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Platform For Organ Donation and Transplantation Using Blockchain

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Abstract: The critical shortage of organs for transplantation necessitates exploring innovative solutions to improve the matching and allocation process. Blockchain technology, with its significant principles of the decentralization, security, and transparency, presents a promising avenue for building a more efficient and trustworthy platform for organ donation and transplantation. This paper surveys the current state of organ donation systems, explores the potential benefits of blockchain integration, and analyzes existing research on blockchain-based platforms for this domain

Keywords: Organ Donation, Transplantation, Blockchain Technology, Smart Contracts, Decentralization, Transparency.

I. INTRODUCTION

The organ donation and transplantation landscape is a critical domain within healthcare, offering a lifeline to countless individuals in need. However, the current systems grapple with inefficiencies such as irregular record storage, opaque allocation practices, and ethical concerns. The drawbacks in previous existing technology used include irregular record storage, inefficient organ allocation, and concerns about transparency.

This research delves into the application of blockchain technology as a disruptive force poised to address these challenges. Blockchain, with its decentralized, transparent, and immutable characteristics, stands as a promising solution to enhance the security, efficiency, and ethical dimensions of organ donation and transplantation processes. This application introduces new features such as decentralized control over medical records, transparent access management, and an intelligent resource allocation algorithm.

By proposing a blockchain-based system leveraging smart contracts and the Ethereum blockchain, this research aims to empower patients, optimize organ distribution, and fortify the security and privacy of critical medical records. The subsequent sections delve into the methodologies, applications, and implications of this innovative approach, with the overarching goal of contributing to a more robust, patient-centric, and ethically grounded organ transplantation ecosystem.

This application overcomes the drawbacks of other projects by implementing decentralized control over medical records, transparent access management, and an intelligent resource allocation algorithm.

The workflow for application works in the following manner –

1. **Organ Donation and Transplantation Participants:** This represents the various entities involved in the organ donation and transplantation process, including donors, recipients, hospitals, and regulatory bodies.

2. **Blockchain Network:** The overarching blockchain network that facilitates decentralized and secure transactions.

3. **Smart Contracts:** These are self-executing contracts with predefined rules and conditions.

II. LITERATURE SURVEY

The literature survey delves into existing research and scholarly works that contribute to the understanding of organ donation, transplantation, and the application of blockchain technology in healthcare.

Literature provides a foundation for our research, guiding the development of a blockchain-based solution aimed at overcoming existing limitations in the organ donation and transplantation domain.

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3.1 Literature Survey

3.1.1 Literature survey on Blockchain-Based Management for Organ Donation and Transplantation

From the paper [1], The provided excerpt outlines the challenges faced by contemporary organ donation and transplantation systems, emphasizing the need for an end-to-end solution that addresses legal, clinical, ethical, and technical constraints to ensure a fair and efficient process, ultimately enhancing patient experience and trust. The paper proposes a novel approach utilizing a private Ethereum blockchain, introducing decentralization, security, traceability, auditability, privacy, and trustworthiness to the organ donation and transplantation management. The implementation includes the development of smart contracts and the presentation of six algorithms, accompanied by their detailed implementation, testing, and validation. The paper evaluates the performance of the proposed solution through analyses of privacy, security, and confidentiality, comparing it with existing solutions. Notably, the transparency of the project is emphasized by making the smart contract code publicly available on GitHub. This research contributes to evolving discourse on blockchain applications in healthcare, particularly in the organ donation domain, by providing a comprehensive solution that combines technological innovation with rigorous testing and evaluation.

3.1.2 Literature survey on Interoperability in Electronic Health Records Management and Proposed Blockchain Based Framework: MyBlockEHR"

From the paper [2], author has proposed the critical importance of interoperability in Electronic Health Records (EHR) to facilitate seamless information sharing among diverse healthcare stakeholders while ensuring security, privacy, and trust. The study conducts a systematic literature review addressing four research questions, focusing on standards for EHR interpretation and modeling, privacy-preservation techniques, the maturity of blockchain technology for EHR solutions, and the state-of-the-art in cross-chain interoperability for EHR sharing. The findings suggest the potential of a blockchain-based EHR management framework in enhancing privacy, access control, and storage efficiency. However, challenges in blockchain adoption for EHR management are identified, leading to the proposal of a novel framework called MyBlockEHR. The research contributes valuable insights to the ongoing discourse on blockchain applications in healthcare, offering the nuanced understanding of the challenges and potentials associated with interoperable, privacy-preserving EHR solutions.

