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CurbPark Slot Management System Using Peer To Peer Network Over Blockchain

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Abstract: Through the use of a peer-to-peer network over a blockchain, this project offers a novel approach to resolving the issues related to managing parking spaces. By utilizing cutting-edge technologies and applying a modular architecture, the goal is to revolutionize the way parking spaces are reserved, allotted, and monitored. Users of the park may easily look for available parking spaces and make reservations thanks to the user module's simple interface. It offers up-to-the-minute information on parking availability, ensuring a smooth and effective parking experience. A distributed ledger is created by connecting data blocks that are securely encrypted with user parking information. Blockchain technology improves the system's security by safeguarding user data and enabling secure transactions. The project's scope includes creating a user-friendly interface that makes the reservation procedure easier for park visitors.

Index Terms **– Curbpark, Blockchain technology, security, distributed ledger.**

I. INTRODUCTION

Due to the increasing rise of urbanization and the lack of parking spots in cities, parking has become one of the most popular complaints among people. Building multi-level parking infrastructure is one way to enhance the number of cars that can be parked in a specific quantity of space. Despite being more popular, the biggest disadvantage of this option is the significant infrastructure investment and continuing maintenance. Encouragement of the use of public transport, including buses, trains, metros, etc., is another answer to the parking problem. However, in less developed nations, public transport could not be highly effective or provide a wide range of coverage. The peer-to-peer network that underpins the blockchain system collectively maintains a data ledger with the customary characteristics of tamper-resistant, non-repudiable, and publicly verifiable transaction records. Many different industries have shown a lot of interest in it, including the exchange of financial and medical intelligence, the smart grid, the Internet of Things, and smart cities [1][4]. The following characteristics of blockchain technology make it particularly well suited to address the aforementioned problems in the parking sector of today. First, existing infrastructure like Internet-connected automobiles, park management firms, and portable smartphones [2] might naturally include blockchain's peer-to-peer network backbone. As a result, it will be less expensive to create the blockchain infrastructure. Second, the blockchain is created and maintained by all participants[3]. An individual who uses a blockchain service network also contributes to it. The distributed network will automatically disseminate the service transaction. Therefore, the customary middleman or third trust party's additional service fee is no longer required. Third, everyone can access the blockchain. Personal park areas and unopened official parks are examples of private park resources that can easily and flexibly join the blockchain for sharing and obtaining particular rewards[5]. This will encourage sharing of private park resources between users, considerably easing the parking issue in urban traffic. This initiative aims to utilize blockchain's potential to improve urban parking situations. A methodical plan for a new parking-sharing service network based on blockchain technology is being developed.

The goal of Curb Park, a brand-new blockchain-based parking-sharing network, is to provide a viable, affordable, and open infrastructure for sharing parking resources. In particular, Curb Park provides a flexible and trustworthy way to share private park resources and collect parking fees. The expansion of Curb Park has the potential to considerably promote extensive resource sharing for parking, which would help alleviate the parking problem in urban traffic. Numerous experiments have been conducted in Curb Park.

The system uses the SHA 256 algorithm for cryptographic operations to increase security and immutability. This widely used technique guarantees the continued integrity of the data stored on the blockchain. The system is far more resistant to tampering and forgery thanks to the implementation of SHA 256, which offers an additional layer of security against unauthorized modifications. The proof-of-work approach is also used within the network to validate and authenticate parking transactions. The method makes sure that only valid and confirmed transactions are added to the blockchain by making users complete computationally challenging challenges. Through this proof-of-work procedure, the system's security is improved, malicious activity risk is reduced, and the fairness and dependability of the parking management procedure are all guaranteed.

2. SYSTEM ARCHITECTURE

The proposed system consists of two modules: user and admin. The user module is where parkers use to reserve parking spots, and the user parking data is stored in data blocks that are in the shape of a distributive ledger, and blocks of data are connected. Data blocks are saved in blockchain servers after the administrator double-checks and makes the necessary adjustments.

