Innovault Using Blockchain Technology

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***Abstract*—The InnoVault project improves intellectual property management by deploying blockchain and Decentralized applications (DApps), which address transparency and security limitations in centralized solutions. Its methodology includes comprehensive research, developing smart contracts, the incorporation of decentralized storage, and the design of a user interface that is straightforward. Key findings include the successful deployment of smart contracts for asset management, the integration of decentralized storage systems for increased data security, and the user interface's efficiency. In summary, InnoVault illustrates blockchain's transformational capacity for enhancing intellectual property protection and distribution. In a quickly changing digital ecosystem, it empowers creators, stimulates collaboration, and enables the seamless sharing of ideas by providing a safe, transparent, and decentralized.**

***Index Terms*—blockchain, distributed storage, smart contracts, IP protection.**

I. Introduction

The InnoVault project is a ground-breaking initiative at the interface of intellectual property protection and the technology of blockchain. In a world of rapid innovation and technological development, traditional intellectual asset safeguarding techniques have proven inefficient, frequently falling to centralization and security issues. In response, InnoVault leverages the irreversible and transparent features of blockchain technology, together with the decentralized framework of distributed applications (DApps), to create an innovative solution. InnoVault intends to empower creators and innovators by providing a secure, tamper-proof, and readily accessible platform that will transform how intellectual property is secured, shared, and monetized in the digital era. This project represents a key step in establishing a more fair and open innovation ecosystem, prepared to unleash the full potential of human creativity on a global scale. The challenge at hand is the difficulties and challenges present with conventional intellectual property management techniques. The centralized systems can lack transparency, making inventions susceptible to tampering and unauthorized access. In addition, these systems rely mostly on middlemen, introducing inefficiencies and difficulties to the process. This fragmented ecosystem hinders development and restricts development throughout industries. As a result, a secure, transparent, and decentralized solution is needed to streamline intellectual property management, permitting seamless collaboration while respecting innovators' rights. The InnoVault project solves this important issue by combining blockchain technology and decentralized apps (DApps) to build an integrated platform that will completely change how intellectual property is maintained and shared in the digital age.

A. Proposed System

The proposed InnoVault system offers a distributed approach to intellectual property management, integrating blockchain technology and decentralized apps (DApps) to get past the limits present in centralized solutions. The primary features of the proposed system include:

1. Blockchain Infrastructure: Using a blockchain network to produce an irreversible and open ledger for registering and managing intellectual property rights.

2. Smart Contracts: Using smart contracts to manage and uphold the rules and contracts that regulate the use of intellectual property ownership, authorization, and exchange.

3. Distributed Storage: Using decentralized storage technologies such as IPFS to safely store intellectual property assets while preserving confidentiality and availability without depending on central servers for storage.

4. Peer-to-Peer collaboration: Facilitating peer-to-peer cooperation and transactions, enabling creators to interact directly with one another without the use of middlemen.

B. Objectives of the Project Work

1. Implement User Authentication: Build an effective authentication system to restrict access to the platform, making

sure only those with authorization may upload and see files. This could include using authentication methods.

2. Secure File Uploads: Implement methods such as authenticated requests to verify your identity and accept file uploads. Validate file sizes and types to avoid unauthorised or harmful uploads, which enhances platform safety.

3. Choose Storage alternatives: Evaluate and select appropriate on-chain and off-chain storage for data options. Options like IPFS enable decentralized and immutable storage, making them ideal for on-chain storage solutions. If required, traditional servers can be used to store data on the blockchain. Consider utilizing other databases for off-chain data, such as user information.

4. Integrate IPFS or Conventional Servers: Integrate your choice of storage methods into the platform to guarantee seamless file uploads and access. For IPFS, this means using IPFS APIs or libraries to store and retrieve files. Safeguard user data through the installation of secure file storage methods on typical servers.

5. Store Off-chain Data: Connect to other databases like MongoDB or Azure to securely store off-chain data, such as user information. Implement appropriate security measures, such as encryption and access control, to protect sensitive user data from unwanted access or breaches.