3.1.3 Literature survey on A Blockchain-Assisted Verifiable Outsourced Attribute-Based Signcryption Scheme for EHRs Sharing in the Cloud

From the paper [3], literature survey explores the challenges associated with the sharing of Electronic Health Records (EHRs) and proposes a novel solution, the Blockchain-assisted Verifiable Outsourced Attribute- Based Signcryption Scheme (BVOABSC), designed to enhance the security of EHRs in a multi-authority cloud storage environment. The conventional practice of outsourcing EHRs to cloud servers raises concerns about patient control, data integrity, and the potential for malicious tampering. The BVOABSC scheme employs attribute-based signcryption to ensure the confidentiality and unforgeability of EHRs, preserving the privacy of the signer. Additionally, it leverages a verifiable outsourcing computation mechanism to reduce user computational burden while maintaining correctness verification. Blockchain technology is integrated to protect against tampering, with each EHR operation recorded as a transaction, ensuring immutability. Smart contracts, created by patients, address issues such as tampering and incorrect results in cloud storage.

3.1.4 Literature survey on An Efficient Authentication Scheme for Blockchain-Based Electronic Health Records

From the paper [4], literature survey addresses challenges in traditional electronic health records (EHRs) where medical information is controlled separately by different hospitals, leading to difficulties in information sharing. Although cloud-based EHRs alleviate this issue, they introduce a new concern of centralization, with a focus on the cloud service center and key-generation center. The paper proposes a paradigm shift by integrating blockchain technology into EHRs, creating a decentralized solution termed blockchain- based EHRs. The paper proposes a paradigm shift by integrating blockchain technology into EHRs, creating a decentralized solution termed blockchain-based EHRs. This research contributes to the evolving landscape of secure and decentralized EHRs through the integration of blockchain technology and the introduction of an improved authentication scheme.

3.2 Summary of Literature Review

The above survey of various researchers of different papers, about organ donation and transplantation using blockchain. From Literature survey, it is concluded that the challenges inherent in the current systems, including irregular record storage, inefficient allocation, and ethical concerns.

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To address these issues, the review proposes a blockchain-based solution leveraging Ethereum. The motivation is rooted in saving lives through more efficient and trustworthy organ transplantation management. Includes improving transparency, security, and efficiency through use of smart contracts and blockchain technology.

The motivation to build trust among donors, recipients, and medical professionals, along with the goal of combating fraud in organ transactions, is emphasized. The scope of the project extends to benefit healthcare institutions and government agencies involved in organ donation and transplantation processes. Overall, the literature review underscores the transformative potential of blockchain in optimizing organ donation procedures and fostering a more ethical and transparent ecosystem.

3.3 Literature Review Table

Sr. No.	Author /Year of Publication	Title	Strength	Weakness
1	Rahul Ganpatrao Sonkamble , Shraddha P. Phansalkar , Vidyasagar M. Potdar and Anupkumar M. Bongale , 2021	Survey of In-teroperability in Electronic Health Records Management and Proposed Blockchain Based Framework: MyBlock-EHR	Quick Calculation Time Relatively simple and computationally inexpensive method Effectiveness for distributed optimization	High level of communication and computation overheads High complexity, inaccuracy, and inadequacy Big payloads
2	Dinh C. Nguyen , Pubudu N. Pathirana , Ming Ding and Aruna Seneviratne , 2019	Blockchain for Secure EHRs Sharing of Mobile Cloud Based E-Health Systems	It provides easy information processing and cost reduction as well. Better utilization of resources Tolerates Variations	Approach is a bit time-consuming, Cannot be implemented real time Narrowly specialized knowledge
3	Yong Wang , Aiqing Zhang , Peiyun Zhang and Huaqun Wang, 2019	Cloud-Assisted EHR Sharing With Security and Privacy Preservation via Consortium Blockchain	It provides easy information processing and cost reduction as well. Simple to understand and interpret	Have not been investigated thoroughly Complexity of its Real Time Imple-mentation

Sr, No.	Author /Year of Publication	Title	Strength	Weakness
4	Fei Tang , Shuai Ma ,Yong Xiang and Changlu Lin, 2019	An Efficient Authentica-tion Scheme for BlockchainBased Electronic Health Records	Works with very high degree of confidence. Powerful Reprsentation Capability Relatively simple and computationally inexpensive method	Large communication overhead. Complexity of transactions are not analyzed. High complexity, inaccuracy, and inadequacy

