



MEDICAL DATA USING BLOCKCHAIN

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Abstract: In recent years, information technology has expanded dramatically in many areas as many companies have moved from paper-based methods. However, you will not be able to share information about the medication unless you finish the entire test. Blockchain is essential when it comes to solving key issues regarding data security, integrity and efficiency. All drugs exposed to drug testing must successfully complete several medical studies, each with a large-scale testing of participants. Medical reporting data is often kept in a single database, such as SQL or MongoDB. These traditional methods have a major mistake in this data, and can change in the database even if no one knows when a tester gets sick or throws it away. These disadvantages can be reduced by using blockchain technology, as all nodes connected to the network are notified of data changes. It provides a methodology for optimizing blockchain technology so that it can ultimately surpass traditional systems. We increase transparency and ensure that stakeholders have access to medical research carried out by various organizations using private blockchains. An electronic health file for storing data in a database. You will be connected to the cloud. It stores patient data related to private blockchains, but only authenticated users can view the results of medical research.

Index Terms - Blockchain, decentralised database, node, medical trials.

1. INTRODUCTION

While medical research is extremely important for medical research, management and protection of confidential test data remains a major challenge. Traditional systems are based on a centralized database that is susceptible to violations, operations, and unauthorized access. Checking the reliability of your data is often time spent manually, prone to mistakes, leading to inefficiency and delays. This affects data integrity and erodes trust among interest groups such as researchers, regulators, and pharmaceutical companies.

To address these issues, blockchain-based solutions have been proposed. The decentralized, unchanging architecture of the blockchain ensures the secure, manipulated storage of medical laboratory data. This allows for validation and access to actual data, eliminating the need for manual reviews and reducing the risk of human error. All test information, including patient files, treatment outcomes and compliance documents, can be stored on a single, transparent platform. In addition to the most important access to validated data, we have improved decisions - regulatory permits. Blockchain improves verifiability, supports compliance with regulatory standards, and promotes trust through transparent, successful data records. This system not only reduces administrative burdens, but also automatically recognizes fraudulent or inconsistent entries. Overall, integration of blockchain into medical research will improve security, transparency and efficiency, leading to robust and future solutions for the management of sensitive medical research data.

2. LITERATURE SURVEY

Ensuring medical experimental data is important to maintain the integrity of medical research, protect patient privacy, and ensure reliable outcomes. Traditional data management systems are susceptible to operations, violations, and inefficiencies. Blockchain technology offers a decentralized, unchanging solution that improves transparency, security and compatibility. Provides a reliable record of all transactions and enables real-time access and reviews for researchers, supervisors and stakeholders. This literature review explores how blockchain can improve data management in medical research and focus on critical technological advances. One approach involves using blockchain to validate real-time data so that only authentic entries, such as patient files and treatment outcomes, are added via consensus mechanisms such as proof of work or stake-proof. Another important application is to manage patient consent in intelligent contracts, allowing people to transparently grant or revoke permissions. Encryption also guarantees sensitive data, restricts access to authorized users, and at the same time ensures GDPR and HIPAA compliance. Inefficient code can waste funds and cause unsuccessful transactions, so developers need to carefully manage their gas consumption. Research has created design patterns that optimize gas consumption and improve the sustainability of blockchain-based systems. Overall, blockchain introduces transformational models of medical research by improving data security, improving trust and optimizing processes.

2.1 Blockchain for applications of medical

Blockchain, a distributed ledger technology (DLT), offers significant benefits in medical research, including data immutability, real-time access, and increased transparency. The study illustrates challenges in securing medical experimental data such as violations, hospitalization errors, and delayed reviews. Blockchain deals with these issues by creating immutable, distributed

data records. This means that data can be recognized immediately. This ensures integrity throughout the entire test lifecycle. Additionally, blockchain allows real-time data access for stakeholders such as researchers and supervisors. Testable traces of data changes improve transparency and traceability, and the structure and reliability of trust in the medical research process

2.2 The SIESTA project polygraphic and medical database

Actual validation of medical experimental data is important to ensure the accuracy and reliability of the study. While traditional manual methods are slow and error-prone, blockchain offers automated solutions by adding data. The study suggests a blockchain-based platform with consensus mechanisms such as job proof and promotion to ensure only valid data such as patient files and treatment outcomes. This prevents unauthorized changes and improves data integrity. Additionally, blockchain will enable real-time access for researchers, supervisors and sponsors, improve cooperation and enhance test permission decisions through access to current verified information.

