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Control System Design for Failure Starting of Diesel Power Block for Cell on Wheels Communication Tower based on Cloud Service System

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Abstract

Monitoring diesel power blocks is crucial for the management of energy utilities and telecommunication firms, as it guarantees the continuous functionality of their cellular towers and base transmitter stations. Remote monitoring and control are more advantageous than on-site monitoring due to their superior efficiency in terms of time and resources. This study presents a solution to the issue of monitoring and controlling diesel power blocks on-site. The proposed technique involves utilizing online monitoring to gather real-time data on the fundamental characteristics of a functioning power block. For both establishment and upkeep, the proposed system uses easily accessible and inexpensive resources. The study examines the use of a cloud computing-based Internet of Things platform, a flexible technology capable of interacting with the environment and digital entities. The goal of this study is to develop and deploy a control operation system that prevents power block starting failures in an automatic changeover system. The changeover system is responsible for switching between three different electrical sources that provide continuous power to an independent load system. The system's goal is to ensure uninterrupted electrical power supply to a Cell on Wheels communication tower located at a remote site. A cloud computing infrastructure and an ESP-8266+ Wi-Fi microcontroller deploy the solution.

Keywords: Cell on Wheels (COW), Generators, Internet of Things (IoT), Power Block (Generators).

1 Introduction

Many areas rely on generators, including manufacturing, farming, the military, the scientific community, and even cases where the power grid is unavailable. Electric generators generate electrical

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energy, a resource considered essential in modern society (Mwangi et al., 2015). Large and medium-sized power plants use generators to provide electricity for public and industrial uses. Moreover, small-scale power stations utilize them as in-vehicle generators, oil drilling generators, and remote mobile communication towers. Businesses such as hospitals, banks, and shopping centers can benefit from having backup generators on hand. References numbered (Mwangi et al., 2015, Ağaçayak et al., 2017; Corsini & Tortora, 2018; and Corsini et al., 2019) make up the text. Despite their widespread use, on-site generator operation and maintenance can be a hassle and a financial drain. This can make it harder to get results. Natural environments with high concentrations of salt, fog, and humidity can be ideal locations for generators. Machines and generators will not be able to operate reliably under these conditions.

However, the cost of having maintenance personnel perform on-site inspections and repairs for generator operation is too high. Thanks to a plethora of effective management techniques, manufacturing companies and research organizations have made some headway. The execution of a comprehensive and effective management strategy for generators is still lacking (Ağaçayak et al., 2017; Corsini & Tortora, 2018; Corsini et al., 2019; Ghahramani et al., 2019; Accetta & Pucci, 2019; Marzencki et al., 2008). One can use state monitoring techniques to track a generator's status and fix problems with initial failures. Generator data, real-time data presentation, configuration view display, and equipment monitoring are all part of the system. With the help of equipment monitoring, customers may see the generator set running in real time and regulate its start and stop operations with the push of a button. The configuration view display presents engine data such as speed, temperature, oil pressure, liquid level, battery voltage, and total operating time, providing a comprehensive overview of the generator set. The real-time data display option allows one to view the collected current data for frequency, line voltage, and mains voltage. Furthermore, it provides information on the power line's active power, reactive power, apparent power, power factor, voltage, and frequency, as well as its current. Using the generator state data, you can access the interface, which contains various generator management details. Here you can find information about the generator, its collector, its installation location's geographic coordinates (longitude and latitude), model, manufacturer, brand, specifications, production date, rated speed, rated voltage, and rated current, as well as other relevant details. The reliable operation of generators depends heavily on state monitoring. By spotting potential problems early on, we can take preventative action and keep things running smoothly. You may also use it to make your generator sets last longer and work more efficiently. When analyzing generator faults, it is critical to take into account the fault unit, which performs five separate functions. If a machine fails, the fault message push will convey the fault code to either the end-user or a fault diagnosis specialist. Afterwards, the end-user or the expert in problem diagnostics receives the fault code via the fault message push module. The problem can be solved by the user (Shubbar et al., 2021; El Khaled & Mcheick, 2019; Bheemarasetti & Patruni, 2021). Retrieving fault codes and their associated details can be done by using a query for fault codes. This will enable the user to diagnose the error through this knowledge. Real-time analysis of the issue with fast speed can be done through online diagnostic option that uses problem code among other data. Generator’s operational characteristics, failure code and what was put in by the user might have been some of these data. After then, the exact problem can be located and suggestions are given by means of an online diagnostic tool. The defect rectification function is therefore entrusted with correcting defects discovered through online diagnostics service. In such cases, there may be need to repair, replace or adjust the operating settings of generator depending on how serious it appears to be. Simply put, warehousing errors entails storing error reports for research purposes in a database. These searches may help users find similar problems from previous occurrences so as to assist them when they occur again in future.

1.1. Cell on Wheels Mobile Communication Tower

It is established that a cell on wheels (COW) mobile communication tower was particularly engineered to offer wireless communication for a wide array of purposes it may include; natural disasters, calamities, emergency use, disasters' drill, military operations and occasions. They act as a sure method of putting up communication services in areas that are hard to reach or at all not served. It is also important to indicate that this tower is usually engineered for transportation and easy installation in order to provide an efficient means of communication. It is a moveable and easy to use technology which can be used to establish a mobile network in a very short time in areas where there is no network or poor network. It is an effective solution that may be used as the constant one and can be involved in temporary coverage provision by the mobile networks because of the presence of the several features. You can add up to your cell on wheels mobile communications tower more dealing and operations of communication technologies like cellular, radio, power blocks and electrical boards, satellite systems and others to give better quality service every time. Apart from that it can also be configured with solar power and battery systems making it to run on its own and it is also eco-friendly (Kamil et al., 2020). They are quite versatile and can easily be transported hence they could be used for a number of reasons. A CoW system has parts such as a cellular antenna, transceiver apparatus, battery and other crucial organs which are arranged on the trailer or truck. An antenna is generally mounted on a telescopic pole which at times go to several hundred feet up. It connects the cellular network as a whole with the said antenna set. In this case, he mentioned that COW system would be powered by batteries whether or not electric generators are available. From there, the fixing of them could be done in a short time, as within minutes or hours at the most, depending again on the extent of the isolation of the site. Cell on Wheels also referred to as COWs when in use, has the capability of creating cellular network coverage for a certain number of kilometers of radius when in operation. It is about facilities that belong to the cellular network architecture that increases its reach during incident or any other exigent circumstances more effectively.

