UPS Monitoring System Using IOT and GSM

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ABSTRACT : Uninterruptible Power Supply (UPS) systems are critical for ensuring continuous operation of sensitive equipment during power interruptions. Traditional monitoring methods are limited by manual inspection and localized wired systems. This paper presents the design and implementation of an IoT-based UPS monitoring system using the Message Queuing Telemetry Transport (MQTT) protocol and Global System for Mobile Communications (GSM). The system enables real-time monitoring of UPS parameters such as input/output voltage, current, battery status, and temperature. Data is transmitted to a cloud platform and visualized through a graphical interface, allowing remote supervision and preventive maintenance. Experimental results show acceptable accuracy compared to standard instruments, with minor deviations in voltage and power readings. The proposed system increases scalability, efficiency, and reliability for large infrastructures such as hospitals, industries, and data centers.

Keywords: *Uninterruptible Power Supply (UPS), IoT Monitoring, MQTT Protocol, GSM Communication, Real- Time Monitoring, Cloud Platform, Remote Supervision.*

INTRODUCTION

An Uninterruptible Power Supply (UPS) is a critical electrical device designed to provide instant backup power to connected loads during interruptions or failures of the main power supply. UPS systems play a vital role in ensuring the continuous operation of sensitive equipment such as computers, servers, medical devices, industrial control systems, and communication infrastructure. As a result, UPS units are extensively used in industries, hospitals, data centers, educational institutions, banks, and office environments to protect equipment from power outages, Voltage fluctuations, surges, and spikes, thereby preventing data loss, hardware damage, and system downtime. Despite their importance, the effective monitoring and management of UPS systems remain a major challenge, especially in large-scale infrastructures where multiple UPS units are deployed across different locations. Traditional UPS monitoring methods rely heavily on manual inspection or localized monitoring, which requires frequent human intervention. Monitoring parameters such as input and output voltage, current, battery status, temperature, load condition, and power consumption on a continuous basis is difficult, time-consuming, and prone to human error. Moreover, the absence of real-time alerts can delay fault detection, leading to unexpected UPS failures and increased maintenance costs. To address these limitations, this project proposes an Internet of Things (IoT)-based UPS monitoring system utilizing the Message Queuing Telemetry Transport (MQTT) protocol. The proposed system enables real-time monitoring and remote supervision of UPS parameters through cloud connectivity. By using MQTT, which is a lightweight, low-bandwidth, and reliable communication protocol, the system efficiently transmits small-sized data packets over the network. The monitored data is stored on a cloud platform and visualized using a graphical interface, allowing authorized users to access UPS status from anywhere. Additionally, the system supports automatic alert generation during abnormal or fault conditions, enabling timely corrective actions. Overall, the proposed solution offers a scalable, efficient, and cost-effective approach for modern UPS monitoring in large infrastructures. These Real time Monitored data of UPS is displayed on our mobile phone application Thing Speak**.** It represent all data in Graphical form. We use ESP32 which have in-built Wi-Fi it ensuring the use of GSM technology that gives alert through SMS.

I. LITERATURE SURVEY

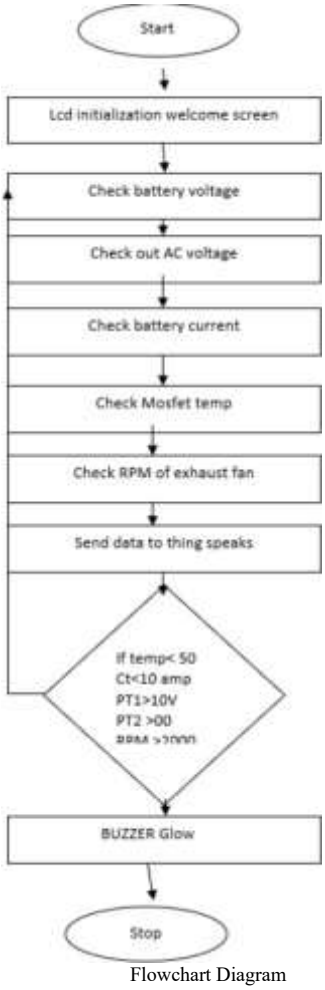
This intelligent UPS setups reduce downtime, which is vital in environments like medical facilities and IT infrastructure [1]. As modern infrastructures it increasingly depend on the uninterrupted power, the need for an intelligent and reliable for Uninterruptible Power Supply (UPS) systems that is more critical than ever [2]. By implementing this IoT- enabled extensions, this solution can be expanded to support the cloud-based dashboards and the SMS/email alerts, making it suitable as for the industrial, commercial, and critical healthcare environments where a UPS reliability is a non- negotiable[2]. One of the major challenges in the maintaining reliable power systems is the lack of an effective real-time monitoring of the UPS units and their battery status [2]. The adoption of IoT in battery monitoring has revolutionized how energy systems are managed and maintained. Researchers have demonstrated that by embedding sensors with microcontrollers and linking them to cloud services, a continuous stream of battery health data can be collected and analyzed in real-time [1]. Traditional UPS systems have limitations in monitoring and managing power parameters, such as insufficient real-time monitoring capabilities for voltage, current, and frequency, making it challenging to respond to and address faults in a timely manner [3]. IoT (Internet of Things) integrated power monitoring systems have been implemented utilizing commercially available products [4]. The effect of maintenance frequency on repairs costs has been investigated. In this reference, the effect of primary and back-up protection systems has been considered [5].

