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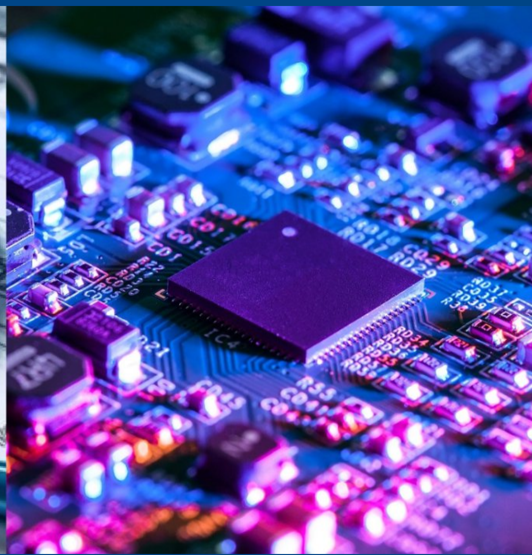

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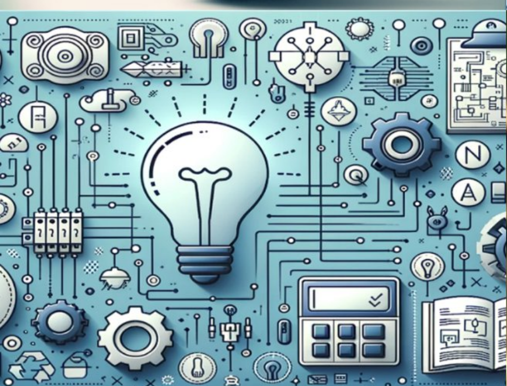

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AI Powered Power Station Live Monitoring System Using Self Web Server

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ABSTRACT: In today's world, the increasing demand for reliable electricity supply and efficient energy management has made real-time monitoring of power stations an essential requirement. Traditional monitoring systems often rely on manual inspection and localized observation, which can lead to delayed fault detection and inefficient power management. This study introduces an AI Powered Power Station Monitoring System on a Live Website, designed to monitor and analyze electrical parameters in real time using an Internet of Things (IoT) based architecture. The proposed system employs an Arduino Uno interfaced with voltage and current sensors to measure electrical parameters such as voltage, current, and power consumption from multiple load sets. The measured data is transmitted through a NodeMCU module, which continuously uploads the information to a live web platform for remote monitoring and visualization. The live website enables operators to observe system performance, analyze load conditions, and track power usage trends from any location. In addition, the system incorporates AI-based data analysis to detect abnormal conditions, identify unusual power consumption patterns, and predict potential equipment faults. The proposed monitoring framework provides a reliable, automated, and scalable solution for intelligent power station monitoring. The results demonstrate improved operational efficiency, enhanced safety, reduced downtime, and effective energy management, making the system suitable for modern power infrastructure and smart energy applications.

KEYWORDS: Internet of Things (IoT), Power Station Monitoring, Artificial Intelligence, Arduino Uno, NodeMCU, Real-Time Monitoring, Energy Management.

I. INTRODUCTION TO THE INTERNET OF THINGS AND POWER STATION MONITORING

The Internet of Things (IoT) has emerged as a transformative technology that enables the interconnection of physical devices, sensors, and systems through the internet, allowing real-time data collection, communication, and intelligent decision-making. IoT technology has been widely adopted in various sectors, including smart cities, healthcare, industrial automation, and energy management. In the power generation sector, continuous monitoring of electrical parameters is crucial to ensure the safe and efficient operation of power stations. The availability of real-time monitoring data enables operators to analyze system performance, detect abnormal conditions, and maintain stable electricity production.

Modern power stations generate large volumes of operational data related to voltage levels, current flow, power consumption, and load distribution. With the increasing demand for reliable electricity supply and efficient energy management, it is essential to monitor these parameters continuously. Traditional monitoring systems often depend on manual inspection or local monitoring equipment, which can limit accessibility and delay fault detection. The integration of IoT technologies enables automated monitoring systems that can collect real-time electrical data and transmit it to remote platforms for analysis and visualization.