Communication on Wheels (COWs) is used primarily for the following: Emergency Communication: The Communication on Wheels is used to create a mobile cellular network for sports kind of events such as hurricanes, floods and earthquakes. With the help of the borrowed COWGSIP system, one can take network coverage for different large event/festival/concerts etc. This is in response to the need the other branch of public safety has been yearning for, thus introducing to you the COW application of Web Rescue. COW systems can increase extension to the rural area which do not have cell towers at the moment. Telecom infrastructure expansion: This way, the COW system substitutes the space between the old and new cell towers until the excessively grew a population of mobile heads is satisfied with the new cell towers. Cows on Wheels are those that accumulate within the cluster of Cellular which appears to be found everywhere that is, such vehicles are recognized in the industry. The fifth type is commonly referred as 'Cellular on Wheels (COW)' as its main purpose is to establish 5G network and connection in distant areas.

COWs are enormous assets of providing auxiliary back up for the cellular communication networks and they are very crucial and essential. Thus, these by-products are the increase in portable deployment speed and even the ability of a human operator to use a balloon-pumped cell tower. This simply makes them a preferred choice in the various expected uses of the company.

1.2. Cloud Computing

The concept of cloud computing, in essence, is the delivery of various computing services via the Internet, including servers, storage, databases, networking, software, analytics, and intelligence. The way the information technology equipment is used and the physical servers are organized can be as a service rather than having to buy, possess, and manage them (Qian et al., 2009; Abdul-hamza et al., 2023; Abdul-Rahaim & Ali, 2015; Abdul-hamza et al., 2023; Shubbar et al., 2021). Cloud computing has a lot of advantages over the old IT infrastructure but it is also full of benefits for the end-user. Firstly, the cloud companies can benefit from the bottom line that they get through the use of economies of scale because of the fact that they have a lot of users of the same type of service. However, at the same time, the reduction in operating expenses was due to the use of smaller-scale companies to provide the same services. Factually, this could have a noticeable effect on the finances of corporate companies, and their development.

Secondly, scalability: cloud resources provide the flexibility to accurately adjust capacity adapting to the fluctuations in demand, this enables organizations to minimize the costs at times of under-utilization while effectively serving the demand during peak load periods. Thirdly, the addition of a virtual cloud to business operations will allow them to respond to changing demands by the quick supply of cloud services. Fourthly: as regards the security, cloud providers offer a plethora of security measures that grant protection to data and applications.

Cloud computing is identified as the prime type of infrastructure that is capable of producing the required revolutionary results rapidly (Höfer & Karagiannis, 2011). Cloud computing is identified as the prime type of infrastructure that is capable of producing the required revolutionary results rapidly (Höfer & Karagiannis, 2011):

Service such as Infrastructure as a Service, offers the fundamental elements of a cloud system for instance virtual compute and storage networks.

Platform as a Service or PaaS is a model that allows people to create, run and operate applications.

This brings about the phrase “Software as a Service” abbreviated as SaaS which implies hosting of whole programs in the time-cloud. When indeed the cloud serves as a system for storing and processing data more reliably than the on-premise, then the certification of using cloud computing system for the control system of COW communication towers to enhance dependability arises. The application of cloud is to have high availability and scalability which make it to stand against the hardware failures that common in on-premise surroundings. Improved efficiency: Actually, thanks to cloud technology which provides centralized data storage & processing, the function of the control system maximally increases its efficiency.

By applying thus model it is possible to reduce required on-site physical infrastructure, software and equipment demands, which results in reduction of required resources and costs. Thus, the cloud technology path to go with minimizes, if not eliminates, all the system operator costs. Therefore, following the above details, businesses are only billed for the number of resources used in production; thus, the end-to-end cost-saving process is easy. Better safety: Cloud can offer more robust protection of the control system through the measures of security as those may include the encryptions and firewall. By doing this, then we shall be in a good position to raise the level of security within the system and thus reduce incidences of cases like, unlawful access to the system and other forms of cyber-attacks.

Cloud computing is a technique of processing whereby the facility that usually houses the data of a specific company is hosted in the "cloud" so that the company can have the storage space and processing might it requires. Combined with other systems the service providers get the power tool for analyzing the data and even may become the great tool for early examination of problems in the blocks of diesel generators in COW communication towers. On this, the approach is all Inclusive as this will not only minimize the network downtime but also augment the utilization of the available resources by making the communication services more reliable in the non-central regions. The most important requirement that is often highlighted when it comes to getting a completely continuous communication service is the free and immediate reporting of a prime fuel cell power block breakdown. It is one of the easiest things that can however only be done by establishing the IoT sensors with the cloud system. Having a thinking process with the clarity in mind of the subject which comprises of the identification of the features as well as the technological tool that is to be used also assist in averting the causes of the issue with the failure being inevitable.

