IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Development Of An Iot-Based Adaptive Charging System For Electric Vehicles

[1]Miss. Mandakini R. Dhavale, [2] Mr. Rajendra B. Nimbalkar, [3] Miss. Pramila R. Gavhane, [4] Mrs. Sneha N. Satbhai,

[5]Mr. Krushna B. Thorat,

[2]HOD, [1,3,4]Professor, [5]Student

[1]Mechatronics Department,

[1]Pravara Polytechnic, Loni Maharashtra, India

Abstract: This paper presents an IoT-based electric vehicle (EV) charging system that adapts charging parameters based on the specific requirements of each vehicle. The system incorporates an IoT module to communicate between the EV and the charger, dynamically adjusting the voltage and current supplied to the car. Experimental results demonstrate the system's efficiency in reducing charging time and optimizing safety by preventing overcharging. The study highlights the advantages of integrating IoT into EV charging systems, providing a more flexible and adaptive solution compared to traditional chargers.

***Index Terms* -** IoT, EV charging, dynamic voltage adjustment, smart grid, adaptive charging system.

I. INTRODUCTION

Electric vehicles (EVs) are rapidly gaining popularity, leading to an increasing demand for efficient charging solutions. Traditional charging systems often fail to adapt to the specific requirements of different EV models, resulting in inefficient charging and safety concerns such as overcharging. This paper introduces an IoT-based adaptive EV charging system that adjusts charging parameters dynamically based on real-time vehicle data, optimizing the charging process while ensuring safety. The system leverages IoT for communication between the EV and the charger, enhancing the overall flexibility and adaptability of the charging process.

Electric vehicles (EVs) are witnessing significant growth in adoption worldwide, driven by the need to reduce carbon emissions and shift towards sustainable transportation. As the number of EVs increases, so does the demand for a robust charging infrastructure. The availability of fast, efficient, and safe charging systems is critical to supporting this growth.

However, the current charging solutions face several challenges in meeting the diverse requirements of different EV models.

Traditional EV chargers, typically classified into Level 1, Level 2, and DC fast chargers, deliver a fixed voltage and current. While this might suffice for basic charging needs, these systems are not flexible enough to handle the variations in battery specifications and charging protocols across different EV models. Each electric vehicle has unique charging requirements based on its battery capacity, state of charge (SoC), and temperature, which, if not properly accounted for, can lead to inefficient charging or even safety risks such as overcharging, overheating, and reduced battery life.

The lack of adaptability in current systems not only affects the efficiency of the charging process but also increases the risk of degrading battery health over time. Batteries are highly sensitive to charging conditions, and delivering a higher voltage or current than required can cause irreversible damage. Moreover, EV users often experience long waiting times due to the lack of optimized charging solutions, further discouraging the broader adoption of electric vehicles.

To address these limitations, this paper proposes an IoT-based adaptive EV charging system that dynamically adjusts the charging parameters—such as voltage and current—based on real-time data received from the EV. By leveraging the Internet of Things (IoT), the charging system communicates with the vehicle's onboard management system to gather critical information, including the vehicle's current battery status, charging capacity, and other specifications. This data enables the charger to optimize power delivery in real-time, ensuring that the vehicle receives the exact voltage and current it requires.

The integration of IoT technology into EV charging systems offers several advantages. Firstly, it allows for remote monitoring and control, giving users and charging station operators the ability to oversee the charging process from anywhere using cloud-based platforms. Secondly, IoT facilitates smart grid integration, enabling the charging system to participate in energy management strategies, such as load balancing and time-of-use pricing, to optimize energy consumption and reduce strain on the grid during peak hours. Thirdly, by continuously monitoring the charging conditions and the vehicle's requirements, the system can enhance safety by automatically adjusting or halting the charging process if unsafe conditions, such as overheating or overvoltage, are detected.

In addition to its adaptability and safety features, the proposed system offers scalability and interoperability. The IoT-based architecture can be scaled to support multiple charging stations, making it ideal for commercial and public charging networks. Moreover, by using standardized communication protocols, such as MQTT or HTTP, the system can be easily integrated with different EV models and brands, ensuring broad compatibility across the market.

The research presented in this paper focuses on the design and development of the IoT-based adaptive charging system, followed by a performance evaluation to assess its efficiency, safety, and user experience. Experimental tests were conducted with various EV models, each having different charging requirements, to demonstrate the system's capability to dynamically adjust charging parameters in real- time. The results showed a significant improvement in charging efficiency and a reduction in safety risks compared to traditional chargers.