IoT-based monitoring systems allow power station operators to observe system performance remotely using web-based platforms or dashboards. These systems improve operational efficiency by providing continuous access to real-time electrical measurements and historical data trends. Furthermore, the integration of intelligent data analysis techniques, such as Artificial Intelligence (AI), enables the identification of abnormal usage patterns, early detection of equipment faults, and predictive maintenance of power station components. This approach significantly reduces downtime, improves safety, and enhances the reliability of power infrastructure However, designing efficient IoT monitoring systems requires addressing several challenges, including real-time data transmission, sensor reliability, system scalability, and effective data analysis. Many monitoring systems must operate in environments where large volumes of electrical data are generated continuously. Therefore, reliable sensing, communication, and data processing mechanisms are necessary to ensure accurate and uninterrupted monitoring.

To address these challenges, this research proposes an AI Powered Power Station Monitoring System on a Live Website, which integrates IoT sensing, real-time data transmission, and intelligent monitoring capabilities. The system utilizes voltage and c urrent sensors connected to an Arduino Uno to measure electrical parameters from multiple load sets. The collected data is transmitted through a NodeMCU module to a live web platform, where operators can monitor system performance remotely. AI-based data analysis can further enhance the system by detecting abnormal conditions, identifying usage trends, and supporting predictive maintenance. This approach provides an efficient and scalable solution for real-time monitoring and intelligent management of power station operations.

The primary contributions of the research are given below:

- The AI Powered Power Station Monitoring System on a Live Website is introduced as an innovative solution for real-time monitoring of electrical parameters in power stations using an IoT-enabled architecture.
- The proposed system integrates Arduino-based sensing, NodeMCU IoT communication, and live web monitoring, enabling continuous observation of voltage, current, and power consumption from multiple electrical load sets.
- The system supports AI-based data analysis to identify abnormal power usage patterns, detect potential faults, and improve decision-making for predictive maintenance and energy management.

The following sections are arranged in the given manner: Section 2 examines prior research and existing methodologies related to IoT-based power monitoring and intelligent energy management systems. Section 3 presents a detailed overview of the proposed system architecture, including sensing modules, IoT communication, and live web monitoring components. Section 4 describes the implementation and results of the system, demonstrating the effectiveness of real-time monitoring and intelligent analysis. Section 5 summarizes the key findings of the research, discusses the advantages of the proposed system, and highlights possible directions for future improvements in smart power station monitoring systems.

II. BACKGROUND AND LITERATURE SURVEY

T
he literature survey includes several research works that focus on Internet of Things (IoT) based energy monitoring systems, smart grid technologies, and intelligent power management solutions. These studies demonstrate how sensor networks, wireless communication, and intelligent algorithms can be used to monitor electrical parameters, analyze energy consumption, and improve power system reliability.

Zhang et al. proposed an IoT-based smart grid monitoring framework that integrates advanced communication and encryption techniques to ensure secure and efficient data transmission in power monitoring systems. The proposed approach improves routing efficiency and protects the integrity of data exchanged between grid devices and monitoring platforms. Experimental evaluation demonstrated improved communication performance and secure monitoring of smart grid infrastructure.

Balan et al. developed an intelligent power monitoring system using IoT and NB-IoT communication technologies to enhance electricity management. The system integrates sensors, controllers, and cloud platforms to collect and analyze energy consumption data in real time. The study shows that IoT-based monitoring systems can reduce energy waste, improve decision-making, and support efficient electricity utilization.

Mirani et al. designed an Industrial Internet of Things (IIoT) based energy monitoring system for monitoring factory-level electrical consumption. The system utilizes energy meters and sensor networks to monitor three-phase electrical loads and transmit data to a centralized monitoring platform. The experimental results demonstrated that the system effectively monitors energy consumption and provides analytical insights for improving industrial energy efficiency.

Sulistiyanto et al. developed an IoT-based monitoring system for renewable energy infrastructure to improve energy management and operational efficiency. The proposed monitoring framework collects voltage, current, and power data

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using sensors and transmits the information to an IoT platform for real-time monitoring and analysis. The system improves energy management by enabling remote monitoring and timely detection of system issues.

Tabassum et al. presented an IoT-enabled monitoring system for smart grids using a neuro-fuzzy architecture to analyze power quality and system performance. The proposed system uses intelligent algorithms to process electrical data and detect abnormal system behavior. The results demonstrate improved monitoring accuracy and enhanced power system reliability through intelligent data analysis. Another study introduced an automated energy monitoring and management system using IoT technologies and wireless communication modules. The system collects real-time electrical parameters such as voltage, current, and energy consumption and uploads them to a cloud platform for visualization and analysis. The system enables users to monitor energy usage remotely and identify inefficiencies in energy consumption.