II. System Design

Innovault focuses on implementing blockchain and smart contracts on the Internet Computer platform to result in a decentralized intellectual property (IP) management system. Motoko, the smart contract language, provides steady storage of ownership information on the blockchain. Every digital asset is provided with a unique identifier on the InterPlanetary File System (IPFS) so that the content is stored in a decentralized manner. With the help of efficient verification through smart contracts and robust access controls, Innovault can make IP management secure and transparent for users.

A. System Architecture

The system architecture of Innovault consists of the basic and mostly used layers in every other application the only peculiar one in our case is the blockchain integration layer. Descriptions of every layer are given below.

1. User Interface Layer: This is the layer where the user interacts with the entire application. It consists of options like User registration and User login to enter the application and make use of its functionalities. Innovault has a dashboard so users can view their accounts, log out, and explore for digital assets. Users can upload their digital assets using the upload options shown in the dashboard of the Innovault.

2. Application Layer: This is the layer that is behind the entire business logic of Innovault. This layer performs the process of IP management by interacting with the user interface to get the digital assets and then the smart contracts are executed if any user wants to download any data, this is done by executing smart contract for passcode management.

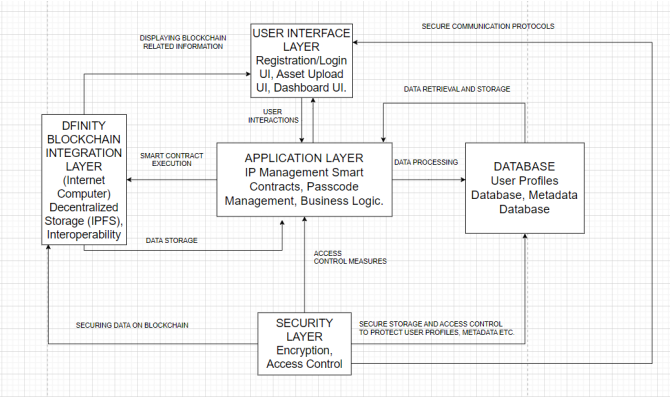

Fig. 1. System Architecture of Innovault

Whenever the user wants to fetch data this application layer interacts with the IPFS layer to fetch them.

3. Blockchain Integration Layer: This layer implements Internet Computer (IC) technology in Innovault. This enables the development and deployment of smart contracts and applications. The IC platform utilizes blockchain principles to achieve features like transparency, security, and decentralized storage.

4. Security Layer: This layer is responsible for implementing security principles and functionalities to the entire Innovault project. Hashing algorithms like SHA-256 are incorporated into the Internet Computer (IC) platform and related technologies, such as the InterPlanetary File System (IPFS). Bcrypt algorithm is used while storing non blockchain related data like user details, passwords, and usernames into the database.

To conclude, Innovault integrates a user-friendly interface for registration, login, and asset uploads. The Application Layer manages IP processes, executes smart contracts, and interacts with the database. Utilizing Internet Computer (IC) technology, the Blockchain Integration Layer ensures transparency and decentralized storage. A robust security Layer employs SHA-256 for blockchain data and Bcrypt for non-blockchain information, fortifying user credentials and maintaining data security. Innovaultstandsas a comprehensive and secure platform for intellectual property management.

B. Data Flow Diagram

The above diagram represents the flow of data in Innovault. The above process can be broken down into the following steps:

1. First the users register themselves into the application by providing their usernames, passwords, and other details.

2. All these user details are retrieved by the application layer and stored in the user profile database.

3. Then the users get access to the dashboard and can upload their digital assets during this process ownership is verified. The files uploaded are stored in IPFS storage. The user receives a unique passcode and CID (Content Identifier).

