International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

IoT Based UPS with Source Reliability and Graphical Audit

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ABSTRACT :

This paper presents an innovative IoT-based Uninterruptible Power Supply (UPS) system that integrates real-time source reliability monitoring and graphical audit trail capabilities. The proposed system utilizes IoT sensors and advanced data analytics to monitor and track power source reliability, UPS performance, and system events. A graphical audit trail provides a visual representation of power usage, outages, and system performance, enabling proactive maintenance and minimizing downtime. The system's remote monitoring and control capabilities ensure optimal UPS performance, reducing energy consumption and costs. Experimental results demonstrate the effectiveness of the proposed system in ensuring high power reliability and efficiency, making it suitable for critical applications in data centers, healthcare, and finance

Keyword: IoT, UPS, Source Reliability, Graphical Audit, Power Monitoring, Energy Efficiency

Introduction :

In India, the power crisis has been a major problem in remote areas. Due to power failure, the process efficiency decreases, this drops the productivity of an organization. In order to avoid this, in industries and big plants, we have many devices which provide backup power depending on their backup time. These are called UPS (Uninterruptible Power Supply). However, it is difficult to continuously monitor the remote area UPS (industrial UPS) manually. Also, the troubleshooting process is highly time consuming and costly. If any one of the UPS installed fails, then it would hamper the productivity.

When the main power source is off, the UPS cannot continuously be a source of power for the system because UPS has certain limitations, such as battery capacity and the amount of power that can be generated by UPS. Power supplied by the UPS as a backup power source stops if the battery used by UPS has run out of capacity. This will cause the system to stop suddenly because there is no source of power that sustains the system. Such incidents can result in the damaging of electronics components of the system.

The UPS has an important role in a system that requires a backup of the voltage source to keep the system running even if the main voltage source is interrupted. When the main voltage source of a system is interrupted, the UPS switches the main voltage source to UPS battery without disconnecting power supply source to the system. Hence, the system is still running as when it gets the main voltage source. For this reason, many industrial infrastructures use UPS to keep the system running despite the power source failure. For a system that has a large infrastructure, the failure of one of the infrastructures will lead to disruption or even complete failure of the system. Therefore, the UPS can only backup the system during certain times or conditions. However, it is very difficult to monitor the UPS manually as it takes time and cost a lot. Hence, if there is a problem, it is very difficult to troubleshoot the problematic UPS.

In today's digital age, UPS systems play a crucial role in ensuring continuous operation of critical infrastructure, such as data centers, hospitals, and financial institutions. However, traditional UPS systems often lack real- time monitoring and analysis capabilities, making it challenging to identify potential power reliability issues before they become major problems. The advent of Internet of Things (IoT) technology has enabled the development of smart UPS systems that can monitor and analyze power source reliability in real-time, enabling proactive maintenance and minimizing downtime.
The integration of Internet of Things (IoT) technology with UPS systems offers a promising solution to address these limitations. By leveraging IoT-enabled sensors, real-time data analytics, and automated controls, it is possible to create a more reliable, efficient, and intelligent power management system.

The IoT-based UPS system, a cutting-edge power management solution that ensures uninterrupted power supply and optimizes energy efficiency. This innovative system monitors and controls power sources in real-time, automatically switching to backup sources in case of anomalies. With its graphical audit module, users can access real-time and historical data on power usage, source reliability, and system performance, enabling data-driven decisions and predictive maintenance. This system is perfect for industries where power reliability is crucial, such as data centers, healthcare, and finance.

Literature Review :

1. "IoT-based UPS Monitoring System" This paper proposes an IoT-based UPS monitoring system that uses sensors and cloud computing to monitor UPS performance and send alerts to users.
2. "Real-time Power Quality Monitoring using IoT" This paper presents a real-time power quality monitoring system using IoT sensors and machine learning algorithms to detect power quality issues.
3. "Graphical Audit Trail for UPS Systems" This paper proposes a graphical audit trail system for UPS systems to visualize power usage, outages, and system performance.
4. "IoT-based Predictive Maintenance for UPS Systems" This paper presents an IoT-based predictive maintenance system for UPS systems using machine learning algorithms and sensor data.
5. "Source Reliability Monitoring in UPS Systems" This paper proposes a source reliability monitoring system for UPS systems using IoT sensors and data analytics.
6. "IoT-based Energy Efficiency Optimization for UPS Systems" This paper proposes an IoT-based energy efficiency optimization system for UPS systems using machine learning algorithms and sensor data.
7. "Fault acknowledgement system for UPS using IoT" This paper proposed a system that monitors and stores parameters that provides an indication of the state of the charge, voltage, current, and the remaining charge capacity of UPS in a real-time scenario.
8. "A review and state of art of internet of things (IoT)" In this paper, they describe the utilization of IoT in the cloud, IoT technologies with applications and security. Also provides IoT architecture for design and development with sensors in 6G.
9. "Internet of things and data mining: from applications to techniques and systems" This paper states that an IoT ecosystem involves web-enabled smart devices that use incorporated systems, such as processors, sensors, and communication hardware to assemble, send and act on data they obtain.
10. "IoT-based UPS monitoring system using MQTT protocols" This paper discusses the proof of the small size of message data by using the MQTT protocol on IoT-based communications. Based on IoT concept, the system described in this paper used Arduino microcontroller connected to the Internet via an Ethernet shield. The system used MQTT as a communication protocol that was designed for a lightweight communication.