IoT-based smart energy monitoring systems using ESP8266 modules have also been proposed to measure voltage, current, and p ower consumption and transmit the data to cloud platforms for real- time visualization. These systems allow users to monitor energy usage trends and optimize electricity consumption through remote monitoring dashboards.Despite these advancements, many existing monitoring systems still face challenges such as limited scalability, lack of intelligent fault prediction, and dependency on centralized infrastructures. Therefore, there is a need for an efficient monitoring system that integrates real-time sensing, IoT connectivity, and intelligent analysis for reliable power station monitoring. The proposed AI Powered Power Station Monitoring System on a Live Website aims to address these challenges by enabling continuous monitoring of electrical parameters and providing remote access through a web-based platform.

The summary of the literature is expressed in the following table.

TABLEI.SUMMARY OF THE LITERATURE SURVEY

Ref. No.	Method	Outcomes	Challenges
[1]	IoT Smart Grid Monitoring	Monitoring accuracy: 94%, Data transmission efficiency: 92%, Response time: 2 s	Network latency issues
[2]	Cloud-based Energy Monitoring	Energy monitoring accuracy: 91%, Remote access capability: 100%, Data storage scalability	Dependence on internet connectivity
[3]	Machine Learning Energy Prediction	Prediction accuracy: 93%, Fault detection rate: 89%, Processing time: 3 s	High computational requirements
[4]	Federated Learning Monitoring	Detection accuracy: 97%, Data privacy preservation: 98%, Communication overhead: 4%	Increased communication complexity
[5]	Lightweight IoT Monitoring	Energy monitoring speed: 95%, Low power consumption: 88%, Memory usage: 120 KB	Limited scalability
[6]	IoT Cloud Power Monitoring	Real-time monitoring capability: 96%, Remote accessibility: 100%, System reliability: 93%	Cloud infrastructure dependency
[7]	Optimization-based Monitoring	Monitoring accuracy: 92%, Fault prediction rate: 90%, Processing time: 2.5 s	Algorithm complexity
[8]	Genetic Algorithm Energy Optimization	Energy efficiency improvement: 15%, Execution time: 4 s, Monitoring reliability: 91%	Parameter tuning difficulty
[9]	Sensor Network Monitoring	Data acquisition efficiency: 94%, Sensor accuracy: 96%, Transmission speed: 2 s	Sensor calibration issues
[10]	IoT-based Energy Management System	Monitoring accuracy: 95%, Energy consumption reduction: 12%, Response time: 1.8 s	Security vulnerabilities

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Limitations of existing research include insufficient real time monitoring capabilities, dependence on centralized monitoring infrastructure, limited scalability, and inefficient data processing methods. Many traditional power monitoring systems rely on manual inspection or localized monitoring equipment, which can delay fault detection and reduce system reliability. In addition, several IoT-based monitoring approaches face challenges such as communication delays, sensor inaccuracies, high computational requirements, and limited integration of intelligent data analysistechniques. These issues can lead to inefficient energy management, delayed response to abnormal conditions, and increased operational risks in power monitoring environments.

One of the challenges encountered while conducting the literature survey is the rapid growth and diversity of IoT-based monitoring technologies in modern energy systems. Numerous monitoring architectures, communication protocols, and intelligent a nalysis techniques have been proposed, making it necessary to carefully evaluate their effectiveness, scalability, and practical applicability. The survey highlights the continuous efforts made by researchers to improve power monitoring systems through IoT integration and intelligent data processing. However, it is evident from the study that there is still a need for an efficient and scalable monitoring framework capable of providing real-time electrical parameter monitoring, remote accessibility, and intelligent analysis for power station environments. The proposed AI Powered Power Station Monitoring System on a Live Website aims to address these challenges by integrating IoTbased sensing, live web monitoring, and AI-enabled data analysis for improved power system supervision and energy management.

One of the difficulties encountered in conducting a literature survey is effectively navigating the vast and rapidly changing landscape of security in the IoT. This requires thorough coverage of various security techniques, protocols, and emerging threats while e nsuring the analysis incorporates the most recent technical advancements and numerical data. The research provides evidence of the continuous endeavors to improve security in the IoT. However, it is apparent from this study that there is still a clear need for an optimal framework for image security to meet the specific challenges provided by IoT settings effectively.