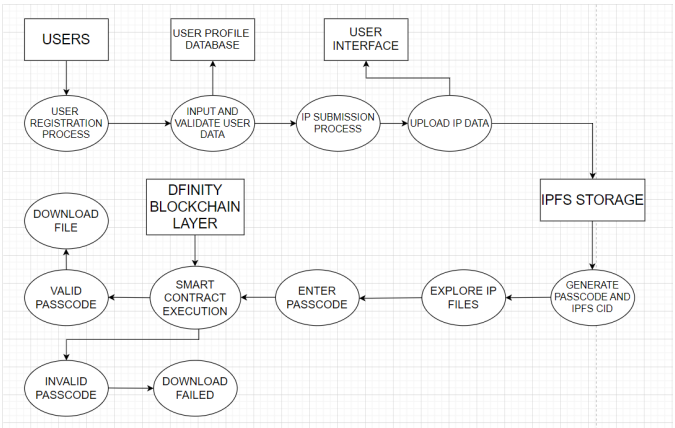

Fig. 2. Data Flow Diagram of Inovault

4. When a user wants to retrieve another user's digital assets, passcode-checking occurs. This process facilitates the validation of the user's request and ensures the user hasthe correct passcode to access the specified digital asset.

5. After the passcode is validated the download process of the file is complicated, if the passcode is incorrect the download process is failed and an error message is displayed to the user.

III. Implementation

A. Implementation steps for Innovault

1. Node.js Server Setup: Among other essential tasks, Node.js was utilized in the server setup to manage EJS files, render dashboards, and manage authentication. Express.js, a lightweight web framework for Node.js, was used in the server's construction and contributed to its effective route handling. Login credentials were strictly verified, and sessions were managed to ensure a seamless user experience and maintain program state.

2. Frontend Development: JavaScript was essential to the frontend development process since it scripted dynamic behaviors, improved user interactions, and guaranteed responsiveness. The foundation for organizing and presenting web content was made up of HTML, CSS, and Bootstrap for simplified styling. The dashboard's user interface was painstakingly created to give consumers a clear, visually appealing, and intuitive experience.

3. MongoDB Integration: Integration with MongoDB was essential for organizing and effectively storing off-chain data, especially user login credentials. The beautiful MongoDB object modeling tool, Mongoose, was made for Node.js and allowed for easy database interaction. User credentials were safely saved and retrieved during the authentication process by establishing schemas and utilizing Mongoose's robust querying capabilities, guaranteeing data integrity and secrecy.

4. IPFS Storage: Files uploaded, including PDFs and photos, were safely kept by using the decentralized storage network offered by IPFS. The application included an easy-to-use "Contribute" button that made it simple for users to upload files. Files were uploaded, and automatically stored on IPFS, and each user was given a different passcode. In order to guarantee that only authorized users could safely access and download their data, this passcode acted as a crucial authorization method.

5. Dfinity Integration: An important project milestone was reached with the integration with Dfinity Internet Computer, which used its decentralized infrastructure to host the full web application. The native programming language of Dfinity, Motoko, was essential to securing digital assets and guaranteeing the resilience, scalability, and security of the application. Through the use of Dfinity, Innovault becomes a state-of-the-art decentralized application that has the potential to completely transform the protection of digital assets.

B. Working of Innovault

1. User authentication: Users must provide their login information to access Innovault. The Node.js server meticulously confirms the legitimacy of the user by comparing these credentials to the data that is kept in MongoDB. Users are automatically taken to the dashboard after completing the authentication process, where they can examine the program's features.

2. Dashboard Navigation: The dashboard acts as users' main hub with its unambiguous design and simple navigation options. "Explore" and "Contribute" are the two buttons that users will notice here. Users can interact with the site in a way that suits their requirements and tastes thanks to these possibilities.

3. File Contribution: Contributing files is one of Innovault's primary features. Users can easily contribute files through the web application by clicking the "Contribute" button. They are asked for necessary information, including the file name and extension. After uploading, the file is safely kept on IPFS, and the user is given a special passcode. To improve protection and control, this passcode serves as a key to guarantee that only authorized users can access and download the content in the future.

4. Exploring Files: Users can view a comprehensive page with all uploaded files in Innovault by using the "Explore" option. They can peruse the assortment of digital resources that different users have supplied here. However, by requiring users to provide the correct passcode, access to download these files is restricted. This strict security feature preserves the platform's integrity and confidentiality by guaranteeing that only authorized users can access the digital assets that have been saved.