2.3 Smart contracts with blockchain in the public sector

Ensuring data protection patients is a critical issue in medical research, as regulations such as the general data protection ordinance (DSG) and HIPAA strictly prescribe personal health information management under the obligation to portability and accountability (HIPAA). Blockchain technology can improve privacy by ensuring patient control over data while ensuring compliance with official compliance. The researchers proposed a blockchain-based system for managing patient consent, which individuals can give or revoke consent. This ensures greater transparency and confidence in the research process, not allowing consent to be altered or forged. Additionally, blockchain allows patients to use their data. To further protect your privacy, the blockchain platform uses encryption to protect sensitive information. Only accredited parties such as researchers and regulators can access these encrypted data, ensure confidentiality, and at the same time maintain data availability for analysis. Overall, blockchain offers a secure, transparent, and compliant approach to treating patient data in medical research.

2.4 ETHEREUM SEPOLIA FAUCET

Ethereum Water Tap is a developer tool for getting tests (ETH) to test and modify distributed applications or protocols before moving to live on the mainnet. Most TAPS requires social authentication (e.g. Twitter posting or registration). This will queue them to wait for test tokens) or on tap. The Alchemie Seolia Tap is free, fast and requires no authentication, but you can optionally register with Alchemy to increase your drops. To prevent abuse, developers require developers in the same wallet to maintain the minimum balance of their ETH main network before receiving the test token.

2.5 Design patterns for gas optimization in Ethereum.

Development of smart contracts (SCS) differs greatly from traditional software development, and presents its own challenges, particularly in terms of security and resource limitations. In many cases, SC is important, compiling a significant amount of money, and security is the number one priority. Furthermore, programming languages and virtual machines used in blockchain development are still being developed, and the resources for developing these platforms are limited. A particular challenge is the gas mechanisms used on platforms such as Ethereum that manage the execution of SCs. Gas represents actual value and if insufficient gas is allocated, the transaction can break down. According to a study by Zou et al. Over 86% of developers surveyed looked into the importance of gas consumption management based on their impact on costs and successful transaction.

The exact estimate of the gas required to execute an intelligent contract is complex, and in the event of an error, setting up too high gas limits can lead to resource ignoring. To address these issues, the research focused on developing design patterns and strategies to optimize gas consumption. These techniques aim to reduce waste and improve the efficiency of the SC version. Careful management of gas consumption allows developers to ensure that SCS is run more effectively, while minimizing costs and preventing failed transactions. This task will improve the general sustainability and reliability of blockchain applications and help you manage some of the key challenges developers face in working with blockchain platforms such as Ethereum.

3. SYSTEM DESIGN

3.1 Data Flow Diagram

Medical research can be derived from a variety of sources, including participants, healthcare services, portable devices, and research systems. This data is extremely important for blockchain systems based on accurate information. It uses consensus mechanisms such as proof of authority to store, verify and reproduce data within a blockchain network. Data is synchronized through nodes and operations create a general lid. Channels within the blockchain ensure secure communication between authorized parties and protect sensitive information. medical research institutions (CROs) manage research, check data reliability, analyze results, and ensure compliance with standards such as GDPR and HIPAA. Data is uploaded to knot 1 and synchronized via the other knots. The channel allows secure communication between the CRO and associated nodes, ensuring data protection and regulatory compliance during reviews and analysis.