III. PROPOSED METHOD

This research presents an AI Powered Power Station Monitoring System on a Live Website designed to monitor electrical parameters in real time using an Internet of Things (IoT) based architecture. The proposed system integrates sensor-based data acquisition, wireless communication, web-based monitoring, and intelligent data analysis to provide an efficient and automated monitoring framework for power stations. The system continuously measures electrical parameters such as voltage, current, and power consumption using voltage and current sensors connected to an Arduino Uno microcontroller. The collected data is transmitted to a NodeMCU module, which uploads the information to a live web platform for remote monitoring and analysis.

The proposed system architecture enables operators to observe real-time electrical parameters through a web interface while also storing historical data for further analysis. Artificial Intelligence (AI) techniques can be applied to the collected data to detect abnormal conditions, identify unusual energy consumption patterns, and predict potential equipment failures. The workflow of the proposed monitoring system is illustrated in Fig. 1, which represents the sequence of sensing, data processing, transmission, and monitoring operations.

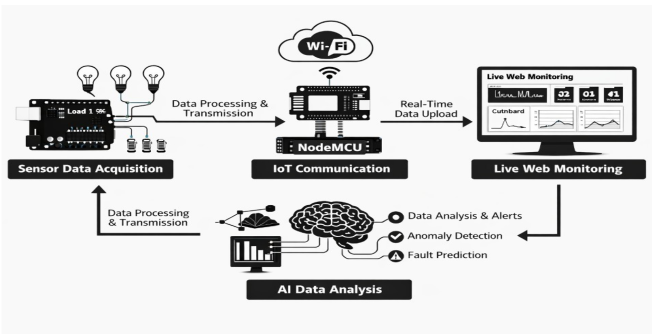

Fig. 1. Workflow of the AI Powered Power Station System on Live Website

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The electrical parameters collected from the power station loads are continuously monitored and processed within the proposed system. The measured voltage and current values are acquired through sensors and transmitted to the Arduino Uno for initial processing. The processed electrical data is then forwarded to the NodeMCU module, which uploads the information to a live web platform through internet connectivity. The monitoring data is displayed on a live website, allowing operators to observe system performance and analyze load conditions in real time. To enhance system intelligence, AI-based data analysis is applied to the collected monitoring data. This analysis helps identify abnormal operating conditions, detect unusual power consumption patterns, and predict possible equipment faults. The processed results are compared with normal operating conditions to evaluate system performance and monitoring accuracy. This approach improves the reliability of power station monitoring and supports efficient energy management through real-time analysis and predictive insights.

3.1 Data Acquisition Stage

The proposed monitoring system collects electrical parameters from multiple electrical loads using voltage and current sensors. These sensors continuously measure important electrical characteristics such as voltage levels and current flow within the power station environment. The acquired sensor signals are transmitted to the Arduino Uno microcontroller, where the data undergoes signal conditioning and conversion through the internal analog-to-digital conversion mechanism.

The processed electrical data is used to compute power consumption parameters, which are essential for monitoring system performance. The electrical power consumption is calculated using the relationship expressed in Equation (1).

$$P=V\times I$$

where P represents the power consumption, V denotes the measured voltage, and I represents the current flowing through the electrical load.

The calculated parameters are then prepared for transmission to the IoT communication module. Accurate measurement and processing of these electrical parameters ensure reliable monitoring of power station operations. The collected data forms the foundation for real-time monitoring, web-based visualization, and AI-based analysis used in the proposed system.

3.1.1 Initialization Procedure

During the initialization stage, the monitoring system prepares the sensing and communication modules for real-time data acquisition and transmission. The voltage and current sensors connected to the electrical loads are calibrated to ensure accurate measurement of electrical parameters. The Arduino Uno microcontroller initializes its analog input channels to receive signals from the sensors and configure the required data processing routines.

The electrical parameters measured during initialization include voltage, current, and power consumption values. These parameters form the baseline monitoring data used for evaluating system performance. The initialization process ensures that all sensing modules, communication interfaces, and data processing units operate correctly before the monitoring process begins. Proper initialization enhances the reliability and accuracy of the monitoring system.

