E-Vehicle Charging Station Parameters Monitoring And Protection System

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Abstract- *The increasing adoption of electric vehicles (EVs) has highlighted the need for efficient, safe, and intelligent charging infrastructure. This paper presents a smart EV charging station monitoring and protection system designed to enhance battery safety, optimize charging efficiency, and enable remote control. The system integrates voltage, current, and temperature sensors to monitor charging parameters in real time. A microcontroller processes the sensor data, detects fluctuations or overheating, and automatically disconnects the power supply to prevent damage to the battery.The implementation of this system ensures enhanced battery lifespan, improved energy efficiency, and increased reliability of EV charging stations. By leveraging automation and IoT technology, this solution contributes to the development of a secure and sustainable EV charging infrastructure.*

I. INTRODUCTION

With the rise of electric vehicles (EVs), reliable and efficient charging infrastructure is crucial. This model proposes a smart E-Vehicle Charging Station Monitoring and Protection System that continuously tracks key parameters like voltage, current, temperature, and power usage while implementing safety mechanisms to prevent overloading, short circuits, and overheating.

With the rapid adoption of electric vehicles (EVs), the demand for efficient and safe charging infrastructure has increased significantly. Charging stations play a crucial role in ensuring reliable energy supply for EVs, but challenges such as power fluctuations, overheating, and overcharging can impact battery performance and lifespan. Traditional charging stations often lack real-time monitoring and control, making it difficult to detect faults and optimize charging processes.To address these challenges, a smart EV charging station monitoring and protection system is essential. This system integrates sensors to measure voltage, current, and temperature, ensuring safe and efficient charging. A microcontroller processes real-time data, detects abnormalities, and automatically disconnects power in case of fluctuations or overcharging. Additionally, an IoT-enabled interface allows remote monitoring and control via a web or mobile application, enhancing user convenience and system reliability.By implementing this intelligent monitoring and protection system, EV charging stations can improve battery health, reduce risks, and optimize energy consumption. This innovation supports the large-scale adoption of EVs while ensuring safe and efficient charging infrastructure.

As the adoption of electric vehicles (EVs) increases, ensuring efficient and safe charging becomes a critical challenge. Fluctuations in power supply, overheating, and overcharging can damage EV batteries, reducing their lifespan and efficiency. Additionally, traditional charging stations lack real-time monitoring and remote-control capabilities, making it difficult to track charging status, power consumption, and faults. To address these issues, a smart EV charging station monitoring and protection system is needed. This system should integrate sensors to track voltage, current, and temperature, use a microcontroller for real-time data processing, and provide IoT-based remote monitoring and control. By implementing such a system, battery health can be safeguarded, charging efficiency improved, and users can manage charging operations remotely for enhanced reliability and safety.

II. LITERATURE SURVEY

The proposed system ensures safe EV battery charging by monitoring voltage, current, and temperature using sensors. A microcontroller processes data, compares it with set cutoff values, and disconnects supply in case of fluctuations or overcharging. Users can set charging time via a keypad and receive alerts via an IoT-enabled app. The system enhances battery life, performance monitoring, and remote control, making it compatible with various EV batteries. [1]

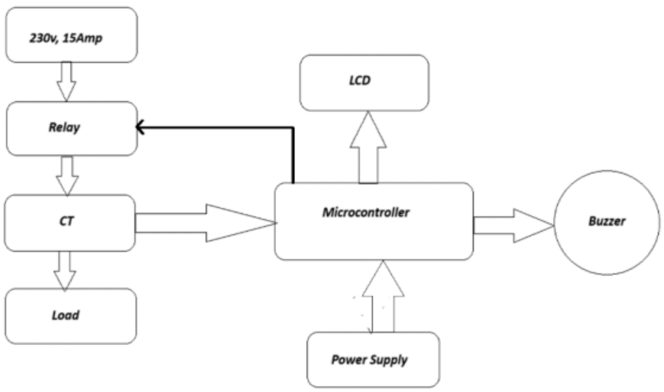

Fig.1: Block diagram of EV Charing and Monitoring System

This paper presents the design and implementation of a charging station aimed at enhancing the charging process while ensuring authentication and monitoring functionalities. The proposed charging station integrates advanced technology to enable seamless communication between the EV, charging station, and utility grid. Overall, this System represents a significant advancement in EV charging technology, offering enhanced security, efficiency, and intelligence.