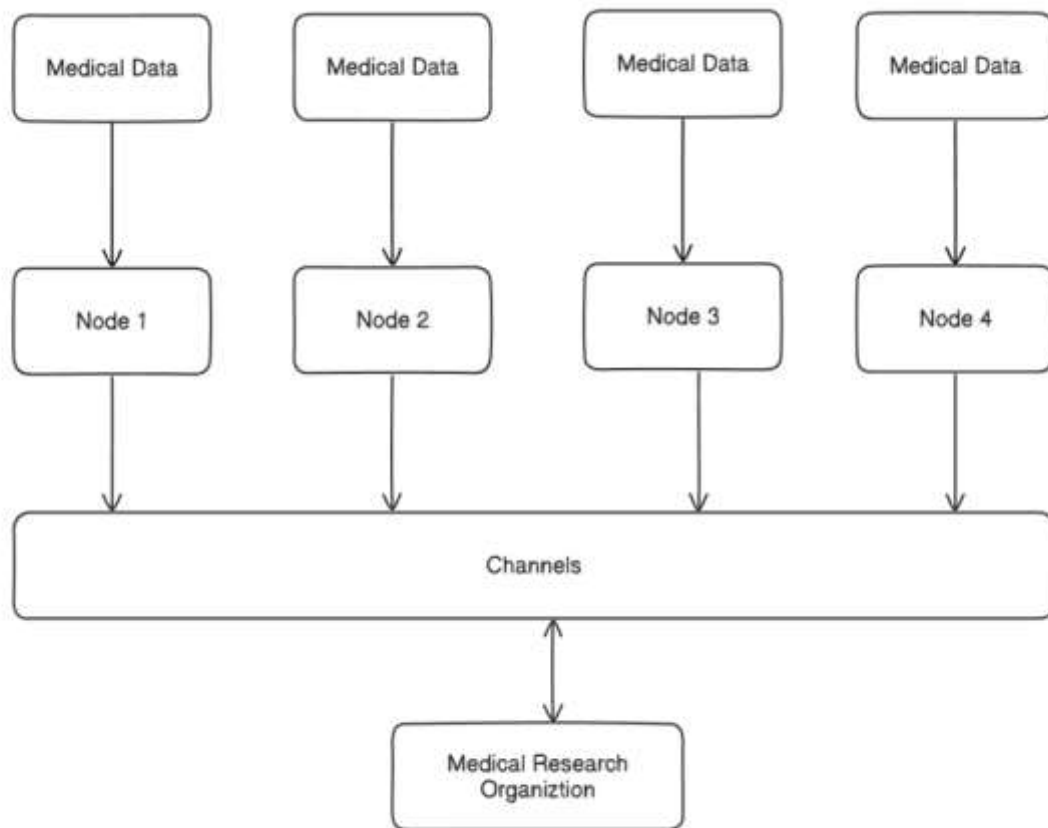


Fig 3.1: -Data Flow Diagram

The DFD underscores the system's modularity and clarity. Each function operates semi-independently but contributes to a unified goal-efficient network management. By breaking the system down into logical processes and data interactions, the DFD simplifies understanding while maintaining a high level of technical detail. This makes it easier to troubleshoot, enhance, or scale the system in the future.

3.2 Activity Diagram

An activity diagram, similar to a flow diagram, provides a visual representation of a series of actions or control flows within a system. This starts from the output state or the starting point indicated by a filled circle, then ends in the final state, passing through an arrow to the fill circle in another circle. This diagram uses the action state, shown as a rectangle with rounded corners, to display uninterpretable actions on an object. Transitions between these actions are indicated by arrows, also known as action currents. Object flow describes the creation and modification of an object through activities indicated by arrows that combine actions and objects. The decision or point of branching is indicated by the diamond where the conditions or protective formula that determine which path is taken next are determined. Wachen is a condition that must be applied before continuing the next activity. Users such as doctors, nurses, administrators, and pathologists interact with the system in relation to medical data. Doctors provide diagnosis, update patient files, nurses record important statistics, manage care, manage administrators to access data and claims, and access updates to pathologist results from medical testing. A distributed ledger ensures that the secure operating storage of medical transactions, synchronous data records for participating nodes, and encryption privacy are compliant. Smart contracts validate self-contracts, medical transactions using predefined rules, so that only valid transactions are added to the main register. The review process involves sending transactions through blockchain consensus mechanisms. As soon as it is checked, it is stored securely to provide transparency, eliminate fraud and ensure an obligation to calculate.