1. **IoT Sensor Data Collection:** The diesel power block can be fitted with permanent sensors for such important variables as fuel level, oil pressure, engine temperature, vibration, and emissions of the exhaust gases. They amass information constantly and hence act as the preliminary foundation used to identify failure indicators.
2. **Data Transmission and Connectivity:** As the collected sensor data is, mostly, transported wirelessly with the help of cellular or satellite connection, the data is sent to a secure IoT gateway. This unit serves as an interface between the station installed sensors and the cloud-based platform.
3. **Cloud-based Data Processing and Analysis:** For the received raw data from the IoT gateway, it is passed to the cloud platform. The utilization of cloud computing in handling big data is very effective considering it provides affordable space for the data gotten from sensors. The analytics algorithms can be incorporated in the cloud to analyze the patterns and rhythms as well as to look for abnormality in the sensor data.
4. **Predictive Maintenance and Alerting:** The data collected from the historical and real time data acquired from the sensors can be as input to the machine learning algorithms hosted on the cloud to predict failures within the diesel power block. It prevents inevitable breakdowns before the system or tool is completely compromised. Then, the cloud platform can automatically alarm the concerned technicians about some possible challenges.
5. **Remote Monitoring and Visualization:** Application platforms can be conveniently used as a control panel in which technicians can monitor the performance and state of the diesel power block in real time through a web interface. This makes it possible for the staff to make decisions without delay and they can also respond a quickly to dispatch repairmen if need be.

Using cloud-IoT for COW diesel power block failure detection offers the following benefits: Using cloud-IoT for COW diesel power block failure detection offers the following benefits:

- **Early Failure Detection:** This is because it is possible to notice that there are possible problems that could result in a complete breakdown of a machinery or equipment and prevent such incidences from happening.
- **Improved Uptime and Reliability:** Preventive care that is carried out at a tender age means that there is constant power supply to the COW communication tower, hence an improved network reliability.
- **Reduced Operational Costs:** This means that before organization gets to spend too much money on rectifying a problem, they first diagnose it and find a way of fixing it.

- **Enhanced Decision Making:** Technicians are enabled to make adequate decisions with regards to the maintenance intervals of the equipment and need for resources through cloud-based data visualization and data analysis.

2 Literature Survey

This is what is referred to as the Internet of Things (IoT) (Marzencki et al., 2008) when typical products and sensors are equipped with Internet and computation features. This paradigm enables these devices to produce, communicate, and utilize information without much intervention from people. The fact that objects need to be controlled and monitoring by the help of computers, networks and sensors has been in existence for some time now. The present technological boom and improvements in information and communications technology (ICT) have made the Internet of Things (IoT) more practical and closer to becoming a mainstream reality. The Internet of Things (IoT) has many potential uses in many different contexts, such as the following: the human body (through implanted or placed devices that track health, fitness, and well-being); the home (through monitoring residential buildings for security system control and surveillance); the retail environment (through self-checkout, inventory optimization, and personalized in-store offers); the office (through monitoring to ensure building security and manage energy consumption); and the factory (through monitoring to enhance In industrial settings, the Internet of Things (IoT) can monitor and control diesel generators using an internet connection. Research on the use of the Internet for economic sector supervision and regulation has been extensive. In their article (Pandey et al., 2013), the authors presented a smart online system for widespread diesel engine monitoring. The task utilizes IT to set up an intelligent maintenance system. Two parts make up the system: one that records data for continuous monitoring and another that gives the operator advice based on the kind of failure that occurred. Included in the data set are lubricating oil, charge air cooling water, engine cooling water, nozzle cooling water, intake air, heavy fuel oil, splash oil temperature, engine temperature, and engine bearing temperature. We design a database to store the data acquired by the sensors. Additionally, the web-based application incorporates the user interface design. A real-time detection system will notify the operator and sound an alert if it detects an unusual element measurement. The research in (McArthur et al., 2005) introduces a load frequency management approach for a hybrid generating system. A diesel generator, an aqua electrolier, a fuel cell, a battery energy storage system, and wind turbines made up the hybrid generating system. Changes in wind speed and load affect the system frequency, which in turn affects wind power production's operating conditions. To account for these fluctuations, a robust load frequency controller is required. The research suggests that the integration of IoT technology can realize an all-encompassing energy management system, thereby facilitating the creation of a web-enabled smart grid. This will allow networked devices to communicate over the internet. Within the framework of anomaly detection for condition monitoring of electrical plants, the article (McArthur et al., 2005) describes how multi-agent system technology may efficiently collaborate as a community to solve problems. The primary roles of a software module known as an agent include intelligent decision-making, data processing, modeling, and control. According to the authors, there are a few essential characteristics of a successful anomaly detection system. To start, it must work with a variety of plants that have internet monitoring systems. In addition, it must be able to monitor several parameters concurrently, at least three of them. Moreover, the system has to understand the correlation between multiple parameters and tendencies and patterns of behavior in the data values. Besides, it should be able to comprehend regular plant functioning and alert consumers instantly if there are any deviations. Last, information is vital to users, so they must receive alerts on time to make the required actions. The units based in different physical centers can perform the analysis away from the physical environment. In this process, the prototype anomaly detection system was illustrated based on the 2. 5 MW power generating system, where on 50 identified characteristics of the engine/alternator system were emphasized. Equations calculated from these included actual engine load, temperatures and pressures within cylinders, generator output, exhaust temperature and pressure and other thermal determinants of the engine and alternator sites. It is worth to note that users could be provided with numerical and graphical representations of the data at the same time and each point is computed by the system in time. The prototype anomaly-detecting system design involved a large number of agents. This process involves a number of agents, including those responsible for data processing, analysis, presentation, and administration. This technique monitored the sensor readings of a diesel-powered generator. This study focuses on the Internet of Things (IoT) and its potential for controlling actuators through a free smartphone app. Additionally, it delves into the use of Sensor Cloud, a cloud service that enables the visual representation and analysis of information. Furthermore, the article delves into the topic of building "virtual sensors" by merging data from actual sensors. Since these features are already in the sensor cloud, designing the user interface and activating alerts does not need any more work. We have confirmed the effectiveness of the arrangement by controlling and monitoring the diesel generator and measuring its basic characteristics. The study presented in (Abdul-Rahaim & Kaittan, 2023) describes a fundamental automatic transfer switching service based on cloud computing that requires no control over the failure generator's beginning.