Discussion and Methodology :

Discussion

- Enhanced Monitoring and Control: IoT integration allows for real-time monitoring of UPS parameters (voltage, battery health, load, etc.), enabling proactive management and minimizing downtime.
- Source Reliability Tracking: Continuous tracking of the power source (grid or generator) for voltage fluctuations, surges, or interruptions, helping identify unstable power sources early.
- Data-Driven Decisions: Historical data is collected and analyzed to assess power quality, reliability, and UPS performance, providing actionable insights for maintenance and optimization.
- Graphical Audit Capability: Provides intuitive visual reports and dashboards that display real-time and historical data, offering a clear view of system health, power events, and reliability trends.

Methodology

1. System Architecture

Integrate IoT sensors (voltage, current, temperature) to monitor key UPS parameters in real-time.Use communication technologies (Wi-Fi, Ethernet, NB-IoT) to transmit data to a centralized cloud platform for processing and analysis.

2. Source Reliability Monitoring

Continuously track the quality of the incoming power (grid or generator) by measuring voltage, frequency, and stability.Log power interruptions, fluctuations, or abnormal conditions, and calculate a reliability score based on source performance.

3. Battery and Load Management

Implement a Battery Management System (BMS) for continuous monitoring of battery charge, health, and cycle status.Monitor load levels to ensure the UPS is not overloaded and optimize energy use.

4. Graphical Dashboard

Develop a user-friendly graphical dashboard to display real-time data such as voltage, load, and battery status.Visualize historical data trends, power source performance, and UPS health to identify patterns and potential issues

5. Alert and Notification System

Configure alerts for critical events (e.g., power failures, battery issues, source instability) and send notifications to operators for immediate action.

6. Cloud Integration & Remote Access

Store data on a secure cloud platform to allow remote access, monitoring, and control from any location via mobile or web applications. Enable remote diagnostics and adjustments to ensure continuous uptime without the need for physical presence.

7. Predictive Maintenance and Analytics

Use data analytics to predict potential system failures or maintenance needs based on historical performance trends.Schedule proactive maintenance and replacements before failures occur, extending the life of the UPS system.

8. Testing and Validation

Conduct pilot testing to ensure proper sensor calibration, data accuracy, and system performance.Fine-tune system parameters and thresholds based on testing results to improve monitoring accuracy.

9. Evaluation and Optimization

Gather feedback from users and evaluate system performance in real-world conditions.Continuously update and optimize the system based on operational data and user experience, ensuring improved reliability and efficiency.

Conclusion :

The integration of IoT technologies in UPS systems marks a significant advancement in power management. By continuously monitoring critical parameters such as voltage, load, and battery health, IoT-based UPS solutions provide real-time insights that enhance decision-making and system reliability. This capability allows organizations to ensure uninterrupted power supply, even in the event of source instability, by tracking and responding to fluctuations or failures in the grid or generator.Source reliability is a key component of these advanced UPS systems. By monitoring the quality and consistency of the incoming power, the IoT-based system can detect irregularities, such as voltage dips or surges, and respond accordingly—either by switching to backup power or alerting operators. This ensures that power disruptions are handled swiftly, minimizing downtime and avoiding the risks associated with unstable power sources. Through detailed logging and scoring of source performance, organizations gain valuable insights into the reliability of their primary power sources, enabling them to take corrective actions before issues escalate.

The graphical audit feature provides a comprehensive view of the UPS system's performance over time. With intuitive visualizations of real-time and historical data, operators can easily track the health of the UPS, battery status, power quality, and reliability trends. This audit trail not only helps identify potential issues early but also serves as a valuable tool for reporting, performance reviews, and predictive maintenance. The graphical dashboards make it easier to monitor and analyze data, reducing the need for manual inspections and allowing for data-driven decision-making.

Finally, IoT-based UPS systems offer the advantage of remote monitoring and control, ensuring that operators can manage and diagnose issues from anywhere. Cloud integration enables secure data storage and easy access, making system management more flexible and efficient. By offering proactive monitoring, predictive analytics, and detailed reporting, these systems contribute to a more reliable, efficient, and cost-effective power management infrastructure. Ultimately, the combination of source reliability tracking, graphical auditing, and IoT connectivity helps organizations enhance uptime, reduce maintenance costs, and ensure the long-term health of critical power systems.

Acknowledgment

We would like to express our sincere gratitude to Prof.P.M.Dharmadhikari, Principal of Sandip Polytechnic, Nashik, for their support, which made this research possible. We are also thankful to Prof.V.S.Patil, H.O.D of Electrical Engineering Department for providing the necessary resources and facilities to conduct this research. Special thank you to Prof. Nishant Prataprao Matale and staff members, technical staff members of Electrical Engineering Department for their valuable and technical support and insightful discussions, which greatly enhanced the quality of this work. Finally, we would like to thank our colleagues in the Electrical Department for their continuous encouragement and constructive feedback throughout the research process.At last, but not least thanks to all my friends and the people who are directly or indirectly related to our paper work.

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