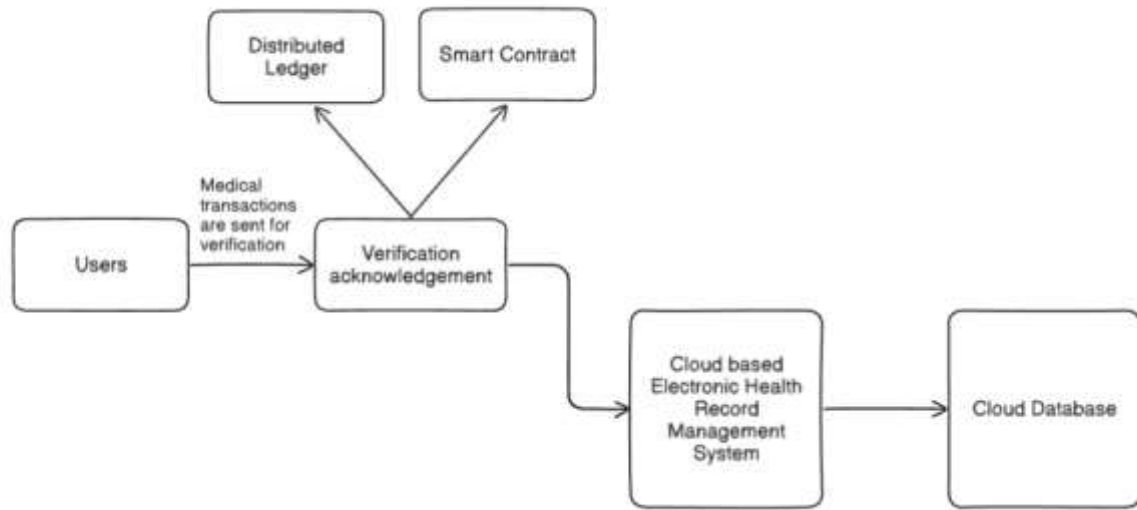


Fig 3.2: -Activity Diagram

In summary, the activity diagram for storing medical data effectively shows the flow of measurements and decisions within the system, ensuring smooth coordination between various users, such as doctors, nurses, and administrators. By using distributed main registers and intelligent contracts, the system ensures safe and transparent operations, medical transactions of operations. This diagram highlights the importance of objects and action currents as well as decision points for maintaining data integrity. Ultimately, this structured approach ensures accuracy and accountability for medical data management, supporting efficient and safe health processes.

4. IMPLEMENTATION

4.1 Typescript

TypeScript is a powerful typed super of JavaScript, improving your development experience by adding type safety, improved tools and extensions. Developed by Microsoft, first published in 2012, it has become one of the most popular languages in modern web development. In contrast to dynamically typed JavaScript, TypeScript offers the advantages of static typing, allowing developers to understand errors rather than during development. It is designed to be fully compatible with JavaScript. This means that all valid JavaScript code is also valid typescript code. This makes it easier for developers to switch from JavaScript to Typescript and gradually add codebases. The main advantage of TypeScript is its ability to define explicit types of variables, function parameters, and return parts, reduce the chance of runtime errors, and improve the quality of your code, especially in large applications. It is often used with popular JavaScript frameworks and libraries such as Angular, React, and Vue.js, which have strong support for typescripts. One of the key benefits of TypeScript is its extension tools. Code editors such as Visual Studio code provide integrated support for automatic completion, real-time error testing, and enhanced refactoring. These features increase developer productivity by providing immediate feedback and avoiding frequent coding errors.

Typescripts allow developers to define the type of variable, make the arguments work, return parts, log errors in development, and make sure the code works as expected. Additionally, the type can be automatically closed if it is not explicitly declared. This reduces the need for comments to be repeated while repetitive comments still benefit from static typing. TypeScript supports interfaces and custom types, allowing developers to define the format of objects and enforce consistent data structures for applications. The language introduces many features that are not yet available in JavaScript, such as Async/Aused support, decorators, and generics. Typescript code must be implemented in JavaScript before it can be run on a browser or node.js server to ensure compatibility with JavaScript time. The compatibility between TypeScript and existing JavaScript code allows developers to gradually induce typescripts in their projects without the need for full explanation. Typescripts are often used in enterprise-level applications and large web projects because they can manage complex codebases and improve maintainability, readability and scalability. Provides clear types of definitions and allows for better support for the tool. This means that developers can write clean, reliable and robust code.

4.2 Docker

Docker is an open source platform that automates application regulations, scaling and management in light portable containers. This allows developers, applications, and all their dependencies to enter a single container image to ensure consistent behavior across different environments. By using containerization technology, Docker applications are isolated from each other from the underlying system, ensuring that each application in their own environment runs using the required libraries and dependencies. This quarantine deals with common delivery challenges, such as dependency conflicts and inconsistencies between development and production environments. Docker containers are lightweight and efficient, offering greater advantages over traditional virtual machines as they share the core of the host operating system and maintain process insulation at the same time.

This will allow containers to start faster, manage resources and make them easier to manage. Docker also provides important features such as portability, allowing containers to run anywhere on your local machine, test server, or production environment, ensuring that your applications run consistently across all phases. Docker Hub offers a repository of prefabricated container images that simplifies release and provisioning. Version features and rollback functions enable efficient updates and maintenance, while Docker Compose simplifies the management of multi-container applications. Additionally, Docker is well integrated into the continuous integration and continuous deployment (CI/CD) pipeline, automates the software development lifecycle and ensures consistent testing and deployment. This makes it ideal for applications such as Microservices architecture, development, testing, cloud preparation, CI/CD automation.