3 Problem Statement

The communication system in CoW systems typically consists of a hybrid system of electrical sources that provide power to the communication tower. Photovoltaics and generators serve as the primary power sources for the communication system during daylight hours when the sun shines. Throughout the night, the two generators will provide power to the COW system in order to mitigate the expensive maintenance costs of the power block. There are two generators employed here and they are worked in turns and each generator is set to be master generator for 3 hours, while the other one for its turn performs the role of slave generator. Prior work did not propose a plan that was intended to address the issue of cloud computing in COW systems if in case the generators fail. The solution recommended in this work is the introduction of the cloud-based system to avoid the shutdown of the Cell on Wheels due to the failure or malfunction of the generators. The proposed system would also use cloud computing control to carry out the starting of a standby generator so that there would be a guaranteed supply of electricity to the COW system throughout the day.

4 Proposed System Design

The use of three power sources ensures appropriate electrical current supply to the Cell on Wheels by fast switching between the sources. This system relies on one solar panel to support the base load during transition between the two generators. The Proposed Control System shown in figure 1.

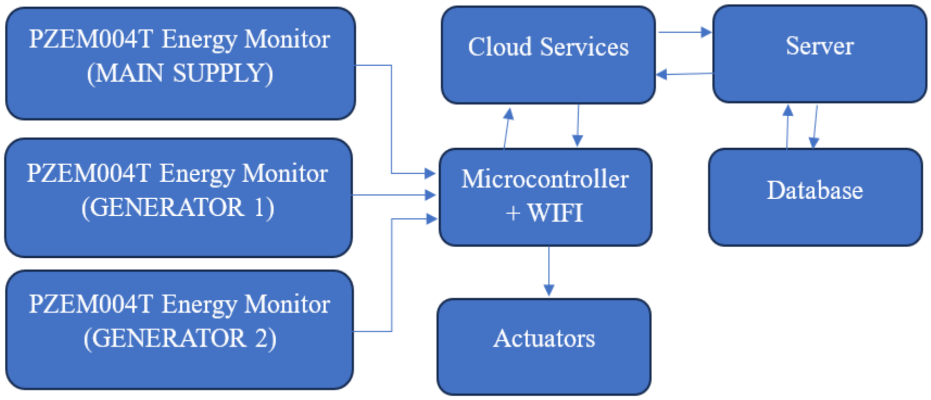


Figure 1: The Proposed Control System

The two generators function in rotation, with a standby duration of three hours. Once the first generator (source 2) has finished running for three hours, the proposed control system sends a control signal to the second generator (source 3) to continue operating for three hours. The control system detects the failure at the start or during operation of the second generator and resolves the issue by temporarily activating the first generator for an additional three hours. This procedure allows for troubleshooting of the second generator by notifying the owner about the problem through an error notice. This approach involves online verification for two generators throughout their entire operational period, utilizing cloud computing technology.

- **Sensor Integration:** We use the PZEM004T Energy Monitor to monitor the diesel power block.
- **Failure Detection:** The PZEM004T Energy Monitor can detect a power block failure. The designer can set sensor readings exceeding the pre-defined threshold at ESP-8266 with a delay time.
- **Cloud Platform Selection:** The Microsoft Azure IoT Hub is the specific cloud service system.

Communication Protocol: Explanations of how this ESP-8266 works when it comes to connectivity with the cloud.

Data Collection: With regard to the monitoring process, the ESP8266 would receive sensor data from the power block.

Data Processing: Before the actual transmission was done the ESP could filter or perform arithmetic operations such as averaging of data obtained from one or several sensors.

Cloud Communication: By employing the Wi-Fi feature the ESP would be able to connect to the selected cloud platform and at the same time create an encrypted connection.

Data Transmission: Based on the selected protocol, the ESP would transmit information from the sensors as well as failure alerts to the cloud environment.

Benefits of Cloud Integration

Remote Monitoring: Real-time or historical data visualization of the power block's health is easily possible from anywhere /anyplace that has internet access via the cloud platform.

Alerts and Notifications: If there are detected failures, then the cloud gets it and brings the alert and the notification thus enabling rapid response.

Data Analysis: Cloud providers also offer tools to enable the analysis of data with a view of predicting future failures, and probably maintenance intervals.

5 Control System Description

The control system is made up of a primary control board which comprises of an ESP8266 microprocessor, Wi-Fi, PZEM-004T energy meter, and four channel relays. The ESP8266 is an affordable versatile microprocessor that has revolutionized the area of the Internet of Things (IoT) applications. The ESP8266 is a powerful and versatile microcontroller that offers basic and affordable Wi-Fi capabilities to the plethora of creations. Some of the features include simple interface, cheap and yet it has an open-source appeal to it that attracts not only novices but also those who are professionals in the field.

