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IoT Based Battery Monitoring Unit in Electric Vehicles

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Abstract: *Electricity theft, inefficient energy monitoring, and delayed billing are major challenges in conventional power distribution systems. This project presents an IoT and GSM based smart energy meter capable of real-time energy monitoring, overload detection, and theft identification. The system continuously measures electrical parameters such as voltage, current, and power using energy meter sensors and processes the data through a microcontroller. IoT connectivity enables remote monitoring through cloud platforms, while the GSM module provides instant alerts during abnormal conditions such as overload or unauthorized power usage. The proposed system reduces manual meter reading, improves billing accuracy, enhances consumer awareness, and ensures safe and efficient energy utilization.*

Keywords: IoT, GSM, Smart Energy Meter, Electricity Theft Detection, Overload Protection, Real-time Monitoring, Microcontroller, Cloud-based Energy Management

I. INTRODUCTION

Electricity is a vital resource for modern society, but power systems face significant losses due to inefficient monitoring and electricity theft. Conventional energy meters lack real-time tracking, making it difficult to detect unauthorized usage and overload conditions. To overcome these challenges, an IoT and GSM-based smart energy meter system is introduced. This system enables continuous monitoring of energy consumption, early detection of theft, and instant communication with users and utility providers. By integrating smart technologies, the proposed solution enhances transparency, safety, and efficiency in energy management.

II. PROBLEM STATEMENT

Traditional energy metering systems suffer from delayed billing, manual readings, and inability to detect power theft or overloads in real time. These limitations lead to revenue loss for utility companies and increased electricity costs for consumers. There is a need for an automated, intelligent system that can monitor energy usage continuously, detect abnormal conditions, and provide instant alerts using IoT and GSM technologies.

III. LITERATURE REVIEW

1. Belgali et al. developed an IoT system to monitor battery voltage, current, and SOC, providing real-time range estimation and alerts for abnormal conditions.
2. Karuppsamy et al. implemented microcontroller and wireless-based real-time battery monitoring, emphasizing continuous remote visibility of performance.
3. Wahab et al. used GSM and cloud connectivity to track battery health, voltage, and temperature, enabling centralized monitoring.
4. Insia et al. integrated safety features, preventing overcharging and thermal risks, enhancing decision-making for charge/discharge processes.
5. Priya et al. proposed a low-cost Arduino and Wi-Fi system with mobile app visualization and alert generation for battery parameters.

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6. Recent studies added advanced safety functions like fire detection and automated battery disconnection alongside real-time cloud storage.
7. Overall, IoT-based systems improve remote monitoring, data accuracy, historical tracking, and early warning, enhancing traditional BMS for better diagnostics and maintenance

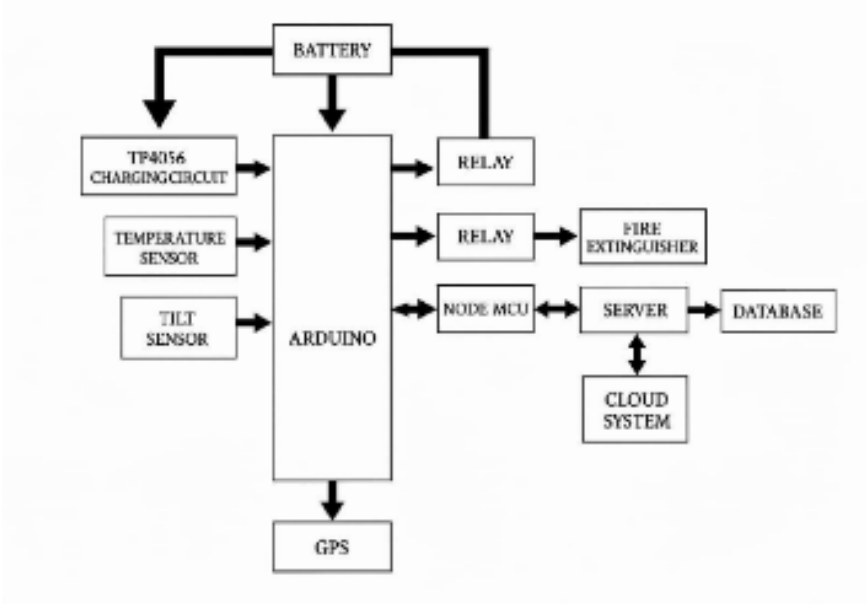
IV. METHODOLOGY

The system is built around a microcontroller that collects voltage and current data from energy sensors. This data is processed to calculate real-time power consumption. A Wi-Fi module uploads readings to an IoT cloud platform, while a GSM module sends SMS alerts to users. Theft is detected by comparing main meter and sub-meter readings, and overload conditions are identified when consumption exceeds predefined limits. The entire process operates automatically with minimal human intervention..

WORKING

The smart energy meter continuously measures electrical parameters such as voltage, current, and power. The microcontroller analyzes this data to compute energy usage. If abnormal conditions like overload or power theft are detected, the system triggers alerts through GSM and updates the IoT dashboard. Users and utility providers can remotely monitor consumption, receive alerts, and take corrective actions instantly.

V. BLOCK DIAGRAM



ADVANTAGES

- Enables real-time energy monitoring through IoT
- Detects electricity theft accurately
- Provides overload protection to prevent damage
- Reduces manual meter reading and human error
- Improves billing accuracy and transparency
- Sends instant alerts using GSM
- Enhances safety and energy efficiency

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VI. LIMITATIONS

- Requires reliable internet and GSM connectivity
- Higher initial installation cost
- Possible data security concerns
- GSM alert delays in poor network areas
- Needs periodic maintenance and updates

VII. CONCLUSION

The IoT and GSM-based smart energy meter is an effective solution for real-time electricity monitoring, theft detection, and overload protection. It minimizes manual intervention, improves billing accuracy, and enhances consumer awareness. By integrating smart technologies, the system contributes to efficient energy utilization and reduced power losses in modern electrical networks.

VIII. FUTURE SCOPE

Future enhancements include online electricity bill payment, mobile apps for advanced energy analytics, and AI-based energy consumption prediction. The system can also support automatic power disconnection during severe theft and integration with smart grids for efficient, reliable, and intelligent energy management.

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