4.3 Blockchain

Blockchain is a distributed digital ledger technology that ensures secure, transparent and manipulated transactions. Originally developed for Bitcoin, it has become a versatile platform used in a variety of fields, including supply chain management, finance and healthcare. Blockchain works by connecting with encryption and consensus mechanisms to ensure data consistency and transparency, and securely logging transactions on the blocks that it relies on. Each data record is a timestamp and is checked through a network of nodes. That means it is resistant to fraud, censorship and manipulation. Its distributed nature ensures that central authorities control data and improve safety and resilience. As soon as data is added, it cannot be changed. This means that you cannot modify or delete all subsequent blocks without modifying them, but this is not feasible. Combining this constant transparency and auditability, blockchain is ideal for applications such as medical research management. Additionally, blockchain uses advanced encryption technology to protect your data, ensure reliability and encryption, while simultaneously enabling the creation of intelligent and intelligent contracts. Blockchain decentralization ensures data redundancy and accessibility, even when there are nodes.

4.4 Networking

Networking is an exercise in connecting several computer devices, such as computers, servers, routers, switches, and more to enable communication and resource release. It facilitates data exchange, remote resource access, and system-wide communication, and uses a variety of media such as cables, radio waves, and optical fibers. The network is based on protocols such as IP, TCP, and UDP to ensure reliable data transmission between devices. The main goal of networking is to enable communication, whether it's simple messaging or large-scale data transmission. It also ensures data reliability through error detection and transmission mechanisms, and security measures such as encryption and firewalls protect data from unauthorized access. In medical data management, networking plays a key role in the integration with blockchain for secure transfer of medical data, remote access for certified users, and secure, immutable data storage. Additionally, network segmentation protects sensitive medical data by isolating it in specific areas of the network.

4.5 Express.js

Express.js is a fast and flexible web application framework based on node.js to simplify web applications and API development. Published in 2010, it offers a lightweight, minimalist approach and is one of the most popular frameworks in the node.js ecosystem. Express.js allows developers to manage HTTP requirements and attacks, remove them with detailed traffic, and integrate middleware for tasks such as authentication, data analysis, and protocols. Node.js-Not blocking, using event control architecture, provides higher level functions for handling requirements/response cycles. Express is known for its simplicity and flexibility, allowing developers to configure their applications modularly and simultaneously create integrated functions such as routing, template rendering, static files, and more. It is also ideal to write an API to support a wide range of third party middleware. Additionally, Express often combines with front-end frameworks to create full-stack applications. This makes it a variety of tools for web development.

5. RESULTS AND DISCUSSION

By replacing current manuals and centralized systems, this project provides a real-time, robust solution that addresses key challenges in the management of medical data. By leveraging blockchain technology, the proposed system ensures greater transparency, security, and immutable immutability of medical trial data, and promotes trust among stakeholder searches as medical research institutions (CROS), sponsors, and regulatory authorities. The system eliminates risks associated with data manipulation, loss, or misuse by creating a distributed, operating main book. It also includes features such as monitoring medical test data, automated notifications to ensure timely updates or renovations, and a secure mechanism for participants to access or update records when required. Additionally, the system simplifies compliance with regulatory requirements by providing audits with constant and understandable data.

