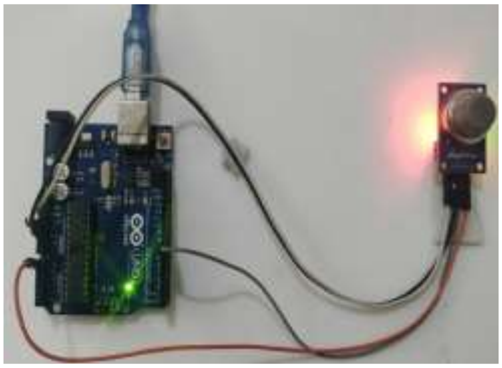

FIGURE 11: Smoke Detection test

Figure 12 explains the SEN02011F Flame sensor tests that require the connection to the board of Arduino. A flame is lit near the black-led of the sensor, which detects its fame and sends the signal of detection of fire.

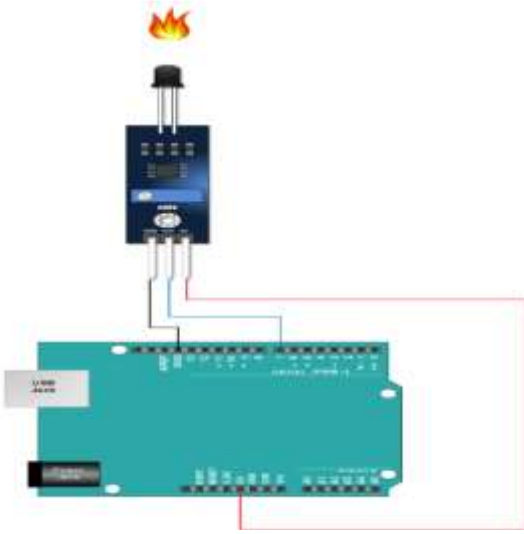

FIGURE 12: Flame Sensor Test

Finally, the data gathered by application is shown in Fig. 13.

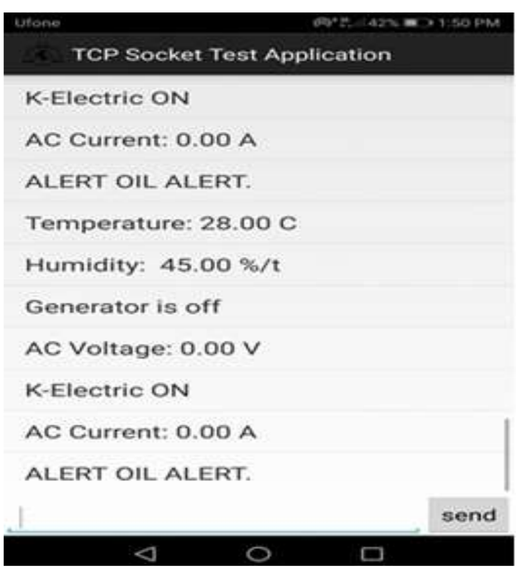

FIGURE 13: Results gathered by the application [1]

VI. CONCLUSION

The following list outlines the different types of graphics. They are categorized based on their construction and use of color/shades of gray: This paper has explored the platform of IoT for industrial use and Monitoring and controlling of engines. The methodology concentrates on the parameters collected by the wireless sensors, and all the data may be transferred to an Android application that enables system monitoring. With every problem being answered within reach thanks to the IoT and its link to the cloud, our lives are easier. Moreover, the IoT can be calibrated to get full details about the system, which can be updated to a cloud and accessed from around the globe anytime. It can reduce generator accidents and predict building failures. Other Distributed Energy Resources can be adapted to this development.

The basis of this structure is to add to the world as an impelled watching and control system, as it will, in general, be conveyed in another edge to reflect absolute necessities. This system gathered a mix of structures and committed them to a principal issue faced by people related to the business. The idea does not apply in all cases on the planet and will ensure the major benefit and make human life more straightforward. As the Android application is used, it is not hard to manage this structure. Because of this application, the time and human undertakings get decreased. This task is intended to provide the perception of distinct generator factors, such as the oil level, temperature, and humidity. This approach allows us to provide information on the generator expressly. We can determine the extent to which the generator will function by paying attention to the specific parameters. Additionally, using these parameters, we can check how the generator's state is handled. The undertaking fills in as an amazing gadget for various purposes as different sensors will be used, which will be commonly successful.

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