By providing a more flexible and intelligent charging solution, the proposed IoT-based system not only enhances the EV charging experience but also contributes to sustainable energy management. As electric vehicles continue to play a crucial role in reducing carbon emissions, the need for smarter, safer, and more efficient charging systems becomes ever more important. This paper aims to pave the way for future developments in smart EV charging infrastructure, ultimately supporting the global transition to clean energy.

Several studies have explored the application of IoT in EV charging, focusing on smart grid integration and remote monitoring. However, existing solutions often lack dynamic adaptability to different vehicle models. Recent advancements in IoT communication protocols, such as MQTT and HTTP, provide opportunities to develop more flexible charging systems. Our study builds on this research by introducing a system that adapts the charging process based on specific vehicle data and requirements.

- **System Design and Architecture**

The proposed system consists of an EV charger, a microcontroller, and an IoT module (ESP32) that communicates with the vehicle's onboard system. The car sends its charging requirements (voltage and current) to the charger via the IoT module. A display connected to the charger shows real-time data such as the vehicle's model and charging status. The system dynamically adjusts the charging voltage based on the vehicle's needs, ensuring safe and efficient power delivery.

- **Algorithm Development**

The charging algorithm begins by retrieving the vehicle's charging requirements through IoT communication. It then adjusts the charger's output voltage and current to match the vehicle's specifications. Throughout the charging process, the system monitors voltage and current levels, adjusting the power delivery as needed. The algorithm also includes safety mechanisms to shut off charging if any unsafe conditions, such as overheating or overcharging, are detected.

- **Implementation**

The system is implemented using an microcontroller, ESP32 IoT module, and an Mobile display. The IoT module communicates with the vehicle using the MQTT protocol. The charging process is monitored using voltage and current sensors, while the microcontroller dynamically adjusts the charger's output. A platform stores real- time data, enabling remote monitoring of the charging process. The software is developed using C and C++ for the embedded systems, with a mobile app interface for remote control.

RESEARCH METHODOLOGY

The proposed IoT-based EV charging system was developed using an STM32 microcontroller for charging control and an ESP32 for IoT communication. The system dynamically adjusts charging voltage and current based on real-time data from the vehicle. Key components include voltage/current sensors, an display, and the MQTT protocol for communication between the EV and the charger. The charging algorithm retrieves the vehicle's charging specifications, adjusts the charger's output, and monitors voltage and temperature for safety. If unsafe conditions occur, charging is halted, and alerts are sent via the IoT module. Experiments were conducted with multiple EV models to evaluate charging efficiency, safety, and the usability of the display interface. Data was collected on voltage, current, and charging time, and the system's performance was compared to traditional chargers.

