International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 06 | June - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

Refuelling of Electric Vehicle Batteries Using Blockchain Technology

Nikhil Arte, Vishal Singh

MASTER OF COMPUTER APPLICATION OF

ASM's Institute of Management and Computer Studies, Thane

University of Mumbai, India

Abstract

Battery Exchange is a solution for refueling electric vehicle (EV) batteries using a decentralized blockchain system. The current centralized systems lack trust and transparency, making it challenging for EV owners and exchange stations to ensure the accuracy and fairness of battery and transaction information. To address this, we propose an objective mechanism based on blockchain to manage battery exchanges and solve the trust problem. The blockchain ensures the immutability and traceability of battery life cycle information and operating histories. Smart contracts drive key processes, such as calculating battery prices and facilitating digital currency exchanges between EV owners and stations. We analyze and implement a prototype based on Ethereum to demonstrate the feasibility of using blockchain for managing battery exchanges and addressing the trust issue.

Introduction:

The rapid development of EV technologies has significantly reduced greenhouse gas emissions and fuel costs for electric vehicle drivers. However, the process of refueling EV batteries remains a challenge. Traditional centralized systems store battery and transaction information unilaterally, leading to fairness concerns, especially for EV owners. To address this, we propose using a distributed and secure blockchain system to establish trust in the battery swapping process.

Blockchain and Smart Contracts:

Blockchain, initially introduced in Bitcoin, is a distributed ledger system that ensures transaction immutability and decentralization. It stores data in blocks chained together, making it difficult for hackers to tamper with transactions. Smart contracts, executable codes on the blockchain, provide self-governance and decentralization. They automatically execute predefined rules and conditions, ensuring fair and just transactions.

Smart Contracts for Battery Exchange:

We design three smart contracts to facilitate battery exchange. The Battery Process contract manages battery information, including static properties (e.g., manufacturing time, brand) and dynamic status updates (e.g., charging times, remaining capacity). The contract also handles ownership between the farm and account, allowing for configuration, information retrieval, and property management.

The Balance Process contract manages the electrical parts of different users, using a token called E-coin as the system's currency. It calculates prices for battery transactions and facilitates automatic transfer of e-money between accounts.

The Battery Interface contract provides an API interface for terminal users, including station operators, EV owners, and a super account representing the battery manufacturer. Station operators manage batteries belonging to the station and process trade-in requests from EV owners. EV owners can manage their batteries and send swap requests to stations. The super account manages the gas required for invoking smart contracts and receives electronic parts from station operators and EV owners when purchasing batteries.

Benefits of Blockchain for EV Charging:

There are a number of potential benefits of using blockchain for EV charging, including:

Security: Blockchain is a secure technology that can help to protect EV charging transactions from fraud and cyberattacks.

Transparency: Blockchain provides a transparent record of EV charging transactions, which can help to build trust between EV owners, charging providers, and grid operators.

Efficiency: Blockchain can help to improve the efficiency of EV charging networks by making it easier for EV owners to find and use charging stations.

Reliability: Blockchain can help to improve the reliability of EV charging networks by making it easier for charging providers to manage their networks.

Use Cases for Blockchain in EV Charging

There are a number of potential use cases for blockchain in EV charging, including:

Charging station management: Blockchain can be used to manage charging stations, including tracking the availability of charging ports, managing payments, and recording charging transactions.

EV charging network management: Blockchain can be used to manage EV charging networks, including tracking the location of charging stations, managing the capacity of charging networks, and recording charging transactions.

EV charging billing: Blockchain can be used to bill EV owners for charging services, including tracking the amount of energy used, managing payments, and recording charging transactions.

EV charging market: Blockchain can be used to create a decentralized EV charging market, where EV owners and charging providers can directly trade charging services.

Implementation of Ethereum-based Cyber-Physical Battery Refueling System:

Due to the development of battery technologies and environmental awareness, EV technologies have developed rapidly over the past decades. With the large-scale use of EV technologies, greenhouse gas emissions can be reduced and energy use can be more efficient. However, refueling the battery is still an issue that has not been addressed well. There are three main methods of refueling electric vehicle batteries: alternating current (AC)charging, direct current (DC) charging, and battery swapping. It's convenient but time consuming. It will take more than eight hours to fully recharge a depleted EV battery by charging it with AC power. DC charging can be provided by a charging station. It will take you 1-2 hours to fully charge a depleted EV battery by charging DC power. DC charging may damage the EV battery due to the large power. Battery swapping is the least time consuming of the three methods of refueling the EV battery. It will only cost you a few minutes to replace a dead battery with a fully charged battery by a battery swap station. Tesla Inc. and NIO Inc. introduced their EV battery swap technologies in 2013 and 2017 respectively, suggesting that battery swap may be a promising solution for EV battery refueling. A blockchain-based EV battery exchange system (in the form of a web application) was proposed to evaluate the batteries to be fairly traded by smart contracts and to manage the 8 pieces of information of the batteries such as its manufacturer, brand, power capacity. , price and supply history. It is actually an IoT scenario to use our previous blockchain-based EV battery exchange system in real life, as battery exchange stations and EVs need to be connected to the internet, and cyber interaction - physical battery information must be involved. In this section, we check if our blockchain-based IoT solution can be used in the EV battery swap scenario.

IOTA Tangle Integration:

While Ethereum provides smart contract functionality, IOTA's Tangle offers a scalable solution with no transaction fees. However, IOTA currently lacks smart contract support, requiring a master node to manage application logic. Integration of IOTA's Tangle with Ethereum's smart contracts presents challenges but offers potential benefits in scalability and fee-less transactions.

Maintenance of the Blockchain:

The implementation and testing of the proposed solution focus on a private blockchain. In practice, authorization methods and peer node management need to be considered. Consortium blockchain networks may be applicable, requiring control over peer node addition, removal permissions, and maintaining the checkout power of each peer node.

Challenges of Blockchain for EV Charging

There are a number of challenges that need to be addressed in order to implement blockchain-based EV charging solutions, including:

Scalability: Blockchain is a relatively new technology, and it is not yet clear how scalable it is for EV charging applications.

Cost: Blockchain-based EV charging solutions can be expensive to develop and deploy.

Regulation: The regulatory environment for blockchain-based EV charging solutions is still evolving.

Conclusion and Future Work:

We propose a blockchain-based solution to ensure trust in battery exchanges for EVs. By recording battery information on the blockchain and utilizing smart contracts, we automate the assessment of battery quality, considering degradation over time and during recharge cycles. The solution ensures fair transactions between EV owners and station operators. Future work involves optimizing code for depreciation rate calculations, simulating real environments, exploring cost-efficient networks, and conducting.

References

[1] A.G. Boulanger, A.C. Chu, S. Maxx, etal., “Vehicle electrification: Status andissues”, Journal, Proceedings of the IEEE, 2011, 99(6): 1116-1138.

[2] S. Nakamoto, “Bitcoin: A peer-to-peer electronic cash system”, white paper, 2008.

[3] G. Wood, “Ethereum: A secure decentralised generalized transactionl ledger”, Ethereum Project Yellow-Paper,2014.