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5	Ayesha Shahnaz , Usman Qamar and Ayesha Khalid, 2019	Using Blockchain for Electronic Health Records	Capable of further reducing the required level of human effort, Have Well-Understood Formal Properties, Relatively simple and computationally inexpensive method	Difficulties to obtain better performance, It is not an easyto-use method, Approach is a bit timeconsuming
6	Xiaodong Yang , Ting Li , Wanting Xi , Aijia Chen and Caifen Wang, 2020	A Blockchain-Assisted Verifiable Outsourced Attribute-Based Signcryption Scheme for EHRs Sharing in the Cloud	Keeping the control overhead at regular levels Powerful Reprsentation Capability High Effective with Complex Problems	Difficult to be used in large-scale parallel computing. Maximizes the complexity of the problem
7	Mohammad Zarour , Md Tarique Jamal Ansari , Mamdouh Alenezi , Amal Krishna Sarkar , Mohd Faizan , Alka Agrawal , Rajeev Kumar and Raees Ahmad Khan, 2020	Evaluating the Impact of Blockchain Models for Secure and Trustworthy Electronic Healthcare Records	Enhance correlation strength with finer and more compact information, Streamlined and decoupled services, Better operational efficiency	Tedious message updating, Signicantly increases capital and operating expenditures, Narrowly specialized knowledge

III. SYSTEM ARCHITECTURE

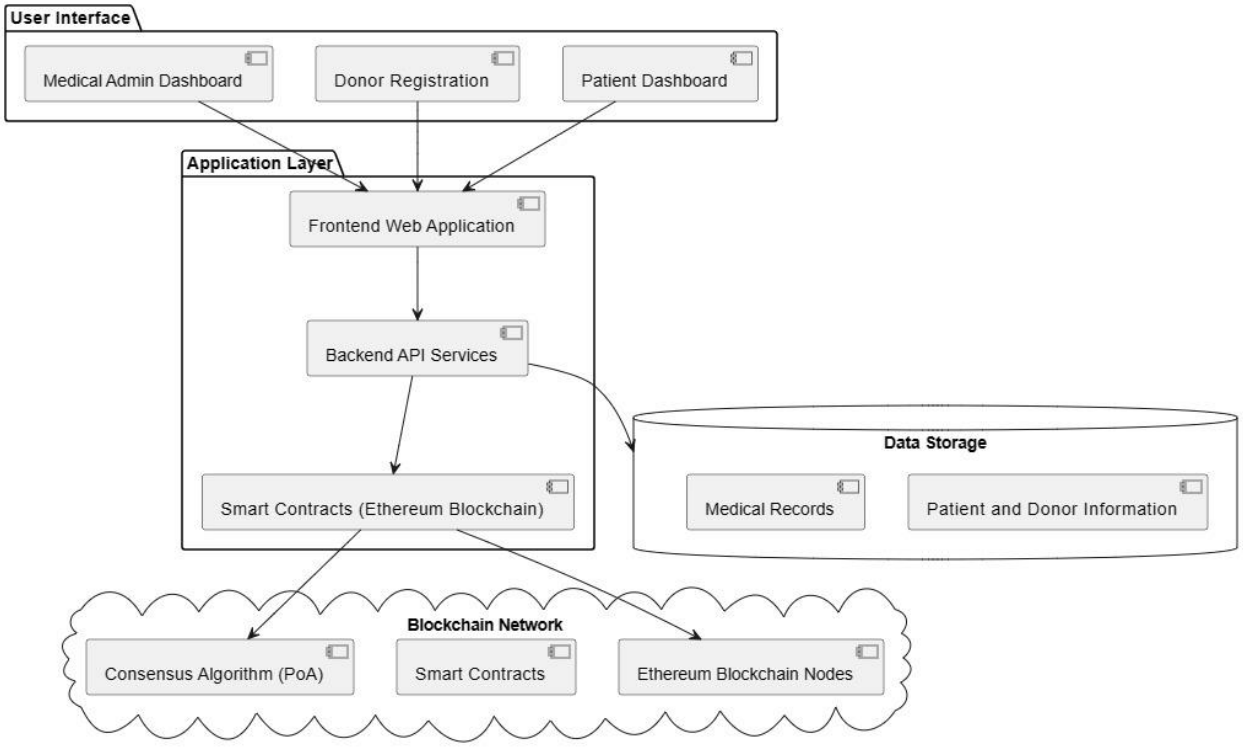

Fig. System Architectutre

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A high-level system architecture of the proposed blockchain-based solution for organ donation and transplantation

Entities/Actors

- **Donors and Recipients:** Interact with the system through web page. They register, access information, and potentially manage their preferences through the web page.

- **Smart Contracts:** Automate various tasks and processes within the system. They reside on the Ethereum Distributed Ledger.

Processes

- **Organ Donation Registration:** Donors register their organ donation preferences through Web page. This information is securely stored on the Ethereum Distributed Ledger.

- **Matching:** The matching smart contract plays a central role. It verifies the registered patients (recipients) and donors, and automatically matches them based on compatibility criteria.

- **Transplantation:** The Organ transplantation smart contract verifies and tracks the actions involved in the organ removal and transplant surgery.

Data Storage

- **Ethereum Distributed Ledger:** Secured ledger that stores all the critical information about donors, recipients, waiting lists, and matching results. Authorized actors (hospitals, transplant centers) can access this data through APIs (Application Programming Interfaces).