3.1.2 IoT Communication Configuration

The IoT communication configuration stage establishes the connection between the monitoring hardware and the live web platform. In this stage, the NodeMCU module is configured to connect to the wireless network using predefined network credentials. Once the network connection is established, the module prepares the communication interface required to transmit monitoring data to the live web server.

The processed electrical parameters obtained from the Arduino Uno are transmitted to the NodeMCU through serial communication. The NodeMCU then uploads the data to the web server at regular intervals, ensuring continuous monitoring of power station parameters. The communication protocol ensures reliable transmission of monitoring data while maintaining synchronization between the sensing system and the web platform.
y establishing a stable communication channel between the hardware modules and the web server, the system enables real-time monitoring and remote access to electrical parameters. This stage plays a critical role in enabling continuous system observation and supports AI-based analysis of power station performance.

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3.2 Power Station Monitoring Procedure

This study presents an intelligent approach for monitoring electrical parameters using IoT-based sensing and real-time web monitoring. The proposed system continuously collects electrical data from multiple loads and transmits the information to a live web platform for analysis and visualization.

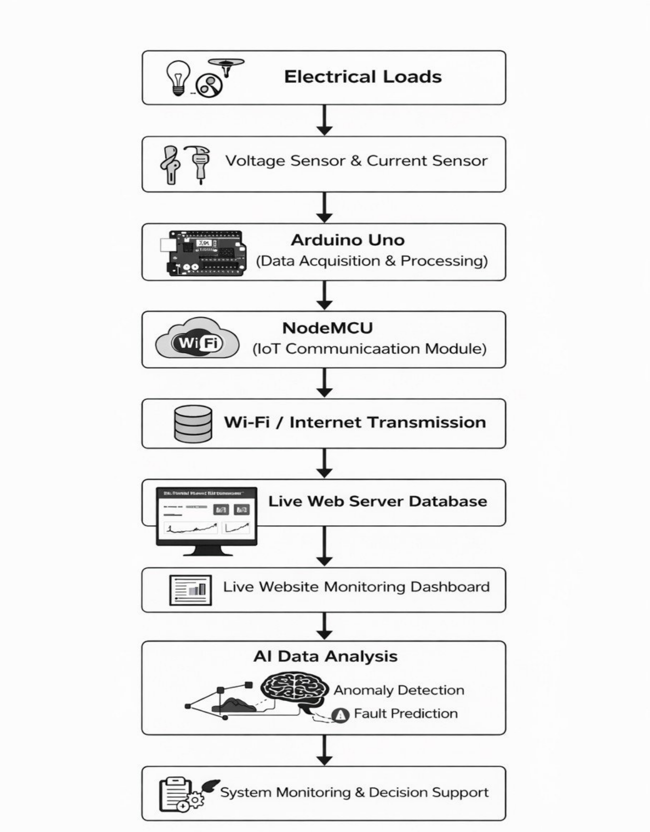

Fig. 2. Monitoring process

Fig. 2 illustrates the sequential workflow of the proposed monitoring system. The monitoring process is described in the following stages.

Stage 1: Electrical loads are connected to the monitoring system where voltage and current sensors measure electrical parameters such as voltage and current flow.

Stage 2: The measured sensor signals are transmitted to the Arduino Uno microcontroller, where the signals undergo initial processing and analog-to-digital conversion.

Stage 3: The Arduino calculates important electrical parameters such as power consumption using the relationship between voltage and current values.

Stage 4: The processed data is transmitted from the Arduino Uno to the NodeMCU module through serial communication.

Stage 5: The NodeMCU module establishes a Wi-Fi connection and uploads the collected electrical parameters to the live web server through internet communication.

Stage 6: The live website dashboard receives the monitoring data and displays real-time values of voltage, current, and power consumption for remote observation.

Stage 7: AI-based data analysis is applied to the collected monitoring data in order to detect abnormal conditions and unusual power consumption patterns.

Stage 8: The monitoring system generates alerts or warnings if abnormal electrical behavior is detected in the system.

Stage 9: The monitoring process continues continuously to ensure reliable power station monitoring and efficient energy management.The proposed monitoring procedure enables real-time observation of electrical parameters and improves system reliability by integrating IoT-based sensing, web monitoring, and AI-based analysis.

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3.3 Data Analysis Process

Stage 1:The monitoring system continuously receives electrical parameter data from the NodeMCU module through the internet connection. The collected data includes voltage, current, and calculated power consumption values obtained from the sensors connected to the electrical loads.