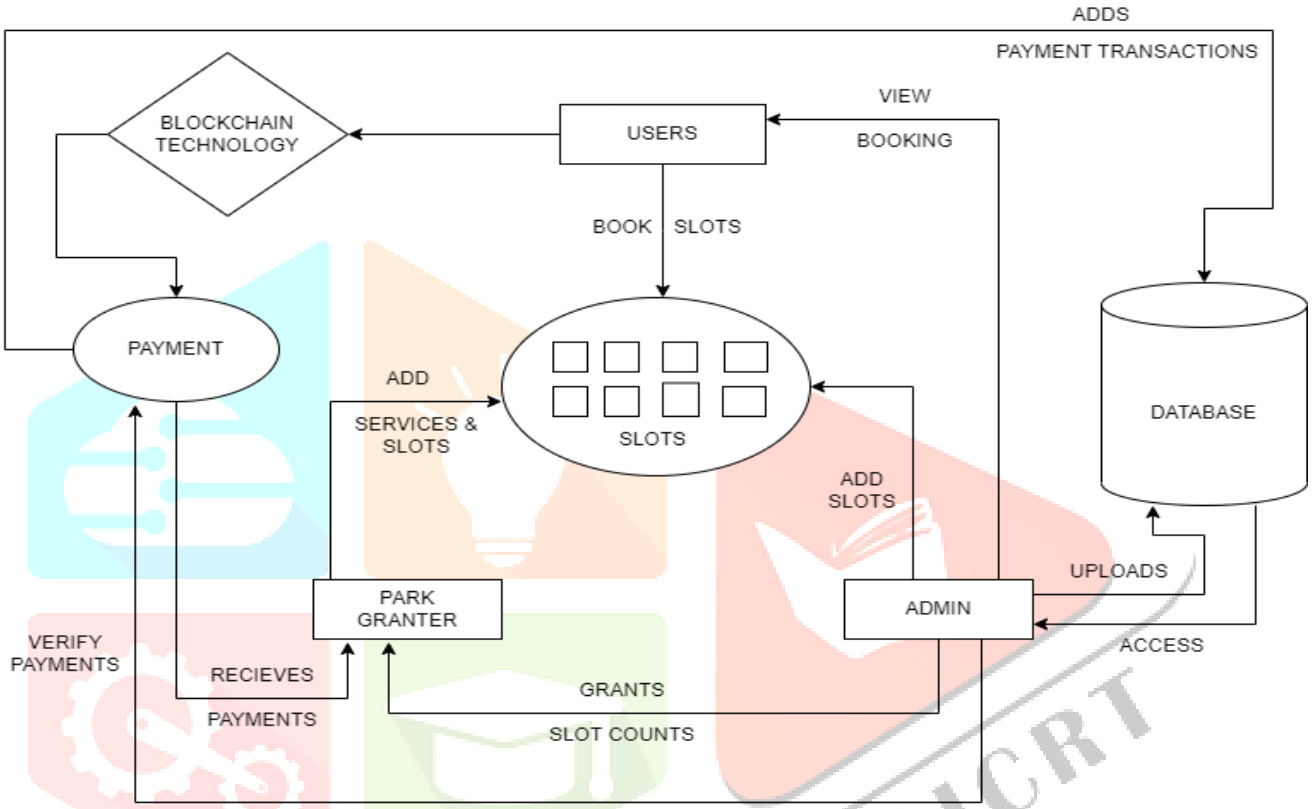


Fig 1: System Architecture

1. User module: The User Module begins with the user registration and login process. Users are required to create accounts by providing their contact information and creating login credentials. when the login setup is done the user can book parking near desired locations and can finish their payment. This step is essential for assuring individualized access to the platform and enables users to make use of all of its features.

2. Admin module: The admin module has a central dashboard that gives managers access to and control over various system components. And the managers can add and remove parking locations, This feature allows system administrators to monitor system performance and make informed decisions based on data insights.

3. Park granter: the granter module adds slot counts in location and the granter helps the user for further process in parking locations and they help to keep the user's vehicle safe.

4. Peer-to-Peer Network: To enable centralized and secure communication between users and parking nodes, the system makes use of a peer-to-peer network. Each network user serves as both a client and a server, enabling direct communication without the requirement of a central authority.

5. Blockchain Network: The blockchain network is the central element of the system. All parking transactions are recorded on a distributed ledger that makes up the system. The data is secure, transparent, and unchangeable thanks to the blockchain. Each block's contents are encrypted and hashed using the SHA 256 method to guarantee its integrity.

6. Smart contracts: Within the blockchain network, smart contracts are used to automate and enforce the rules of parking transactions. These contracts include stipulations regarding payment processing, access control to parking places, and parking length. The agreed-upon actions are automatically carried out by the smart contracts if the requirements are satisfied.

2.1 BLOCK CHAIN TECHNOLOGY

The term "blockchain" refers to a system that is employed to store and confirm data regarding parking space reservations, transaction histories, and user bookings in the form of data blocks. This project's implementation of blockchain is centralized. Blockchain technology is commonly associated with decentralization in its conventional form, which is when a dispersed network of nodes works together to sustain and validate the accuracy of the data. Instead of emphasizing centralization, this project employs blockchain implementation largely for its properties relating to data security, transparency, and immutability.

The blockchain used in this project is a private or permissioned blockchain. A single business or a collection of dependable participants runs the network in a private blockchain. Even in a private or permissioned situation, the project can use specific capabilities and benefits using a blockchain.

These may consist of:

1. Data Integrity: Thanks to the blockchain, data that has been recorded cannot be updated or altered without leaving a trace. This provides extremely high immutability and data integrity.

2. Transparency: The blockchain allows for transparent transactions and data accessibility. Users may check the legality of transactions and follow the history of parking space reservations.

3. Security: Using blockchain technology provides enhanced security measures, such as encryption and cryptographic hashing, to protect the recorded data. Thus, there is a lower chance of unauthorized access to or alteration of sensitive data.

2.2 PHP LANGUAGE

Web development typically makes use of the server-side scripting language PHP, also known as hypertext pre-processor. It is used to implement back-end operations and server-side processing. PHP was designed primarily for server-side scripting, which is the process through which dynamic content is generated on the server and sent to the client's browser. The curb park project relies on PHP to handle user requests, analyze data, and generate appropriate responses. PHP is a fantastic fit for creating web apps. Laravel, CodeIgniter, and Symfony are just a few of the many libraries, frameworks, and tools it provides to make development simpler. These utilities make it feasible to handle HTTP requests and responses, validate forms, manage sessions, and link databases. Databases such as MySQL and others can be easily integrated with PHP. To store and retrieve data regarding parking spaces, user bookings, and administrative activities, PHP may connect with the database in the curb park project. This ensures the system's dependability and integrity and makes data management efficient.