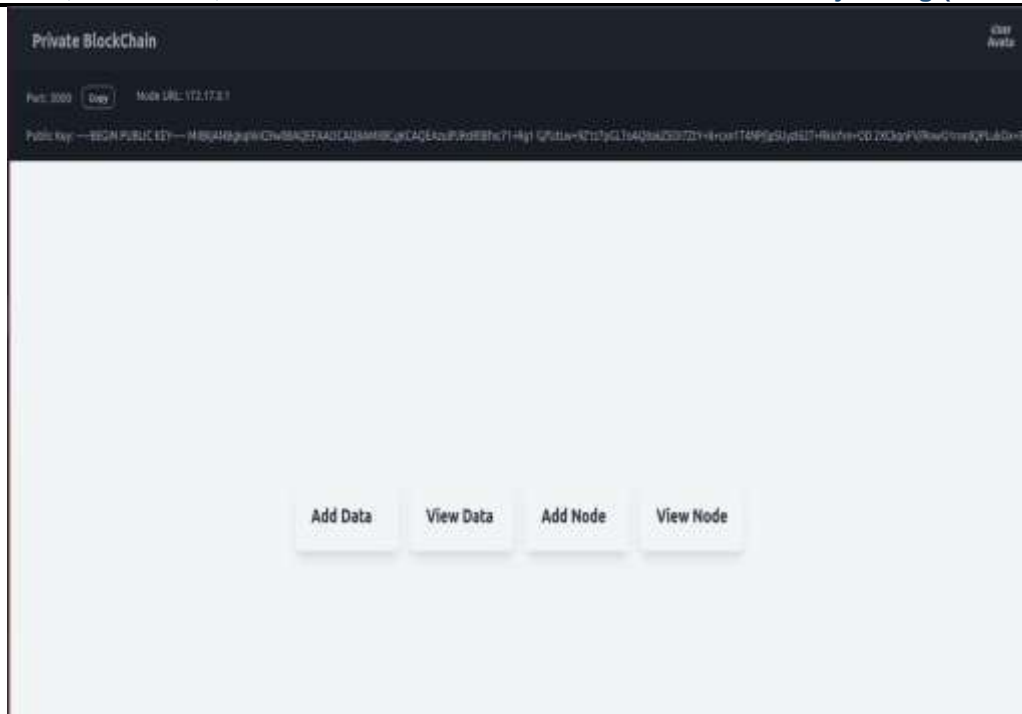


Fig 5.1: Home page

Figure 5.1 shows the homepage of an app with four main buttons displayed. Add data, view data, add nodes, and display nodes. The Add Data button allows users to enter new data, but the Sisticion View Data button displays existing data. Node Nodes - The node button allows users to manage and view network nodes and provide a simple and intuitive interface to provide a simple and intuitive interface.



Fig 5.2: -Add Data Signup Page

Figure 5.2 shows the registration page for a website where a new user enters their username, email, password, and other details required to register. After clicking the registration button, the information will be saved and redirected to the registration page, and access the website using your new login information. This optimized process allows users to register quickly and use the features of the website.

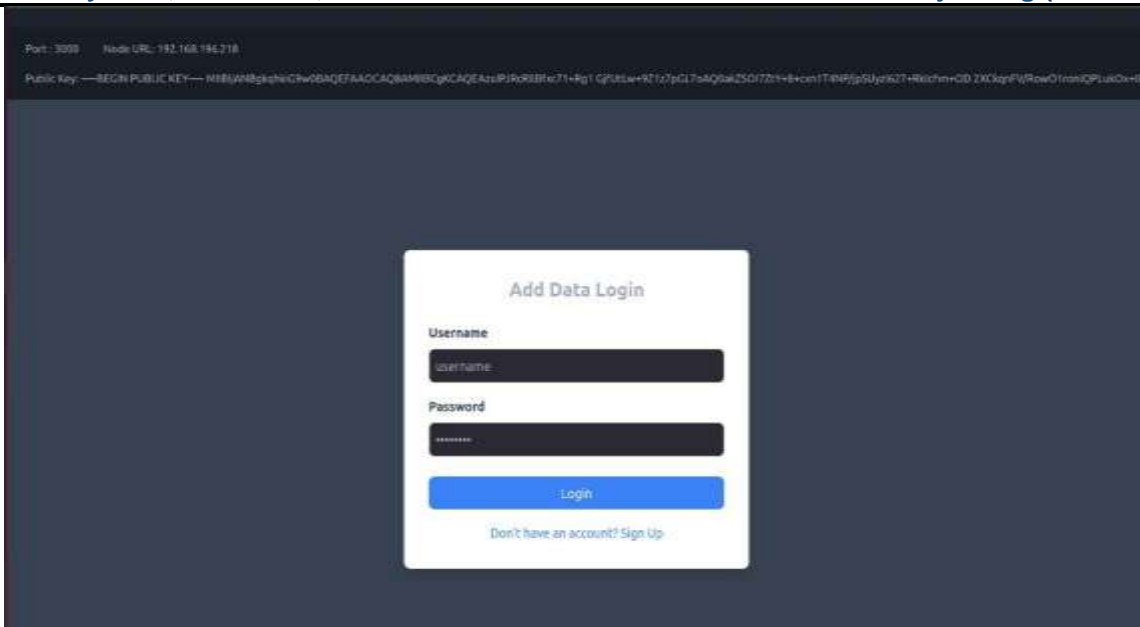


Figure 5.3 Add Data Login Page

Figure 5.3 depicts the login page where users enter their username, email, and password to access their accounts after completing the signup process. Upon successful login, users are redirected to the Add Data page to manage new data, while incorrect login details trigger an error message. The page also includes a Sign-Up button for new users, directing them to the registration page.