IV. Results

1. Home Page: Users can register or log in using the homepage designed for Innovault.On the homepage, we have provided two buttons for the users to register and log in, once any of them are clicked the users are navigated to the corresponding pages.

2. Register Page and Login Page: This page is provided so that the users can register themselves using their email

and also they must provide a password for the complete registration. We have also provided users a way to log in through their Google accounts. This is implemented using the Google OAuth functionality on the server side. The registered details are stored on the MongoDB cloud. The login page is also provided for the users who have already registered. Users who have not registered are not allowed to login through the login page, registration is mandatory.

3. Dashboard Page: In the dashboard page provided the user can view all the files uploaded by various users with their file names. There are mainly three main functionalities provided in this dashboard, first one is to navigate to the page which will allow the users to upload their own digital assets or files, and the second is to explore or view all the files uploaded by all users through our Innovault web application. The third one is the simple user functionality to logout. Additionally, we have also provided a link to our institution and another feature to delete the account.

4. Upload Page: When the user navigates to the upload page when they want to upload any file they will come across a form where they have to choose the file to upload from their device which can be of the format PDF or any image. Then they have to provide the file name with the extension before hitting the upload file button. After hitting the upload file button, the file is uploaded and the user is provided with the file's CID and passcode for maintaining security. The users can share their passcode with others, hence only authorized users can download this file by providing the passcode.

5. Explore Page: When the users land on this page they can see all the files which are uploaded till then. This particular page provides the user the functionality to download the files displayed on this explore page. But again, this can only be done if the user provides the right passcode to the right file, if the passcode is not correct or if it does not match to the corresponding file then downloading is not successful.

6. Download Page: If the users click the download button for any particular file through the explore page then they are navigated to this particular page, here they have to submit the passcode for that particular file in order to begin the download process. If the passcode of the file provided is correct then after clicking the submit button the download process must begin and in few seconds the file will be downloaded and displayed to the user. If the passcode is not correct an error message is displayed saying invalid passcode.

V. Challenges and Solutions

The InnoVault project has an array of issues, but with strategic responses, it has the ability to change IP management. Maintaining security and data integrity is vital, as any breach could compromise the system's reliability. Advanced encryption techniques, including as SHA-256 and Bcrypt, also known, will be utilized to hash and safeguard user data, while multi-signature wallets will boost security by requiring several keys for transaction authorization. Regular security audits and penetration testing will identify and resolve problems. User adoption and accessibility are also essential; consequently, an intuitive and friendly interface, as well as diligent onboarding courses and support for consumers, will be created to help users.Considering that the platform is available on a number of platforms, including desktops, laptops, tablets, and smartphones, can help to increase adoption. Scalability is another major issue; scalable blockchain solutions, such as the second layer protocols (e.g., Ethereum's Optimistic Rollups), will be utilized to handle larger transaction volumes, while off-chain solutions will be created to reduce on-chain load and ensure faster processing times. Navigating the complex terrain of intellectual property rules and blockchain regulations across multiple nations can be difficult, therefore working with legal specialists can help assure compliance with international IP laws and regulations.

VI. Conclusion

In conclusion, Innovault efficiently integrates the Internet Computer (IC) platform through blockchain technology, making sure that the intellectual property is secured and undergoes decentralized management. The user interface lays out a user-friendly experience, permitting the users to log in, register, and interact on the dashboard. Tasks like IP management, interfacing with blockchain, and executing smart contracts are handled by the application layer. Security is dominant, with popular hashing algorithms such as SHA-256 and Bcrypt for ensuring the safety of the user data. Innovault's creative idea leverages blockchain principles for decentralized storage, transparency, and security, marking a significant stride in intellectual property protection and management.

VII. Future Enhancements

Innovault has the potential to undergo several fascinating improvements in the future. By supporting more kinds of digital assets than only PDFs and photos, the application's usefulness may be increased. Sophisticated user authentication techniques like multi-factor authentication or biometric verification could be implemented to improve security even more. The entire user experience may be enhanced by adding more intuitive design components to the user interface and taking user feedback into account. Furthermore, incorporating sophisticated analytics to monitor usage trends and spot possible security risks might support preserving the integrity and functionality of the platform.

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