It provides ready-made routines and libraries for server-side form validation. This is crucial for the curb park project in order to guarantee that user input is verified and cleaned before processing. Cross-site scripting (XSS) attacks and SQL injection are two common security weaknesses that are protected against by PHP's validation mechanisms.

2.3 CSS Language

To control the visual style and layout of the document, CSS (Cascading Style Sheets) are used in HTML web pages. Web designers may specify how HTML elements should look without changing the page's fundamental structure or content thanks to CSS, which separates the presentation layer from the content layer. CSS styling enables you to modify the appearance of HTML components by specifying attributes like colors, fonts, sizes, margins, paddings, borders, and more. You can construct visually appealing layouts and manage your website's overall appearance and feel of your website with CSS. Consistency: With CSS, you can keep your website's appearance constant from page to page. A consistent and unified user experience can be achieved by specifying styles in a single CSS file and then applying those styles to various HTML pages. CSS encourages the division of presentation (styling) and content. Unlike CSS, which is in charge of the document's visual display, HTML concentrates on giving the document structure and semantics. This division makes it easier to manage and enables for simpler upgrades and alterations.

CSS offers methods, including media queries, that make it possible to create responsive designs. To ensure a consistent user experience across different platforms, you can adjust the layout and appearance of your web page to fit different devices, screen sizes, or orientations using responsive CSS styles. Accessibility: CSS is essential for making web pages more user-friendly. By correctly implementing CSS techniques, you can improve your content's readability and effectiveness for readers with impairments, making your website more inclusive and open to a wider audience.CSS enables quick and light rendering of web pages. The browser can cache the CSS file and so reduce the amount of data that needs to be downloaded for subsequent page visits by separating style definitions into a separate CSS file. Performance is enhanced and loading times are reduced as a result.

2.4 JAVASCRIPT

To improve the usefulness and interactivity of web pages, web developers frequently use the potent computer language JavaScript. Interactivity and dynamic content are both made possible by JavaScript and can be added to web pages. You can work with HTML components, change the content, manage events (including clicks, mouse movements, and form submissions), and dynamically update the page without having to refresh it. You can design responsive and engaging user interfaces with JavaScript.

By performing client-side form validation, JavaScript can eliminate the requirement for server-side verification and give users immediate feedback. You can use it to verify form submissions, look for needed fields, verify email addresses, impose particular formatting standards, and run custom validation algorithms. JavaScript offers robust APIs for working with a web page's Document Object Model (DOM). The attributes and styles of HTML elements can be changed, their content can be updated, and the DOM tree can be traversed to access certain elements. HTML elements can also be dynamically added, deleted, or modified. Using methods like Ajax (Asynchronous JavaScript and XML), JavaScript makes it possible to communicate asynchronously with servers. An improved and more responsive user experience is made possible via Ajax, which enables you to obtain data from the server without refreshing the entire page. Real-time updates, auto-suggest search, and dynamic content loading are made possible by this. A wide variety of Web APIs are accessible through JavaScript, enabling you to interact with browser capabilities and include third-party services. Examples include employing drag-and-drop capability, utilizing geolocation, gaining access to the camera and microphone, managing browser storage, connecting with social networking platforms, and exploiting the browser's camera and microphone.

Web page animations and effects can be produced using JavaScript and CSS. You can animate elements, make sliders, use parallax scrolling, animate elements that fade in and out, use transitions, and make interactive visual effects. Even simpler to develop complicated animations are animation frameworks like GSAP and libraries like jQuery.

3. Methodology

The technique used for the System's implementation includes a methodical and structured approach, ensuring the project's successful completion. The Curbpark Slot Management System's initial stage of technique involved gathering specific criteria. Stakeholders were surveyed to learn more about their specific needs and expectations, including administrators and staff members. User authentication, data management, scheduling, payment processing, and communication were among the needs met. System design came next after the collection of requirements. Design work was done on the user interfaces, database architecture, and system architecture. Scalability, safety, and effectiveness were taken into consideration when designing the system architecture. The database's structure was created to securely hold and manage the records of park visitors, financial data, and other pertinent information.

After the system design phase was finished, the Curbpark Slot Management System was put into operation. The implementation's front-backend framework was built using the languages of CSS, JavaScript, HTML, and PHP and the server environment XAMPP. These are powerful and well-liked web frameworks. MySQL was selected as the database management solution for storing and managing the data in the system. Apache-based HTTP server is used for simple database connectivity, URL routing, form handling, and session management, making it ideal for developing complex online web applications like the Curbpark Slot Management System. Popular open-source MySQL is a highly effective, scalable, and reliable relational database management system. Strong data storage and retrieval capabilities enable efficient management of park visitors and grantors, financial data, and other related data. The front-end development of the system was carried out using conventional web technologies. HTML (Hypertext Markup Language) was used for content structuring, CSS (Cascading Style Sheets) was used for style and layout, and JavaScript was used for interactivity and dynamic behavior. The development of aesthetically pleasing and user-friendly interfaces made possible by these front-end technologies allows consumers to freely browse our parking lots. Blockchain technology is employed to enable safe and transparent payment processing, and SHA-256 Hashing techniques were used to preserve the security and confidentiality of user information.