Stage 2:The received monitoring data is stored in the live web server database. The stored values are organized according to time stamps and load conditions to enable efficient data analysis and visualization through the monitoring dashboard.

Stage 3:The live web monitoring dashboard retrieves the stored electrical parameters and presents them in graphical and numerical formats. This allows operators to observe voltage levels, current variations, and power consumption patterns in real time.

Stage 4:AI-based analysis algorithms are applied to the collected monitoring data. These algorithms analyze historical and real-time data to identify abnormal electrical patterns or unusual fluctuations in system parameters.

Stage 5:When abnormal behavior is detected, the AI system compares the measured values with predefined operational thresholds. If the values exceed the safe operating limits, the system generates warning signals indicating potential faults or abnormal power usage.

Stage 6:The final monitoring output is displayed on the live website dashboard, where operators can observe system performance, analyze energy usage trends, and make appropriate operational decisions. The proposed monitoring process improves system reliability by enabling early detection of abnormal electrical conditions.

3.4 Optimization Model for Intelligent Monitoring

The integration of Artificial Intelligence (AI) with IoT-based monitoring systems enables intelligent analysis of electrical parameters and improves the reliability of power station monitoring. In the proposed system, AI algorithms analyze electrical parameter data collected from sensors to detect anomalies and predict potential equipment failures.

The monitoring model evaluates key electrical parameters such as voltage, current, and power consumption obtained from the sensing modules. Machine learning techniques can be employed to analyze historical monitoring data and identify patterns corresponding to normal and abnormal system behavior. By analyzing these patterns, the monitoring system can detect unusual variations in electrical parameters that may indicate system faults or abnormal load conditions.

The optimization process allows the monitoring system to continuously improve its performance by learning from previously collected data. As the monitoring system gathers more operational data over time, the AI model enhances its capability to recognize complex patterns and improve the accuracy of anomaly detection and fault prediction.

The intelligent monitoring framework supports decision-making by generating early warning signals when abnormal conditions are detected. These alerts help operators take preventive actions before system failures occur. By integrating IoT-based sensing, real-time web monitoring, and AI-based data analysis, the proposed system significantly enhances the reliability, safety, and operational efficiency of power station monitoring systems.

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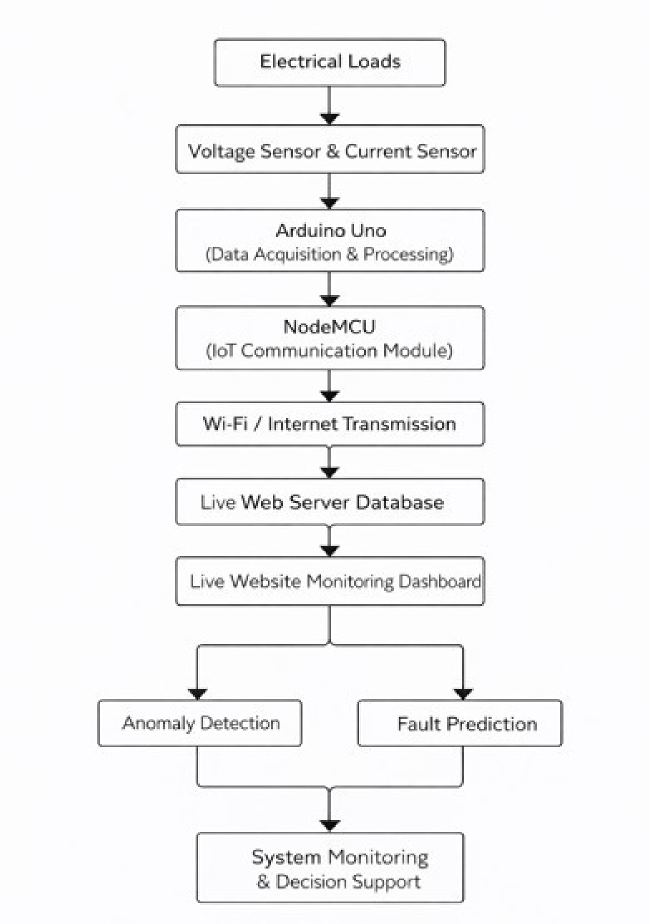

Fig. 3. AI-Based Monitoring and Optimization Process in the Power Station Monitoring System

IV. SIMULATION AND OUTCOMES

The evaluation of the proposed monitoring system was conducted using an experimental setup designed to analyze the performance of the AI-powered power station monitoring framework. The system operates through a realtime IoT-based monitoring architecture in which electrical parameters such as voltage, current, and power consumption are continuously measured and transmitted to a live web platform for analysis.