II. PROBLEM STATEMENT

Uninterruptible Power Supply (UPS) systems for safeguarding essential equipment against power outages and voltage fluctuations is increasingly undermined by the limitations of traditional monitoring practices. Current methods, which heavily depend on manual physical inspections or basic wired systems, are inherently labor- intensive, prone to human error, and lack the scalability required for large-scale infrastructure. These conventional approaches fail to provide real-time data or remote accessibility, meaning that critical faults—such as battery degradation, overheating, and inverter malfunctions—often remain undetected until a catastrophic system failure occurs. Such delays in fault detection pose a severe threat to business continuity, particularly in high-stakes environments like hospitals, data centers, and industrial production lines, where even momentary downtime can result in life-threatening situations, permanent data loss, or significant financial deficits. Furthermore, as UPS units are themselves susceptible to environmental stressors and component aging, the absence of a centralized, automated supervision framework leaves organizations vulnerable to unexpected power interruptions. Consequently, there is an urgent need for an integrated IoT and GSM-based monitoring solution that provides instantaneous alerts and remote diagnostics to ensure the reliability and safety of modern electrical infrastructures.

III. PROPOSED METHODOLOGY

The IoT and GSM-based UPS monitoring system follows a structured approach of data acquisition, processing, and remote transmission. The hardware setup integrates an ESP32 microcontroller with a Hall-effect based ACS712 current sensor and a voltage sensing module to measure real-time electrical parameters. The software logic, developed in the Arduino IDE, converts raw analog signals into calibrated values for voltage, current, and power. The process begins with initializing hardware and establishing Wi-Fi and MQTT broker connectivity. The microcontroller acts as a publisher in a publish-subscribe model, transmitting processed data to the Thing Speak cloud platform and a custom GUI for visualization. A critical phase of the methodology is the automated fault detection. The system continuously compares live readings against predefined safety thresholds for parameters like battery voltage and temperature. If these limits are breached, the system immediately triggers alert mechanisms—including SMS notifications via the GSM module or dashboard warnings—to ensure rapid response and prevent equipment damage. This automated flow minimizes human intervention and improves overall system reliability.



Flowchart Diagram

IV. RESULTS AND IMPLEMENTATION

The implementation of the proposed IoT-based UPS monitoring system involves both hardware setup and software deployment. Proper integration of these two parts ensures accurate monitoring, reliable data transmission, and real-time visualization of UPS parameters.

The hardware setup includes assembling and interconnecting all the required components such as the ESP32 microcontroller, voltage sensor, current sensor, power supply unit, and the UPS system under monitoring.

i. The ESP32 microcontroller is mounted on a development board and powered using a regulated DC power supply.

ii. The voltage sensor is connected across the UPS input and output terminals to measure voltage levels. A voltage divider or voltage sensor module is used to scale down high voltage to a safe range for the ESP32 ADC.

iii. The current sensor (ACS712) is connected in series with the UPS load to measure the current drawn by the load.

iv. A regulated power supply provides stable 5V or 3.3V DC to the ESP32 and sensors.

v. Proper grounding and electrical isolation are maintained to ensure safety and reduce noise.

Fig.1. Hardware Setup

The software deployment involves developing and uploading code via the Arduino IDE to the ESP32 microcontroller. The development process focuses on programming sensor interfacing for raw analog data collection, followed by ADC calibration to derive precise voltage and current values. For connectivity, the system integrates Wi-Fi routines and MQTT client libraries to facilitate cloud communication. Leveraging the C/C++ based Wiring library, the code is structured into setup and loop functions, compiled into a hexadecimal file, and flashed onto the board. This ensures seamless data transmission from the hardware to the monitoring interface.

Fig.2. Result Graph of Battery Voltage

Fig.3. Result Graph of Load Current

Fig.4. Result Graph of Temperature

V. CONCLUSION

The proposed UPS Monitoring System using IoT and GSM concludes as a reliable and scalable solution for addressing the inefficiencies of traditional manual monitoring. By integrating an ESP32 microcontroller with the lightweight MQTT protocol, the system successfully achieves real-time data acquisition and remote supervision with high precision, showing an error. The implementation of automated alerts via GSM and cloud-based visualization through ThingSpeak ensures that critical faults like overheating or battery discharge are detected early, significantly reducing the risk of catastrophic failures in mission-critical environments such as hospitals and data centers. Ultimately, this project demonstrates that leveraging IoT technology enhances the overall safety, efficiency, and reliability of modern power infrastructure while minimizing the need for labor-intensive human intervention.

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