The system uses SHA-256 hashing techniques to safeguard the privacy and security of user data. The security and confidentiality of sensitive data are guaranteed by the widely used hashing algorithm method known as SHA. By encrypting user data, the solution lessens the risk of unauthorized access and protects users' privacy. The Curbpark slot management system's payment processing has become safer and more transparent thanks to the usage of blockchain technology. By utilizing blockchain, the system provides a decentralized and tamper-proof ledger for recording and confirming financial transactions, ensures the immutability and integrity of payment records, and removes the need for middlemen. By implementing these technologies, including the necessary tools and features to create a robust, secure, and effective system, the implementation phase brought the system concept to life using Curbpark Slot management system.

II. IMPLEMENTATION

3.1System Requirements

System requirements are all system-level requirements that specify the functions the system as a whole should perform to satisfy stakeholder needs and requirements. They are expressed through a suitable combination of textual statements, views, and non-functional requirements, with the latter expressing the levels of safety, security, dependability, and other factors that will be necessary.

3.2 Hardware Requirements

- CPU: Intel core I3 Processors
- Hard Disk Space:250 Gb
- Display:15” Color Monitor
- RAM: 4Gb
- Storage: 512GB and above
- Keyboard:104 Keys
- Clock-Speed: 2.6 Ghz

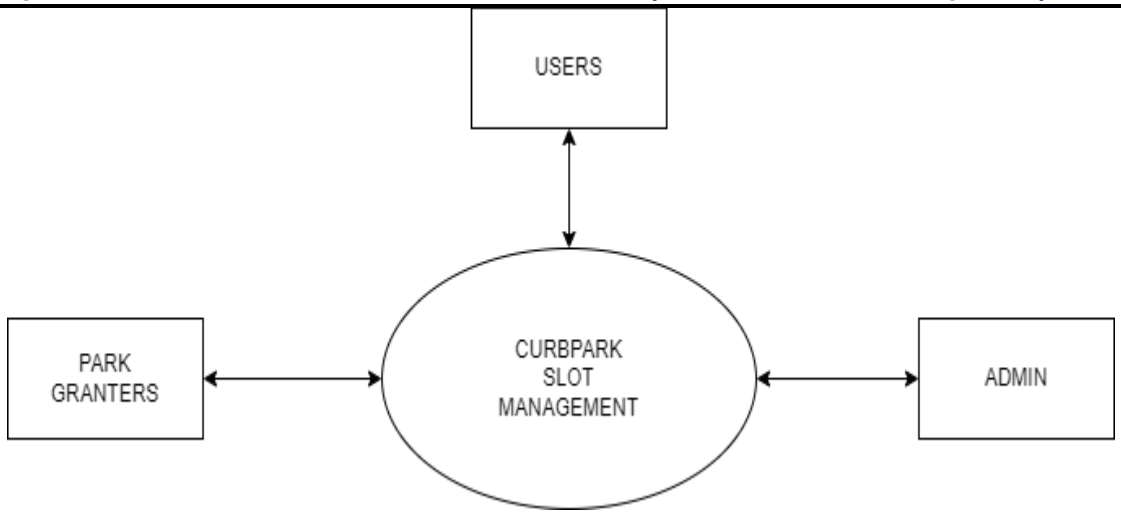
3.3 Software Requirements

- Operating System: Windows 10 and above
- Front End: HTML, CSS, JAVASCRIPT
- Backend: PHP, Mysql
- IDE: Notepad++
- Software Kit: XAMPP

III. MODULE OVERVIEW

The proposed architecture is divided into Three modules:

- ADMIN
- USER
- PARK GRANTER



Level 0

Fig 3.2.1: Data Flow Diagram

Level 0 shows 3 modules in this system such as admin, park users and park granters. users exchange slot information with the system.