This paper presents a cost-effective charging station management system using STM32 as a data exchange interface between the host computer and the charger. Charge data is transmitted to a PC, where a monitoring system developed in LABVIEW optimizes message decoding and enhances system intelligence. By reducing reliance on high-cost industrial computers, the proposed method improves reliability, efficiency, and human-machine interaction. [2]

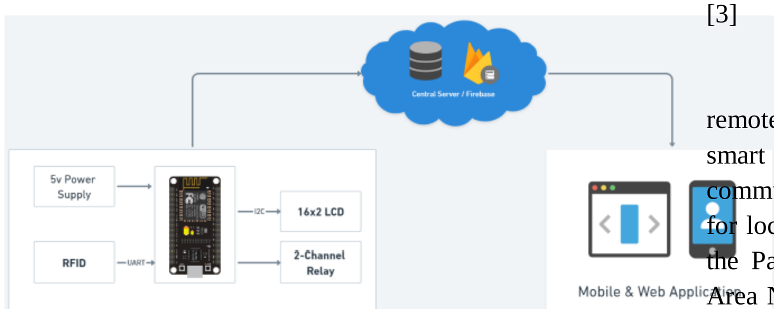

Fig.2: Charging station management system using STM32

The currently present proposed system consists of charging station hardware, a mobile app for vehicle owners (users), and an admin panel for charging station owners. charging stations can provide service to global users because of the central management system. These Networked charging stations are made up of many EVSEs that are managed by a central monitoring system, often known as a Charging Station Management System (CSMS) or Central Management System (CMS). Because multiple users require access to multiple EVSEs in different locations, the system must support networked searching, authentication, monitoring, billing, and payment processes.

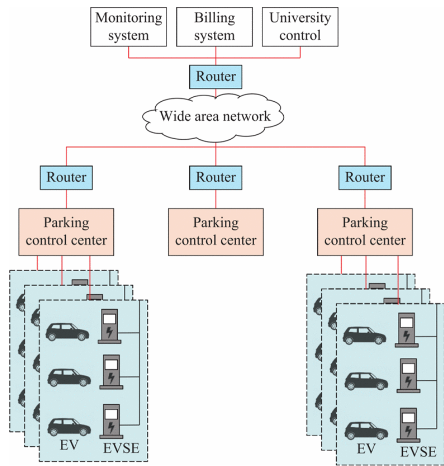

Fig.3: Remote Monitoring of Electric Vehicle ChargingStations

This presently an EV charging station monitoring system using NodeMCU and the Open Charge Point Protocol (OCPP). NodeMCU, based on the ESP8266 Wi-Fi module, acts as a gateway between charging stations and a web application, enabling real-time data collection and remote monitoring. OCPP ensures standardized communication, while the web application provides a dashboard displaying charging status, power usage, and availability. Secure encryption protects data, enhancing reliability. This system optimizes charging management, improves user experience, and supports interoperability across various charging station manufacturers. [3]

This work explores communication networks for remote monitoring of EV charging stations (EVCSs) in a smart campus parking lot. It proposes a two-tier communication structure: The Parking Area Network (PAN) for local communication between EVs, charging stations, and the Parking Lot Local Controller (PLLC), and the Campus Area Network (CAN) for global coordination. To address the challenge of integrating EVCSs with the power grid, communication models based on IEC 61850 standards are developed. Using OPNET Modeler, different network configurations and technologies are analyzed, with a focus on minimizing end-to-end delays for improved system performance. [4]

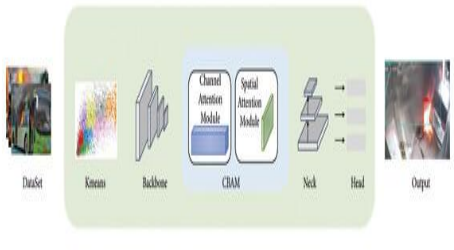

Fig.4: Structural diagram of algorithm

The presently proposed system is the first step of the YOLO series algorithm in the process of target detection is to generate candidate regions (anchor box). In the combustion process of lithium battery, the state changes are complex and dramatic, with great uncertainty, so this method uses the K-means algorithm to recluster the target location of the features in the dataset to get the anchor box based on the lithium battery combustion feature dataset and used for training.

III. PROPOSED SYSTEM

The proposed E-Vehicle Charging Station Parameters Monitoring and Protection Systemis designed to ensure safe, efficient, and reliable charging for electric vehicles by continuously tracking critical parameters such as voltage, current, temperature, and power consumption. The system consists of key components, including a regulated power supply unit, a microcontroller for processing data, and various sensors to monitor real-time charging conditions. A voltage sensor tracks input and output voltage levels, a current sensor measures the charging current, and a temperature sensor detects any overheating in the system. Additionally, an energy meter records the power consumption for accurate billing and energy management.

To enhance safety, the system incorporates several protection mechanisms such as overvoltage and undervoltage protection to prevent fluctuations from damaging the vehicle's battery, overcurrent protection to avoid excessive power draw, short-circuit protection to prevent electrical hazards, and thermal shutdown in case of overheating. In case of abnormal conditions, automatic shutdown mechanisms are triggered, and users are notified via alerts or messages, ensuring a proactive approach to fault detection.The system also facilitates data logging, allowing operators to track historical charging patterns, optimize power consumption, and perform predictive maintenance.