IV. BLOCK DIAGRAM

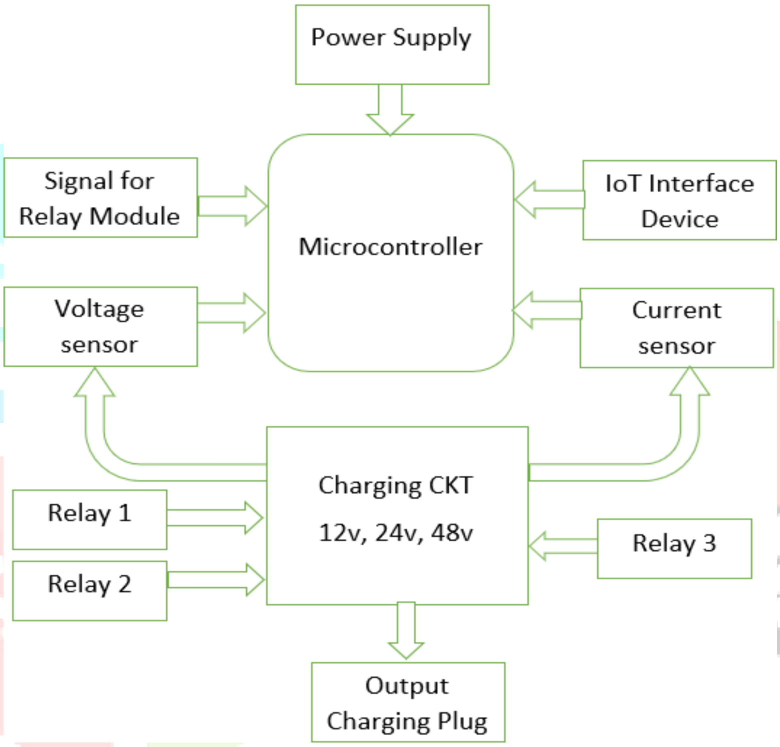

Fig.1 EV charging System

CONCLUSION

This paper presents an innovative approach to improving electric vehicle (EV) charging infrastructure by integrating an IoT-based adaptive charging system. The system is designed to dynamically adjust charging parameters, such as voltage and current, based on the specific requirements of each vehicle. By leveraging IoT communication protocols, the system facilitates real- time data exchange between the vehicle and the charging unit, allowing for efficient and safe charging processes. The experimental results demonstrate the effectiveness of the system in improving both charging efficiency and safety. Vehicles with different battery specifications were able to charge optimally, with reduced charging times and enhanced protection against overcharging and overheating. The inclusion of IoT-based remote monitoring adds another layer of convenience, enabling users and operators to oversee the charging process in real-time through cloud platforms. In comparison to traditional EV charging systems, which often deliver fixed voltages and currents, the proposed system offers significant advantages in flexibility and adaptability. The system's ability to dynamically adjust charging parameters improves overall battery health, as it prevents overvoltage and ensures that the battery receives the optimal amount of energy based on its state of charge and temperature. The scalability of the system is another critical benefit. The IoT-based communication infrastructure allows multiple charging units to be deployed in public or commercial settings, all managed from a centralized cloud platform. Furthermore, the use of standardized protocols like MQTT ensures interoperability with a wide range of electric vehicle models, making the system suitable for various manufacturers. Despite its advantages, the system has some limitations. For instance, the reliance on stable IoT networks means that areas with poor connectivity may experience delays in data transmission, potentially affecting the charging process. Additionally, further work is required to optimize the system for high-traffic environments where multiple vehicles may be charging simultaneously.

REFERENCES

[1] Ramasamy, Suresh Kumar & Pk, Rajesh & Nancy, J. & Abirami, S. & Murthy K, Vishnu. (2020). IoT-Based Monitoring and Management of Electric Vehicle Charging Systems for DC Fast Charging Facility. 10.1007/978-3-030-32530- 5_10.

[2] K. Friansa, I. N. Haq, B. M. Santi, D. Kurniadi,E. Leksono, and B. Yuliarto, “Development of Battery Monitoring System in Smart Microgrid Based on Internet of Things (IoT),” in Procedia Engineering, 2017, vol. 170, pp. 482–487. doi: 10.1016/j.proeng.2017.03.077.

[3] F. Mohammadi and R. Rashidzadeh, “An Overview of IoT-Enabled Monitoring and Control Systems for Electric Vehicles; An Overview of IoT-Enabled Monitoring and Control Systems for Electric Vehicles,” 2021.

[4] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto- optical media and plastic substrate interface,” IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[5] S. S. Arya, M. T. Talluri, and V. Karthikeyan, “An IoT enabled electric tricycle monitoring system,” Jul. 2020. doi: 10.1109/SCES50439.2020.9236699.

[6] D. P. Kingma and M. Welling, “Auto-encoding variational Bayes,” 2013, arXiv:1312.6114. [Online]. Available: https://arxiv.org/abs/1312.6114

[7] N. K. Golla, S. K. Sudabattula, and V. Suresh, “An IoT based approach for EV charging Station Locator,” in 2021 4th International Conference on Recent Developments in Control, Automation and Power Engineering, RDCAPE 2021, 2021, pp. 422–425. doi: 10.1109/RDCAPE52977.2021.9633642.

[8] M Tejaswini and J. Shivdas, “Implementation of Charging Station for E-Vehicle using Solar Panel with IOT,” 2020. [Online]. Available: www.jetir.org

[9] M. Tejaswini and J. Shivdas, “Survey on Charging Station for E-Vehicle using Solar Panel with IOT,” 2020. [Online]. Available: www.jetir.org

[10] Arunkumar P and Vijith K, “IOT Enabled smart charging stations for Electric Vehicle.” [Online]. Available: http://www.ijpam.eu

[11] V. Ravindran, R. Ponraj, C. Krishnakumar, S. Ragunathan, V. Ramkumar and K. Swaminathan, "IoT-Based Smart Transformer Monitoring System with Raspberry Pi," 2021 Innovations in Power and Advanced Computing Technologies (i-PACT), 2021, pp. 1-7, doi: 10.1109/i-PACT52855.2021.9696779.

[12] Ravindran V, Vennila C. An energy efficient clustering protocol for IoT wireless sensor networks based on Cluster supervisor management. Comptes rendus de l’Académie bulgare des Sciences. 2021 Dec;74(12).

[13] S. Urooj, F. Alrowais, Y. Teekaraman, H. Manoharan, and R. Kuppusamy, “IoT based electric vehicle application using boosting algorithm for smart cities,” Energies (Basel), vol. 14, no. 4, Feb. 2021, doi: 10.3390/en14041072.