1. Level 1: ADMIN

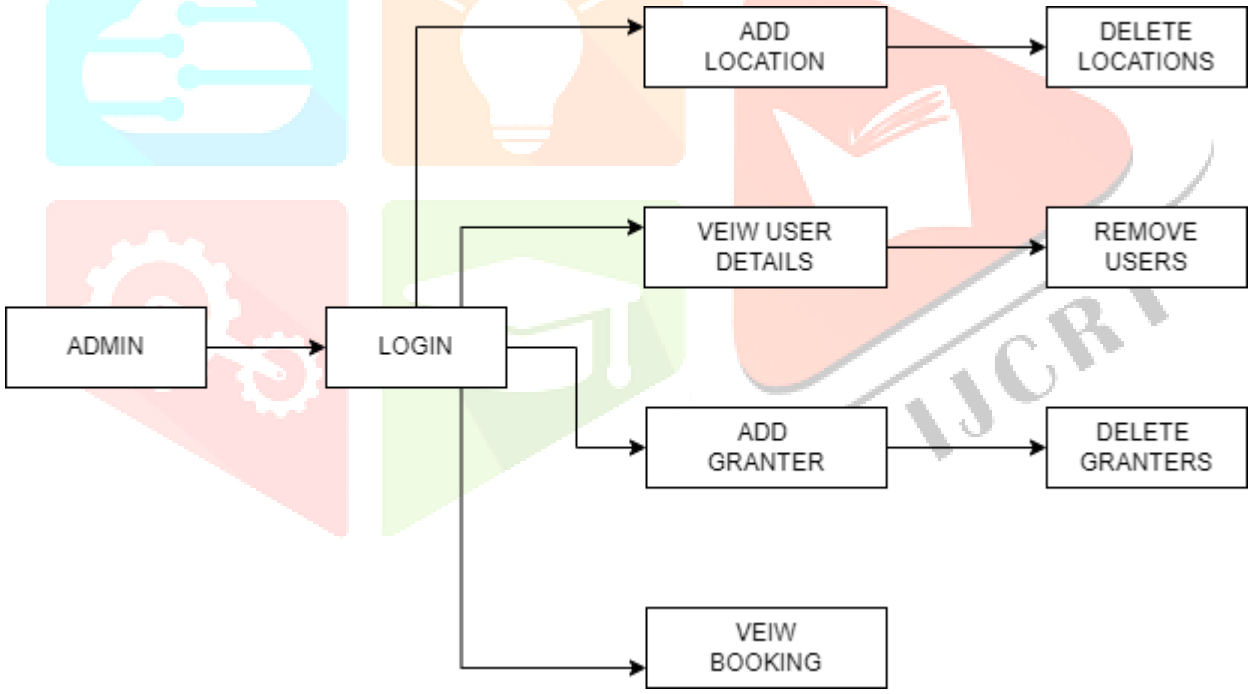


Fig 3.2.2: DFD of Admin

Admin Login:

- The admin can securely log into the system using a unique user ID and password combination.

Registration Form Management:

- The admin has the responsibility to handle the registration forms for park granters and users.
- This includes reviewing and processing the registration information submitted by park granters and users.

Parking slot and location Management:

- Once logged in, the admin has the authority to add park granters and review their parking slots and their location.
- This involves entering their relevant details, such as personal information, contact information, and Slot qualifications.

Supervision of the Entire System:

- As the admin, they have the overarching responsibility of supervising and overseeing the entire Curbpark Slot Management System.
- This includes monitoring system activities, ensuring compliance with regulations and policies, and addressing any issues or concerns that may arise.

2. Level 2: USER

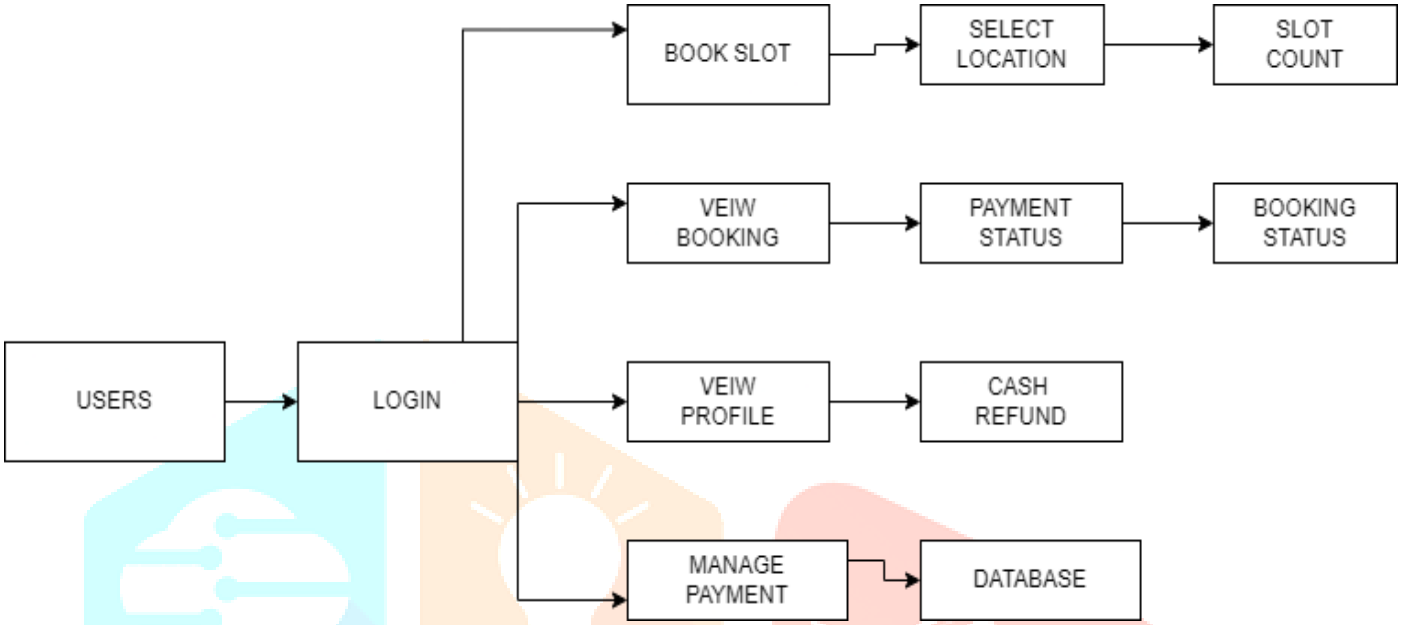


Fig 3.2.3: DFD of User

Park user Login:

- Park user can securely log into the system using their unique user ID and password.