- It features Wi-Fi b/g/n protocols in the 2.4 GHz frequency that helps the gadget make connections to the internet and other devices with Wi-Fi capabilities. It includes a Ten Silica microcontroller, and an internal processor and memory for code execution as well as control of the microcontroller-launched external devices like sensors and actuators.
- Minimal energy consumption: It can run on battery, and it takes longer durations to recharge, which will favor IoT devices that utilize battery power. The features of the PZEM-004T allow it to be used as a small and versatile mode for measuring AC power. They are able to sample many electrical parameters that include voltage, current, active power, power factor, and energy. Many home and industrial facilities use it as it is affordable, easy to use, and provides accurate results in home automation, industrial automation, and energy monitoring.

The device can measure voltage within the range of 80–260 VAC, current up to 100 A using a current transformer, active power up to 22000 W, energy consumption in kilowatt-hours (kWh), power factor, and frequency. PZEM004T Energy Monitor shown in figure 2.

The interface utilizes TTL serial communication to transmit data.

Precision: voltage: ±1.0%, current: ±1.2%, active power: ±1.5%, energy: ±2.0%.

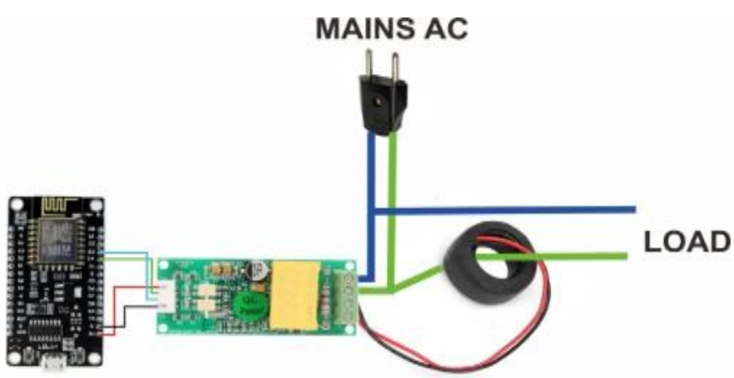


Figure 2: PZEM004T Energy Monitor

The current measurement in the PZEM-004T needs a current transformer (CT) with respect to get accurate current measurement. The current transformer (CT) enables the primary conductor to be placed through the turn containing the core to induce a current in the secondary coil proportional to the primary current. The PZEM-004T device is used to measure the current passing through the secondary circuit to obtain the magnitude of the primary current. The four-channel relay is an advantageous electronic component that has the ability of switching four separate circuits using only one input signal, which is of low voltage. One might be a toggle switch that immediately controls four miniature switches, which makes it viable for most automation procedures and robots. A relay with four channels consists of four relays, which are the primary components responsible for performing the majority of the work. Each relay has three terminals: common (COM), normally open (NO), and normally closed (NC). Upon activation, the relay establishes a connection between the COM pin and either the NO or NC pin, contingent upon the relay's current state. The circuit for controlling receives an input signal with a low voltage, typically 3.3V or 5V, and uses it to trigger the associated relays. It frequently incorporates optocouplers to provide isolation between the control and high-voltage circuits. Terminal blocks allow wires to be connected to the relay's input, output, and power supply using screw or solder points. The operation's principles are:

- Connect a low-voltage signal (e.g., 3.3V or 5V) to the specified control pin for the relay channel you want to activate.
- The control circuit receives the signal and triggers the appropriate relay coil.
- The relay coil generates a magnetic field that pulls a metal armature inside the relay.
- The movement of the armature establishes a connection between the COM pin and either the NO or NC pin, depending on the initial state and configuration of the relay.

6 Design Hardware Components with Proposed Cloud System

Install three power contactors (rated at 40A-250V-50Hz) to facilitate the transmission of electrical current to the COW communication system, ensuring proper power wire connections. Install the control system wire comprising the ESP8266, PZEM004T Energy Monitor, and Four Channel Relay Module as shown in Figure 3.

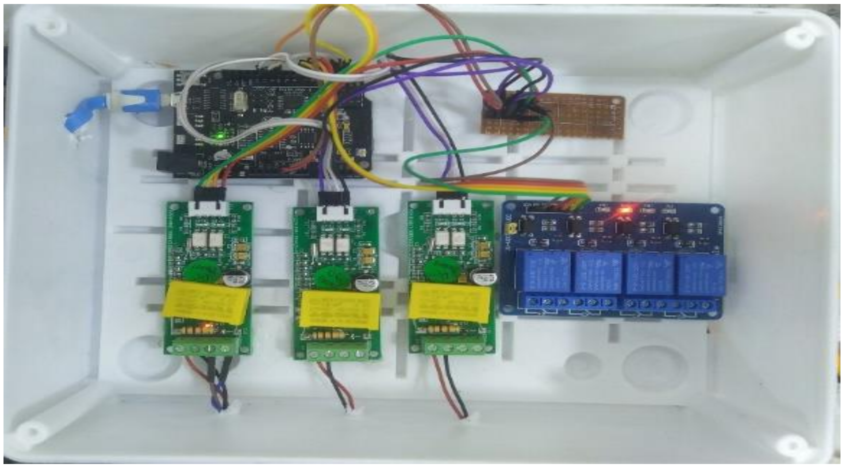


Figure 3: Control System

Set up a software-as-a-service (SaaS) platform in the cloud to monitor and analyze power, voltage, current, energy, frequency, and power factor curves over time. Cloud computing services can manage and control the entire system by utilizing this platform.

- Set up the control system online by connecting it to the internet via a wired or wireless network.
- Install the COW system on the cloud-based platform, and make sure to configure it so that it can receive alerts and warnings in the event of power outages or other difficulties.
- Use a cloud-based platform to remotely monitor and control the COW system. This necessitates the ability to switch between two generators, which are power sources.
- The cloud-based platform will notify the control system (ESP8266) if it detects a power supply issue.