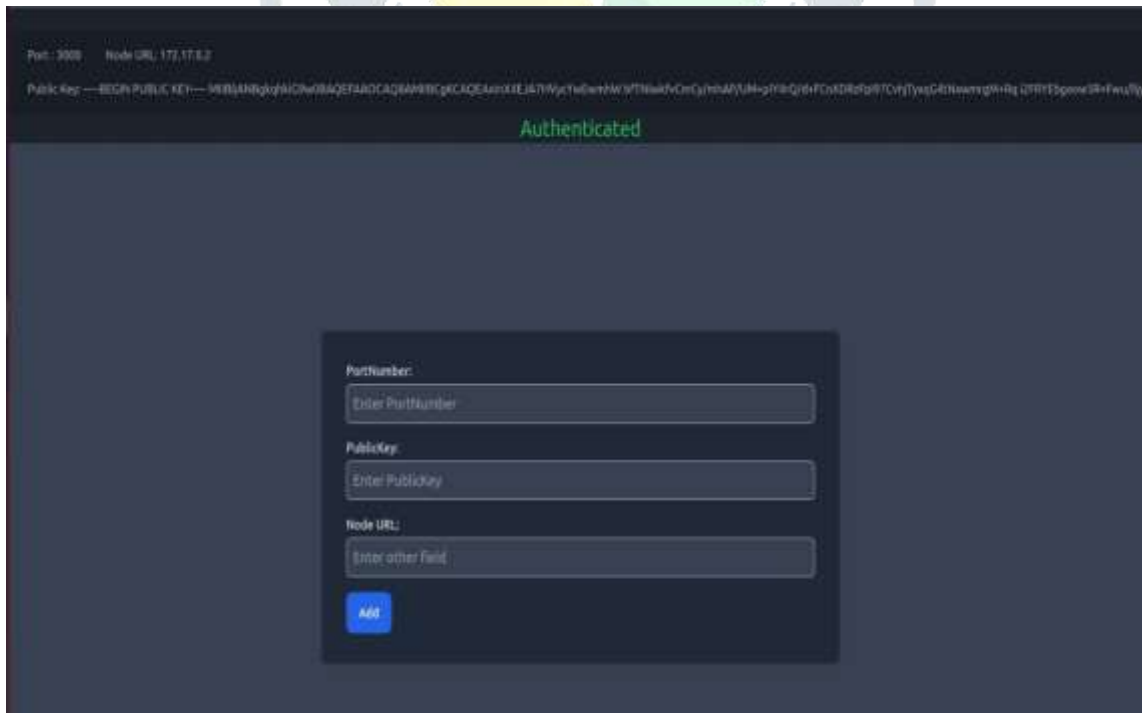


Figure 5.4: Node Connection page

Figure 5.4 shows the user homepage displayed after a successful login, serving as the main interface for accessing core website functionalities. It includes buttons for Port Number, Public Key, Node, Public Key of Other Nodes, and Node URL, each facilitating actions related to network configuration. The layout is intuitive, allowing users to easily view, update, or connect to network details, ensuring a seamless user experience.