Profile Viewing:

- Once logged in, patients can view and access their personal profiles.
- This includes details such as name, contact information, vehicle number, and other relevant information.

View Booking:

- Users can access and view their booking locations and other relevant information in that section.
- This provides park users with easy access to their parking slots and allows them to stay informed about their booking locations and their entry time.

Easy Payment:

- Park users can conveniently pay their fees using a user-friendly payment system integrated into the website.
- This simplifies the payment process for users, ensuring a hassle-free experience.

Cash Refund Viewing:

- Users can view their payment status and they can reach for a refund in the case of cancelation.
- Users need to submit their registered email id for a refund.

The user's role in the System is intended to give users easy access to their profile information, booking information, payment choices, and cash refund. By incorporating these features, the system hopes to improve users' participation, ease, and transparency in parking administration.

1. Level 3: PARK GRANTER

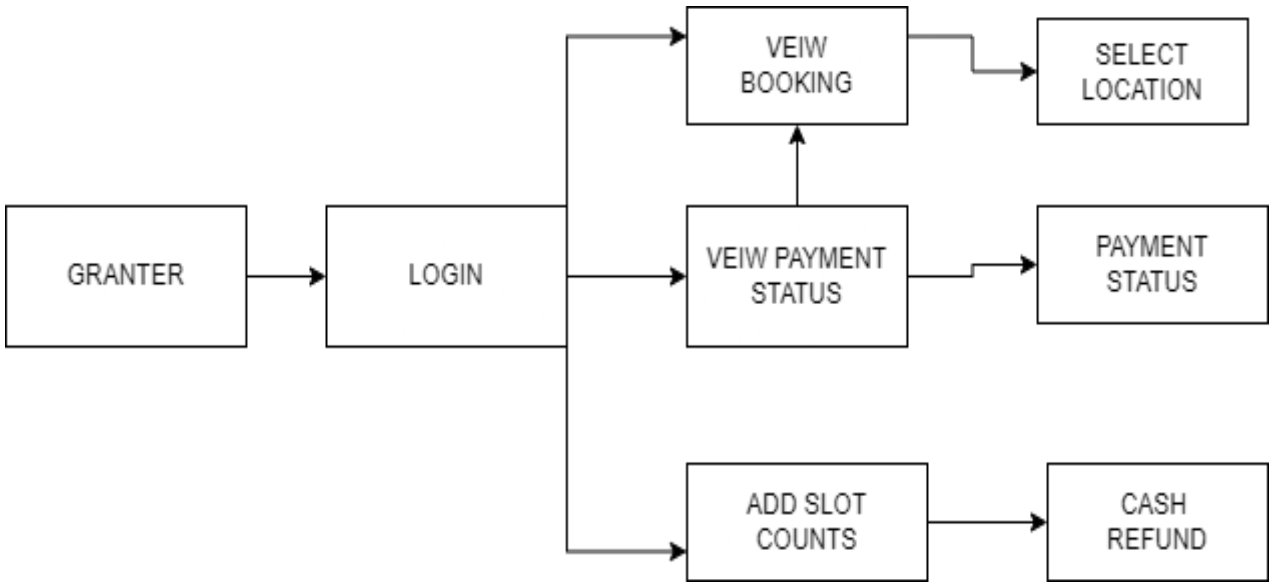


Fig 3.2.4: DFD of Park Granter

Park granter Login:

- Park granters can securely log into the system using their unique user ID and password after they have been verified by the admin.

Parking Management:

- Once logged in, the granter can add the location in which they are focused.
- This includes slots counts which tells about space of the parking area and how many vehicles can be accommodated.

Payment Details:

- Granters receive their payment after the users used their parking slots.
- The payment fee will be reduced or suspended if the user receives any kind of discrimination in the parking slot or if users vehicle is damaged after they have left the vehicle in the slot.

Periodic patrolling and Management:

- Granters are responsible for periodic patrolling in parking locations to keep user's vehicles safe and sound.
- This enables the granters' feedback to rise to a higher level.

The function of the granter within the System is critical in providing high-quality parking services. Granters can conveniently organize their location area and slots. This improves the overall efficiency and efficacy of Curbpark slot management, resulting in better relationships between users and granters.

4. ALGORITHMS

4.1 SHA-256

SHA-256, or Secure Hash Algorithm, is a cryptographic hash function. It ensures that data in various cryptographic applications, like blockchain technology, is correct and safe. the one-way hash function A message with any length can be entered into SHA-256, which produces a fixed-size output (hash value) of 256 bits. Including text, files, and binary data, all forms of input are acceptable. The SHA-256 algorithm was devised to provide a unique, fixed-length digest (hash) for a given input. Since the output hash value depends on the input data specifically, even little modifications will produce dramatically different hashes. Given the same input, the method always produces the same hash value since it is deterministic.