Use the embedded microcontroller's automated solution to handle the detected issue.

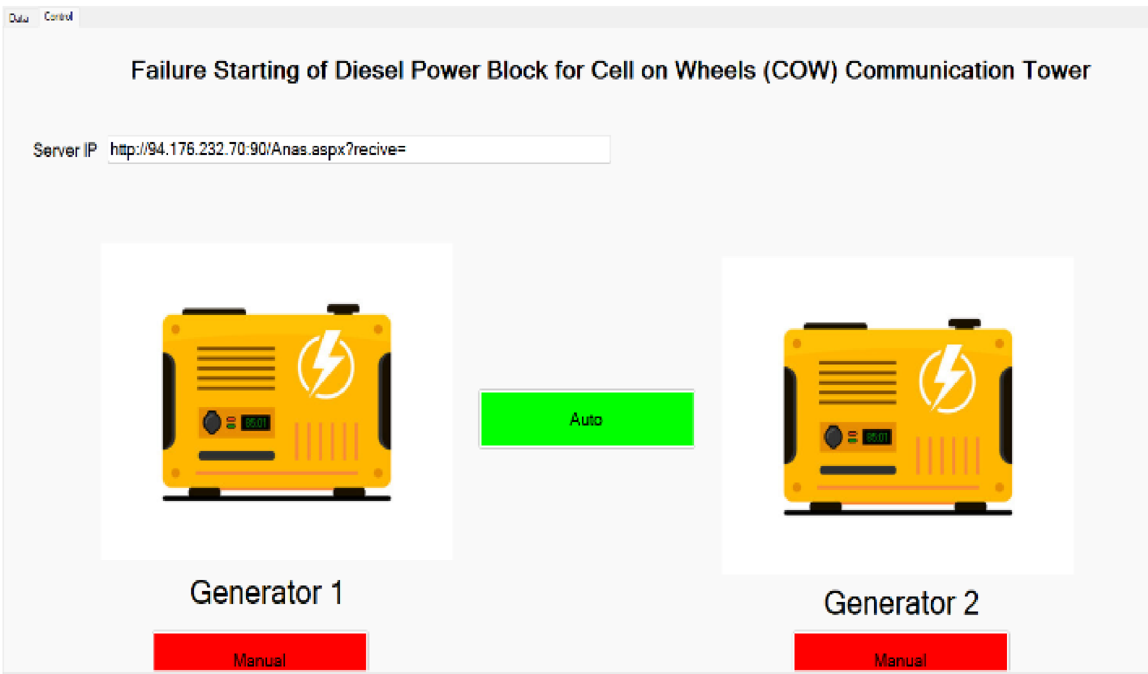


Figure 4: Online GUI Automation

The figure 4 showed everything needed to build and run the system. The two main components are manual control via the Selector Switch and remote control via an Internet-connected cloud server. The server's GUI makes it possible to manage contactors and relays. The control circuits manage the signal that the ESP8266 sends to the relays, which in turn activate and deactivate the contactors of the generators and transformers, respectively.

7 Software System with Cloud Computing Service

The software developed using the C# programming language includes a graphical user interface for controlling server controller boards. Accessing the internet through a cloud server is among the available connection techniques, as shown in Figure 5.

- There are devices that link to Wi-Fi networks and those that offer Wi-Fi connectivity.
- An IP network facilitates the transmission of Ethernet data packets.

To configure the input and output settings for the Cell on Wheel communication system (COW) and integrate it into a cloud computing architecture, you must adhere to the following steps:

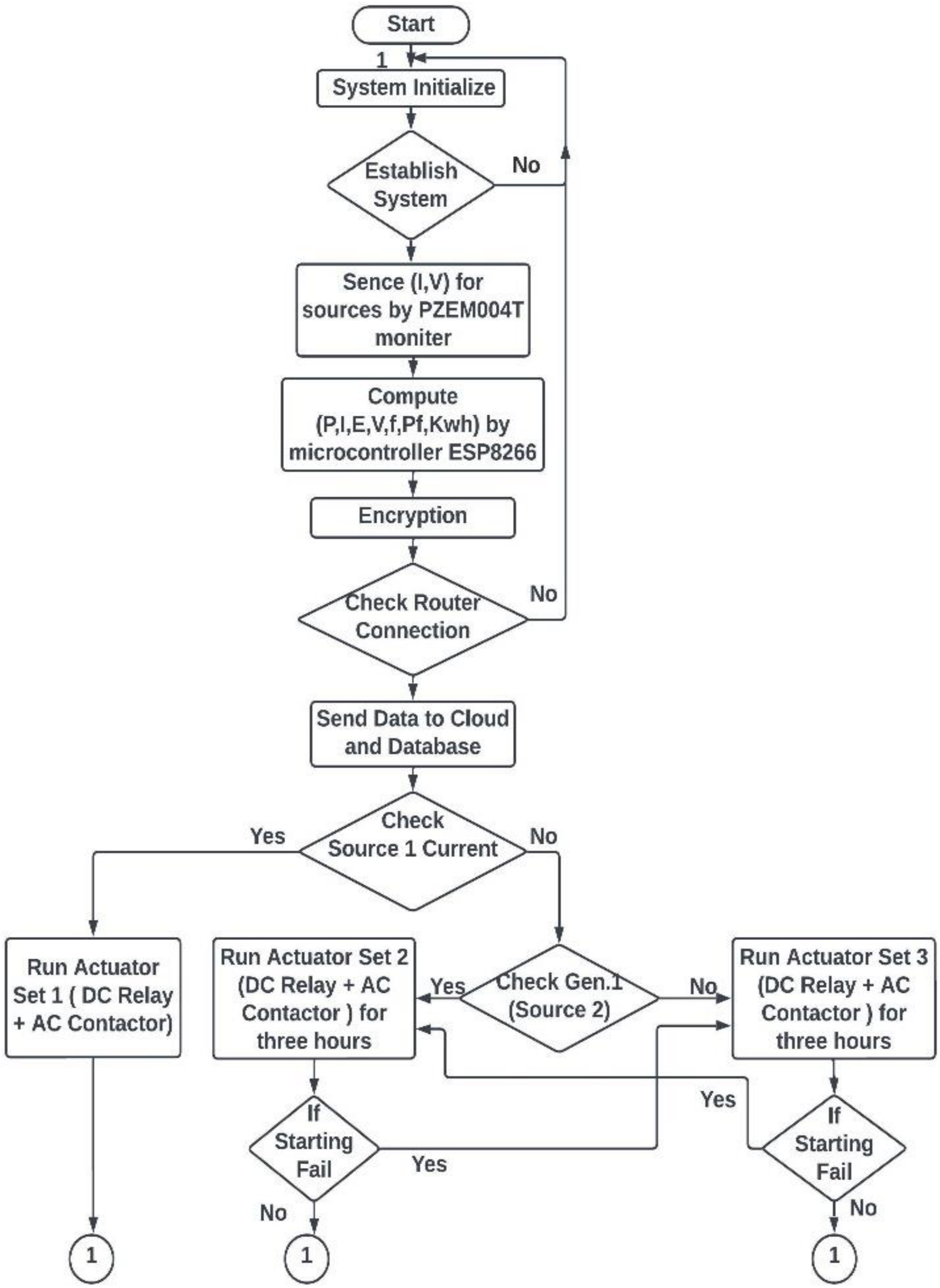


Figure 5: Control Block Diagram

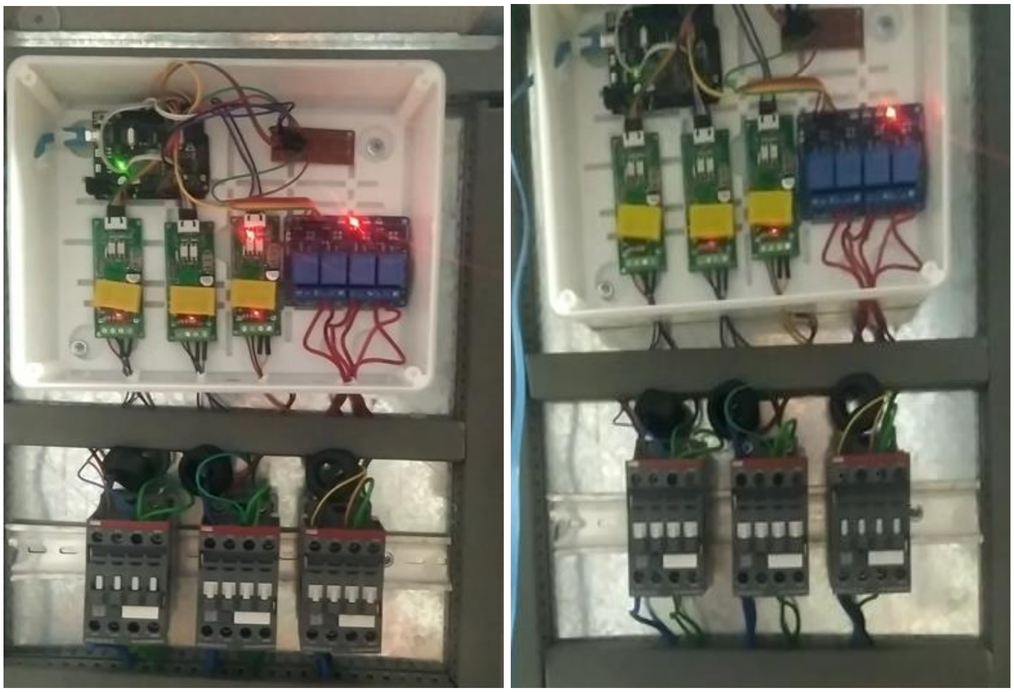
- Analyze the specifications for the CoW system and load: This entails comprehending the power demands of the load, the power supply type (e.g., single-phase or three-phase), and any additional prerequisites or limitations.
- Specify the input and output parameters for the COW system: This means identifying the input power available for instance utility power or generator and type of output power; single phase or three phase etc, other related input and output parameters of the system.
- Develop the cloud computing infrastructure: This involves the selection of the appropriate cloud computing service provider and software as a service (SaaS), for instance, AWS, Microsoft Azure, etc as well as the construction of the infrastructure that meets the necessity of the communication system and workload.
- You have to build the programming for the COW and its load. This means generating the statements that will control the management of the COW’s system and load, for example, initiating the statements for system change over from utility power to generator power or monitoring load control and any other procedures required to be performed.
- Often system testing and debugging is carried out. This include testing the system of the COW on some specific exercises and load to ensure the system is working as required. We will also find out any possibilities of problems like generator startup problems and fix them.
- Implement the system: This involves getting the COW system, fitting it in the right place, and making a link to the cloud computing framework.

Architecture of COW system and load in cloud computing has to be programmed carefully and when assessing the design of the COW system and load in this context, one has to make sure that different requirements of an application are thoroughly analyzed. These are loading demand that powers the load, type of power supply available, reliability of the generator start and stop, and the degree of automation and control required.