The proposed E-Vehicle Charging Station Monitoring and Protection System is designed using an ATmega 238 microcontroller**,** integrating key components for real-time monitoring and safety. The system receives a 230V AC input from the power grid, which is stepped down using a transformer, rectified, filtered, and regulated before supplying power to the circuit. An LED indicator shows the system's operational status. Various sensors, including fire, temperature, and humidity sensors**,** continuously monitor environmental and electrical conditions, ensuring that the charging station operates safely. If any abnormal conditions arise, the system activates protection mechanisms such as a relay-driven water pump for fire safety, a cooling fan for temperature control, and a buzzer alarmto alert users of hazards. A 16x2 LCD display provides real-time updates on voltage, temperature, and system status, allowing users to monitor the charging station's performance easily. The microcontroller processes sensor data and automatically takes corrective actions, ensuring a highly efficient and reliable monitoring and protection systemfor electric vehicle charging stations.This model provides an intelligent, secure, and efficient solution for EV charging stations by integrating real-time monitoring with robust protection features. It enhances user experience, ensures electrical safety, and supports the growth of sustainable transportation.

IV. CONCLUSION

The automated protection features, including overvoltage, overcurrent, and short-circuit detection**,** enhance system security, while additional safety mechanisms likea relay-driven cooling fan, a water pump for fire safety, and a buzzer alarm for alerts ensure quick responses to abnormal conditions. Furthermore, the IoT-enabled remote monitoring feature allows users to track and control charging processes from anywhere, contributing to better energy management and user convenience.By implementing this intelligent monitoring and protection system**,** EV charging stations can significantly enhance battery lifespan, improve energy efficiency, and reduce risks associated with electrical failures**.** This model not only supports the growing adoption of EVs but also contributes to the development of sustainable and smart charging infrastructure**,** aligning with global efforts to create safer and more efficient transportation solutions**.**

Advantages

- Enhanced Safety **–** The system prevents overcharging, overheating, and short circuits through real-time monitoring and automatic fault detection mechanisms.
- Improved Battery Lifespan – By maintaining optimal charging conditions and preventing overvoltage or excessive current, the system helps extend the lifespan of EV batteries.

- Real-Time Monitoring – Sensors continuously track key parameters like voltage, current, and temperature, ensuring immediate detection of abnormalities.
- Automated Protection Mechanisms – Features like overcurrent protection, overvoltage protection, thermal shutdown, and short-circuit prevention enhance the safety of the EV charging process.
- IoT-Based Remote Monitoring **–** Users can monitor charging status and control operations via a mobile or web application**,** improving convenience and accessibility.
- Energy Efficiency – The system optimizes power consumption and prevents unnecessary energy loss, making EV charging more efficient.
- User Alerts and Notifications **–** The system provides instant alerts through a buzzer alarm, LCD display, and IoT notifications to inform users of faults or abnormal conditions.
- Fire and Heat Management – Integrated fire sensors, temperature sensors, and a cooling fan ensure heat dissipation and reduce fire hazards.
- Cost-Effective Solution **–** By automating monitoring and protection**,** the system minimizes maintenance costs and reduces potential damage to EV batteries.
- Scalability and Compatibility **–** The system can be adapted for various EV models and charging stations**,** ensuring flexibility for different infrastructure needs.

REFERENCES

[1] Prince A. Kumar, Sreesha S. Shetty, Prem S. das Gautam S. Salve, Nikesh B. Ranotkar, Vijay S. Patil, "EV BatteryCharging Protection and Monitoring", International Journal of Research Publication and Reviews, Vol 5, no 1, pp 2754-2757 January 2024.

[2] Qian Liu, XiaoJin Yan, LiPeng Zhang, "Design of monitoring system for electric vehicle chargingstation based on LabVIEW and STM32", Journal of Physics: Conference Series 2005 (2021) 012207IOP Publishingdoi:10.1088/1742-6596/2005/1/012207.

[3] Miss Minal Nitin Songirkar, "Electric Vehicle Charging Station Monitoring using Open Charge Point Protocol",International Journal of Scientific Research in Engineering and Management (IJSREM), Volume: 07 Issue: 10 | October - 2023 SJIF Rating: 8.176 ISSN: 2582-3930.

[4] Mohamed A. Ahmed, Mohamed R. El-Sharkawy, and Young-Chon Kim, "Remote Monitoring of Electric Vehicle ChargingStations in Smart Campus Parking Lot", JOURNAL OF MODERN POWER SYSTEMS AND CLEAN ENERGY, VOL. 8, NO. 1, January 2020.

[5] Shan T., Wang Z., Hong J., Qu C., Zhang J., Zhou Y., and Hou Y., Overview of "Mechanical abuse-thermal runaway" of electric vehicle power battery and its safety prevention and control technology, Journal of Mechanical Engineering. (2022) 58, no. 14, 252–275.

[6] Xia Z., Pan X., Song S., Li L. E., and Huang G., Vision transformer with deformable attention, Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, June 2022, New Orleans, LA, USA, 4794–4803.