Since the SHA-256 method is meant to be irreversible, it is computationally impossible to recover the original input data from the hash result. Phases of the SHA-256 algorithm include padding the input message, dividing it into blocks, and performing various bitwise and logical operations on these blocks. These operations involve message expansion, compression, and mixing to produce a final hash value. What adds to the security of SHA-256 is its strong resistance to various cryptographic attacks. It provides a high level of security for the majority of applications, including digital signatures, data integrity verification, and password hashing. Blockchain technology uses SHA-256 to generate a unique identifier (hash) for each block, verify the accuracy of the block contents, and ensure the immutability of transactions. Many blockchain networks, including Proof-of-Work (PoW) networks, include it as a fundamental component of their consensus mechanisms.

Fig 4.1.2: Diagram of SHA-256

4.2 Proof-Of-Work(PoW)

The Proof-of-Work (PoW) algorithm is a consensus method used by blockchain networks to obtain consensus and validate transactions. To safeguard the integrity of the blockchain and prevent double spending, it is done. A difficult computational conundrum that will require a lot of time and effort to solve is what the PoW method aims to do. This puzzle measures the quantity of work performed by network users, also referred to as miners. Network miners fight for the solution to the puzzle by using their computing power. These miners, who commit their processing power to the task, update the blockchain and add new blocks. When a miner solves the challenge and validates a block, they get paid for their work. By making it difficult and time-consuming to alter the blockchain's history, the PoW algorithm secures the network. To modify a block, an attacker would need to redo all of the mining work for that block and all succeeding blocks, which is quite challenging considering the amount of processing power required. In a decentralized network made feasible by PoW, several participants (miners) compete to solve the problem and validate blocks. Blockchain networks use the PoW method to obtain consensus and maintain the distributed ledger's security and integrity.

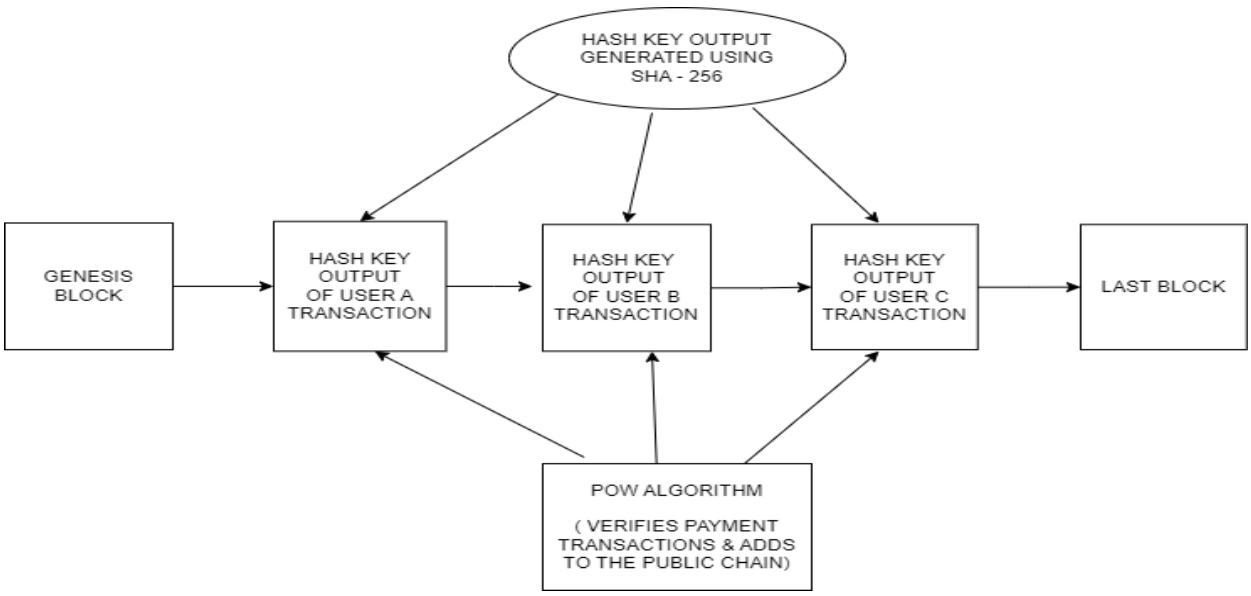


Fig 4.2.1: Diagram of POW

5. IMPLEMENTATION

The following implementation details can be taken into account to create the parking management system using a peer-to-peer network over blockchain with the given features:

Blockchain Platform: Decide on a particular blockchain platform, like Ethereum or Hyperledger Fabric, that meets the needs of the parking system. construct consensus methods, install the required nodes, and set network parameters to construct the blockchain network.

Development of Smart Contracts: For Ethereum, create smart contracts using an appropriate programming language like Solidity. Use the smart contracts to implement the logic for user registration, parking space management, transaction validation, and payment processing. Use the SHA 256 algorithm to ensure the integrity of your data.

User Authentication: Establish a safe user authentication process to guarantee that only authorized users may enter the parking system and interact with it. Take into account methods like public-private key cryptography to enable secure user identification and authentication.