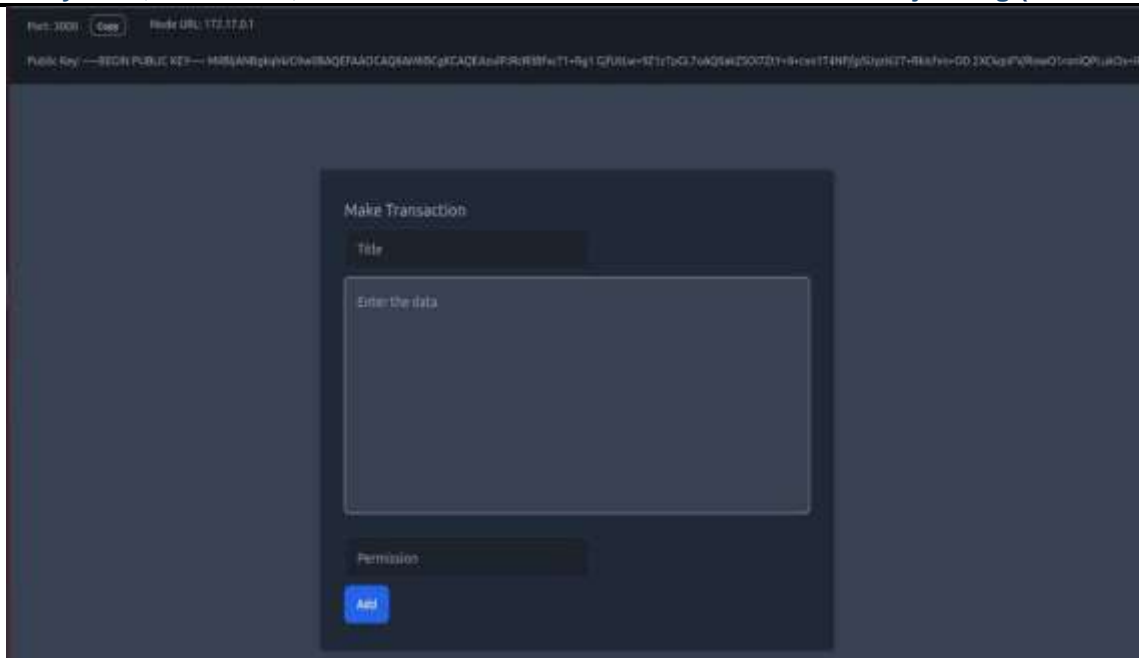


Figure 5.5: Data Entry page

Figure 5.5 depicts the license page where users input valid details, including a Title and data in JSON format. Invalid entries are not accepted, and if errors are found, the problematic fields are highlighted for correction. Upon successful submission, the valid data is added to the database, and users are redirected to the homepage for easy navigation.

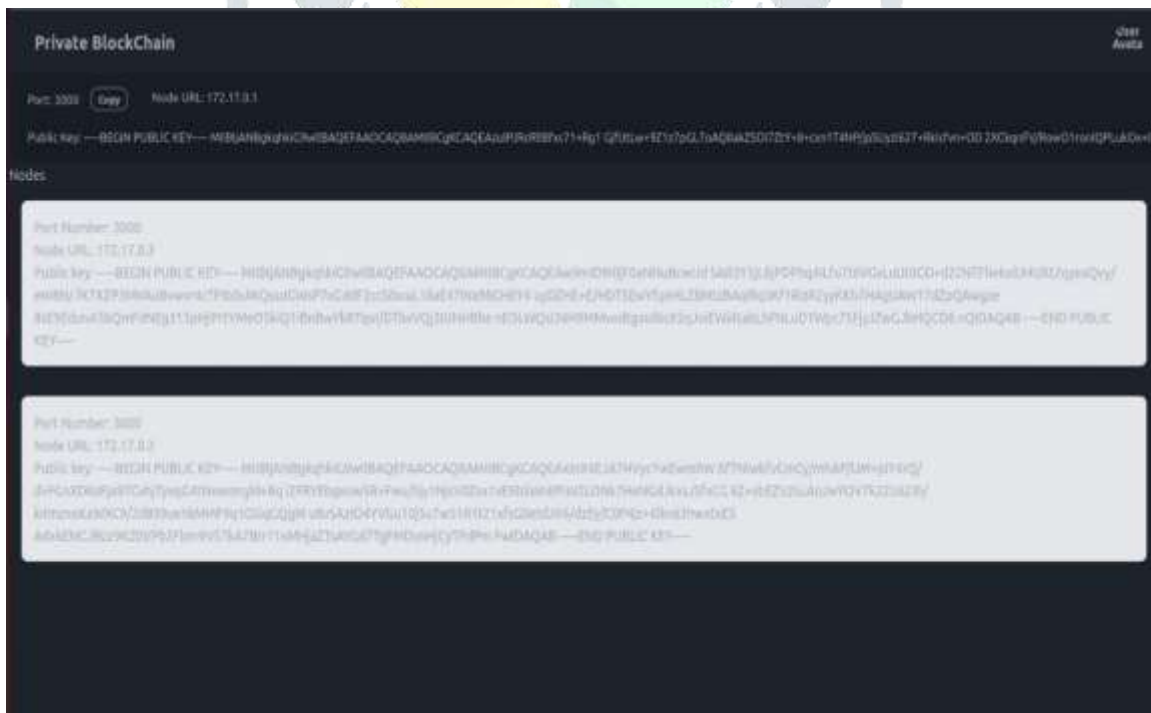


Figure 5.6: View Details Node page

Figure 5.6 represents the View Details Node page, where users can input data, with invalid fields highlighted for correction. The data entered is integrated with information from all connected nodes, ensuring consistency across the app. Any updates made are seamlessly reflected on the View Node page, maintaining accurate information flow throughout the system.

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