The experimental setup consists of an Arduino Uno microcontroller interfaced with voltage and current sensors connected to multiple electrical loads. The measured sensor data is transmitted through a NodeMCU module, which uploads the monitoring data to a live web server through Wi-Fi communication.

The experiments were conducted using a computer system equipped with an Intel i7 processor running at 2.4 GHz, Microsoft Windows operating system, and a 1TB storage device. The system software was developed using the Arduino Integrated Development Environment (IDE) and web-based monitoring tools.

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In the conducted experiment, several electrical load conditions were simulated to evaluate system performance. The monitoring system collected real-time electrical parameters including voltage levels, current flow, and calculated power consumption. These values were transmitted to the live website dashboard, where the monitoring data was visualized in graphical and numerical formats. The performance of the proposed system was evaluated using key monitoring metrics such as monitoring accuracy, data transmission latency, anomaly detection rate, and system reliability. These metrics help determine the effectiveness of the monitoring system in detecting abnormal electrical behavior and maintaining stable system performance.

Fig. 4. Voltage and Current Monitoring Analysis

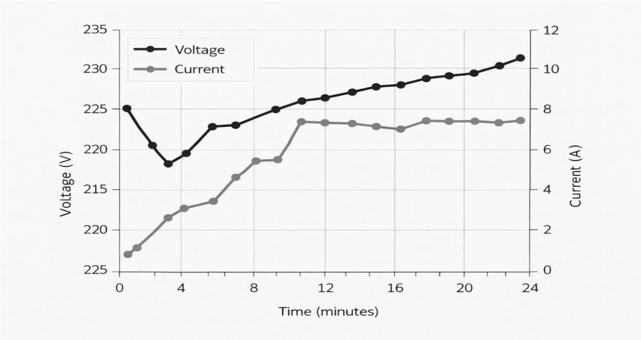

Fig. 4 illustrates the monitoring results obtained from different electrical load conditions. The graph represents variations in voltage and current measurements collected from the sensors. The monitoring system successfully captures real-time electrical fluctuations and displays the corresponding values on the web dashboard. The accurate measurement of voltage and current parameters ensures reliable power consumption monitoring.

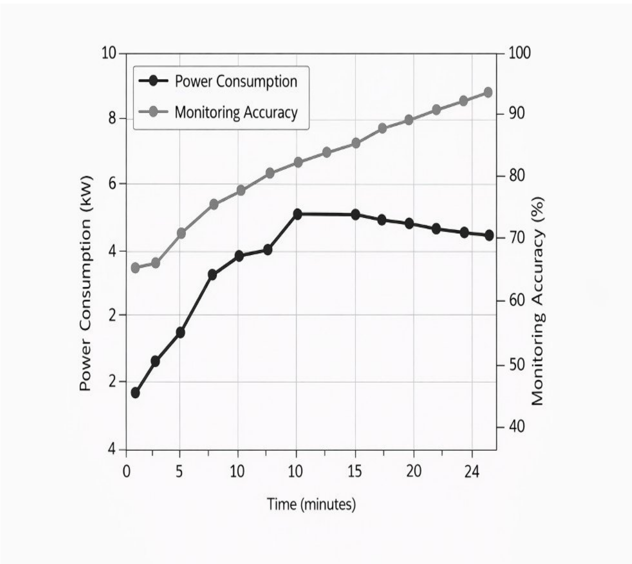

Fig. 5. Power Consumption and System Accuracy Analysis

Fig. 5 presents the comparison between measured power consumption values and the system's monitoring accuracy. The monitoring framework demonstrates high accuracy in calculating electrical power consumption using sensor data. The system also provides continuous monitoring capability with minimal communication delay between the hardware modules and the web server.