8 Results

The implementation procedures are mainly divided into three parts, namely the main power circuit, the control circuit, and the microcontroller. The actual wiring will be done in conformation to the plans that have been drawn and detailed down to the accurate sizes. As an example of the system’s components, the main and secondary centers utilize cloud computing to interact with the microcontroller and offer control options to it. Subsequently, the microprocessor turns on the generators and transformers’ primary circuit breakers employing relays. When the switch is on, it produces a 3.3V output, and when it is off, it produces a 0V output. Additionally, if the primary power source fails to start automatically due to cloud computing, you must manually start the backup generator.

The diagram below illustrates how the system operates using the C#-developed interface. You can manipulate the COW's system using the interface's various control switches. With a secret code (IP) and a special account, you may access the system through a private server platform. We decided to remotely turn off and manage the circuit breakers from the server Figure 6, after connecting to the system over the internet.



(a) (b)

Figure 6: Practical Implementation: (a) Source 1 in Use. (b) Generator 2 in Use.

In order to determine the advantages of using cloud computing for remote control of Cell on Wheels, two scenarios were tested and the corresponding results were measured and presented in the table 1 below.

Table 1: Test Results of Measurements Cases

Operation Case	Source (1) and its Actuators	Source (2) and its Actuators	Source (3) and its Actuators	Power (KW)	Voltage (V)	Current (A)	Switch Time (Sec.)	Case Time Operation (Min.)
Auto	ON	OFF	OFF	9.5	385	16.75	4	80
	OFF	ON	OFF	9.5	385	16.6	3	50
	OFF	OFF	ON	9.5	385	16.59	3	50
Manual	OFF	ON	OFF	9.5	385	16.6	3	50
	OFF	OFF	ON	9.5	385	16.59	3	60
	ON	OFF	OFF	9.5	385	16.75	5	50

Different approaches can be used and each of them has its advantage and disadvantages. This comparison concentrates on ESP-8266 and PZEM-004T and their alternatives.

Proposed Solution: The components used in this design include ESP-8266, PZEM-004T and cloud-based monitoring with display. This solution involves using an ESP-8266 microprocessor to collect data from a PZEM-004T energy monitor. A cloud-based system receives the data, which includes voltage, current, power factor, and active power, for analysis and alerting. To compromise with Other Techniques, we have:

Traditional Methods

- **Manual Monitoring:** Relying on human operators to check the diesel power block's status.
- **Analog Gauges:** Using analog meters to monitor voltage, current, and other parameters.

Limitations

- Human error and subjectivity.
- Delayed detection of anomalies.
- The incapacity to gather and evaluate data for the purpose of predictive maintenance exists.

Advanced Techniques

- **PLC-based Systems:** Using Programmable Logic Controllers for Data Acquisition and Control.
- **IoT Platforms with Dedicated Hardware:** Employing specialized IoT devices and platforms for data collection and analysis.

Advantages of the ESP-8266 + PZEM-004T Solution

- The cost is low when compared to PLC-based systems and dedicated IoT platforms.
- Easy implementation requires basic programming and electronics knowledge.
- Real-time data enables the timely detection of anomalies.
- Remote monitoring facilitates remote troubleshooting and maintenance.
- Cloud-based analysis offers powerful data processing and visualization capabilities.

Potential Challenges and Considerations

- **Reliability:** The ESP-8266 and Wi-Fi connection might be susceptible to failure.
- **Data security:** Implementing appropriate measures is necessary to protect sensitive data.
- **Battery life:** If the system is battery-powered, energy efficiency is crucial.
- Verify the accuracy of the PZEM-004T energy monitor.

The table 2 below summarizes the comparison.

Table 2: Comparison of Proposed Method and Other

Feature	**ESP-8266 + PZEM-004T**	**Traditional Methods**	**PLC-based Systems**	**IoT Platforms**
Cost	Low	Low	Medium	High
Complexity	Medium	Low	High	High
Data Collection	Real-time	Manual/periodic	Real-time	Real-time
Data Analysis	Cloud-based	Manual	On-site/cloud	Cloud-based
Scalability	High	Low	Medium	High
Remote Monitoring	Yes	No	Limited	Yes
Predictive Maintenance	Possible	No	Possible	Possible

9 Conclusion

The proposed solution offers a cost-effective and efficient approach to monitoring diesel power block failures in Cell on Wheels communication towers. While it may have limitations compared to more advanced systems, it provides a significant improvement over traditional method. By addressing potential challenges and continuously refining the system, it can be a reliable and valuable tool for ensuring uninterrupted communication services. Establishing a network of malfunctioning Using a diesel power generator in conjunction with cloud computing in a COW communication system can provide several benefits, including

Increased Dependability: In the event of a power loss, the failed system's cloud connectivity allows it to switch between utility power and two backup generators with ease, ensuring a more consistent output current.

When you link the troubled system to the cloud, you can track it along with its tasks from any place in the world where there is an internet connection. Besides, this can be useful for the problem diagnosis and service of the communication system that has been improved.

Enhanced Efficiency: Thus, using the cloud computing technology, it is possible to manage the proper functioning of the focuses on both communication and workloads of the COW to thereby improve efficiency and concurrently utilize less energy.

Economic Advantages: While integrating the failed system into the cloud, the risk of cutting costs is that activity automation removes the need for monitoring and controlling them.

Thus, by implementing a failure system of generators involving communication system-based cloud computing in an industrial environment, reliability, monitoring, and control can be made more effective and efficient besides minimizing the costs. Nevertheless, it is critical to thoroughly evaluate the application's specific demands and ensure that the failure system and cloud computing infrastructure are appropriately designed, programmed, and maintained to achieve peak performance and sustain an uninterrupted power source.

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