User Interface: Create an intuitive user interface that enables users to engage with the parking system. Create user registration screens and payment and reservation functionality for parking spaces. By fusing the user interface with the underlying blockchain network, a seamless user experience can be guaranteed.

Peer-to-peer: Implement peer-to-peer communication protocols to allow for one-on-one communication between users and parking nodes. Secure communication channels should be used to transmit sensitive data.

Proof of Work: Use the proof-of-work mechanism to verify parking transactions and stop fraud. To prove effort before a transaction is approved and posted to the blockchain, one must complete computationally demanding tasks.

Data security and Encryption: Apply robust encryption mechanisms to safeguard user data stored within the blockchain for data security. Use cryptographic hashing techniques like SHA 256 to protect the integrity of your data. Use safe key management procedures to protect encryption keys.

6. SECURITY AND PRIVACY

Security considerations:

Security is essential for preserving the accuracy, privacy, and accessibility of user information within the parking management system. The system can use cryptographic methods to secure user data by utilizing a blockchain. Data is immutably recorded and tamper-resistant when a straightforward blockchain is used, offering a high level of security. Additionally, by making it computationally difficult for hostile actors to influence the blockchain, the use of proof of work as a consensus mechanism improves system security. This improves the parking system's overall reliability and integrity.

Privacy consideration:

Designing a peer-to-peer parking management system requires careful consideration of user privacy. Although the blockchain by its very nature promotes openness, it is still necessary to take precautions to protect private user data. To reduce privacy threats, personally identifiable information (PII) collection and storage must be kept to a minimum. The system makes sure that only necessary data is gathered by adhering to the principle of data minimization, hence lowering the likelihood that a data breach will have a negative effect.

7. RESULTS AND DISCUSSIONS

To overcome the problems with conventional parking systems, the parking system presented in this paper uses blockchain technology, the SHA-256 algorithm, and the proof of work algorithm. This section summarizes the system's performance and analysis, paying particular attention to the system's effectiveness, security, scalability, and user happiness.

Table 1: Highlights the key features of the proposed system

Features:	Descriptions:
Parking slot reservation	Uses a blockchain-based system to let people reserve parking spaces in advance.
Transaction validation	Ensures the confidentiality and security of parking transactions by using the SHA-256 algorithm.
Proof of work	The proof-of-work algorithm is used to validate transactions and add new blocks to the blockchain.
Secure payment process	Utilizes smart contracts to integrate secure payment systems, enabling dependable and impermeable payments.
Efficient transaction processing	Reduces user waits by completing parking transactions quickly and effectively.
Scalability	By successfully managing a large number of transactions and concurrent user requests, scalability is demonstrated.

8. ADVANTAGES

1. Decentralized Management:
- The proposed system provides centralized management through the Admin Module.
- Administrators have full control over parking space allocation, user management, and system configuration.
- This centralized approach allows for streamlined administration, effective monitoring, and efficient decision-making.
2. Cost Savings:
- By utilizing the proposed system, both users and parking space providers can benefit from cost savings.
- Users can avoid unnecessary fuel consumption and time wastage by quickly finding available parking spaces.
- Parking space providers can optimize their revenue generation by implementing dynamic pricing and efficiently managing their parking inventory.
3. Sustainability and Environmental Impact:
- The proposed system contributes to sustainability efforts and reduces the environmental impact of parking.
- By optimizing parking space utilization and reducing unnecessary driving, the system promotes efficient resource usage and helps decrease traffic congestion and air pollution.
4. Transparent and Secure Transactions:
- The integration of blockchain technology ensures transparent and secure transactions within the system.
- Users can have confidence in the integrity of their bookings and payments, as all transactions are recorded and verified on the blockchain.
- This transparency fosters trust among users and eliminates the risk of fraudulent activities.
5. Data Security and Privacy:
- With the utilization of blockchain technology, the proposed system ensures robust data security and privacy.

9. CONCLUSIONS

In conclusion, the peer-to-peer network over blockchain technique for parking reduction is provided offers a thorough and cutting-edge strategy to solve the challenges associated to parking space management. By utilizing cutting-edge technologies and putting a modular architecture into practice, the system aims to alter the way parking spaces are allocated, allotted, and monitored. With an emphasis on the user and admin modules and the utilization of blockchain technology, the numerous crucial components and functionality were discussed. The suggested approach has the advantages of being more accessible, transparent, secure, and income-optimized. The user module's intuitive interface allows park visitors to rapidly search for available parking spaces, make bookings, and monitor their reservations.

Administrators have complete control over the system through the admin module, including the ability to add or remove parking spaces, handle cancellations, and fix any potential issues. This module ensures smooth operations and coordination between parking spot providers and users. The system gains in a number of important ways from the usage of blockchain technology. Using a distributed ledger and interconnected data blocks, the system upholds data immutability, transparency, and integrity. To reduce the chance of fraud or unauthorized alterations, transactions are recorded and user parking data is safely stored in data blocks. By protecting user information and facilitating secure transactions, integrating blockchain technology also increases system security. The proposed technique addresses the drawbacks of the existing approaches and provides a more efficient and streamlined strategy for managing parking spaces.

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