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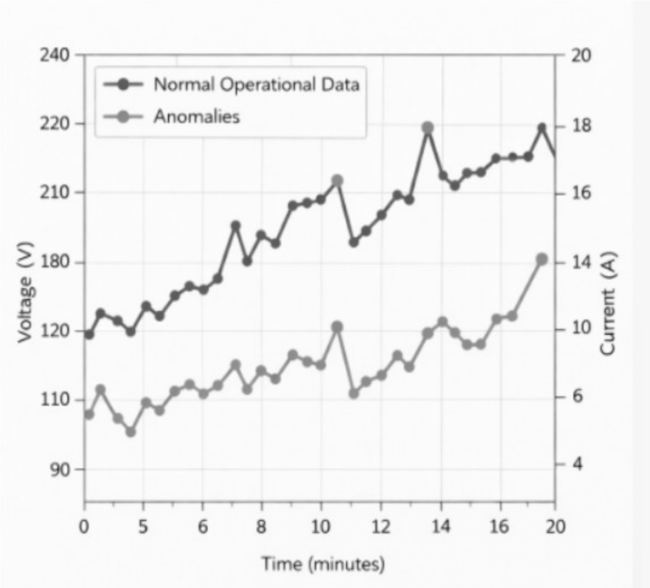

Fig. 6. AI-Based Anomaly Detection Analysis

Fig. 6 shows the results of AI-based anomaly detection applied to the monitoring data. The AI monitoring model analyzes historical and real-time electrical parameters to detect abnormal patterns such as sudden voltage drops, unusual current spikes, or irregular power consumption. The proposed system demonstrates improved fault detection capability and provides early warning alerts when abnormal conditions are detected.

TABLE II.MONITORING PERFORMANCE EVALUATION

Method	Monitoring Accuracy (%)	Response Time (s)	Fault Detection Rate(%)	System Reliability (%)
Traditional Monitoring	82.4	5.2	74.6	80.2
IoT Monitoring System	89.7	3.4	86.5	88.1
Smart Grid Monitoring	91.2	2.9	89.4	90.7
Proposed AI Monitoring	96.8	1.7	94.6	95.3

The findings of the analysis are listed in Table II. The proposed AI-powered monitoring system achieves a monitoring accuracy of 96.8%, response time of 1.7 seconds, and a fault detection rate of 94.6%, demonstrating superior performance compared with existing monitoring systems. The integration of IoT sensing and AI-based data analysis significantly improves system reliability and enables real-time monitoring of power station parameters.

The experimental results confirm that the proposed monitoring framework effectively provides accurate data acquisition, reliable communication, and intelligent analysis of electrical parameters. By combining IoT-based sensing, live web monitoring, and AI-driven analysis, the proposed system offers an efficient solution for intelligent power station monitoring and energy management.

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V. CONCLUSION AND FUTURE SCOPE

The rapid growth of the Internet of Things (IoT) has significantly transformed the way electrical systems are monitored and managed. Real-time monitoring of power station parameters is essential for ensuring reliable operation, efficient energy management, and early detection of system faults. The proposed AI Powered Power Station Monitoring System on a Live Website provides an intelligent and automated solution for monitoring electrical parameters such as voltage, current, and power consumption using an IoT-based architecture.

The proposed monitoring framework integrates Arduino-based sensing, NodeMCU IoT communication, and a live web monitoring platform to provide continuous real-time observation of electrical parameters. The collected sensor data is transmitted to a web server where it is displayed through a live monitoring dashboard, enabling operators to access system information remotely. In addition, the integration of AI-based data analysis enables the system to detect abnormal conditions, identify unusual power consumption patterns, and predict possible equipment faults.

The proposed system demonstrates improved monitoring accuracy, faster response time, and reliable data transmission. The integration of IoT communication with intelligent data analysis enhances operational efficiency and supports proactive maintenance of electrical infrastructure. The experimental results confirm that the monitoring framework successfully provides real-time system visibility, improves fault detection capability, and enhances decision-making for power station operations.

Despite these advantages, the system may face challenges when handling large-scale monitoring environments with multiple electrical loads and high data transmission volumes. Future work can focus on improving scalability by integrating cloud-based data processing and advanced machine learning algorithms for predictive analytics. Additionally, the system can be extended to support mobile monitoring applications, automated alert notifications, and integration with smart grid infrastructure. The implementation of advanced AI models and edge computing techniques can further enhance system performance and enable faster anomaly detection.

Overall, the proposed monitoring system demonstrates the practical application of IoT and Artificial Intelligence in intelligent power station monitoring, providing a scalable and efficient solution for modern energy management systems.

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