IV. SMART CONRACTS

The smart contracts serve distinct purposes within the realm of applications on the Ethereum blockchain. The "DonorContract" facilitates the management of data related to organ donation and transplantation, offering structured storage for information about donors, patients, and pledges. With its defined structs and mappings, the contract allows for the addition, retrieval, and validation of data points such as names, ages, genders, medical IDs, blood types, organs, weights, and heights. Through functions like setPledge, setDonors, and setPatients, individuals can be registered, while getPledge, getDonor, and getPatient enable the retrieval of specific information. Additionally, the contract includes validation methods to ensure the integrity of stored data, along with utilities like getAllPledgeIDs to retrieve lists of all registered pledges.

On the other hand, the "Migrations" contract is focused on managing the deployment and migration process of smart contracts within the Ethereum ecosystem.

This contract primarily tracks the completion status of migrations, allowing developers to keep a record of which migration steps have been executed. With an owner address and a variable to store the index of the last completed migration, the contract ensures that only the owner can update the completion status through the setCompleted function. This contract plays a crucial role in the maintenance and upgrade of smart contract systems, providing a mechanism for controlled deployment and versioning.

Together, these smart contracts contribute to the functionality and reliability of decentralized applications on the Ethereum blockchain. While the "DonorContract" facilitates the organization and accessibility of organ donation-related data, ensuring transparency and efficiency in the process, the "Migrations" contract offers a foundational layer for managing the deployment and evolution of smart contract systems, promoting scalability and maintainability in decentralized applications.

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V. RESULTS AND SCREENSHOTS

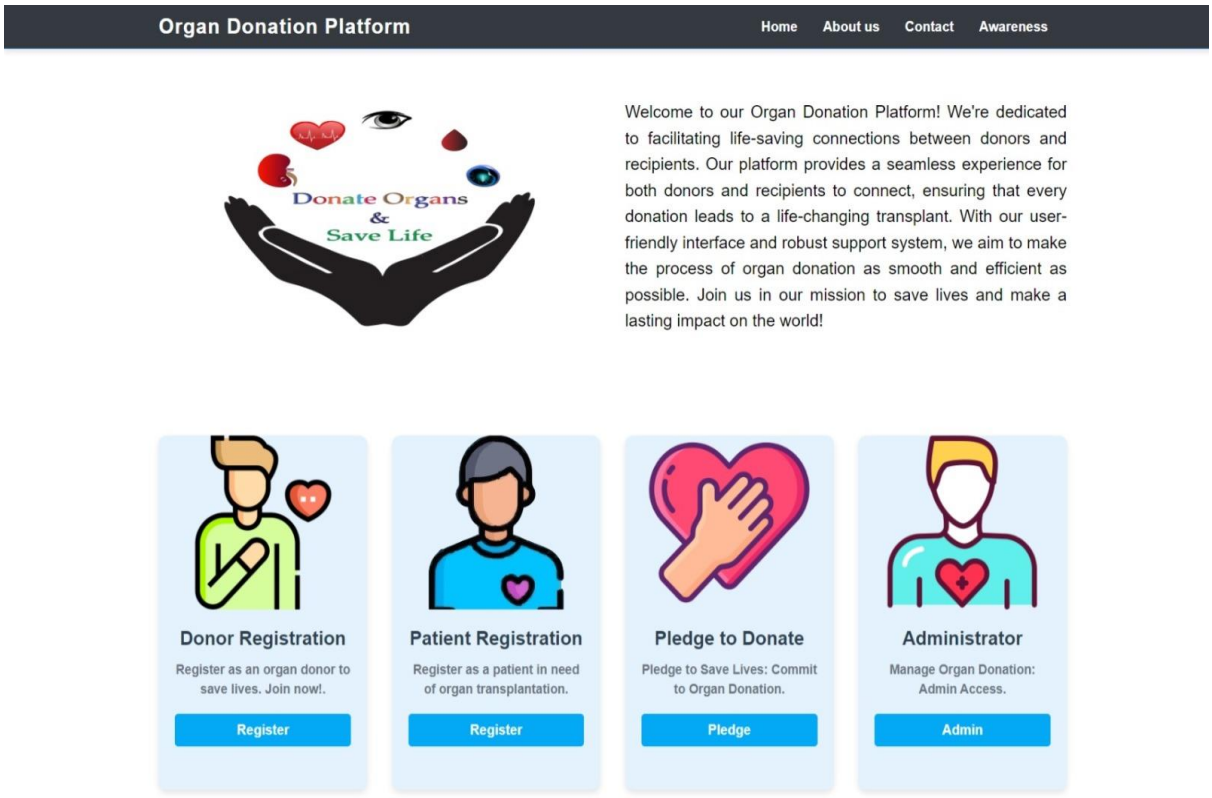

Fig. HomePage

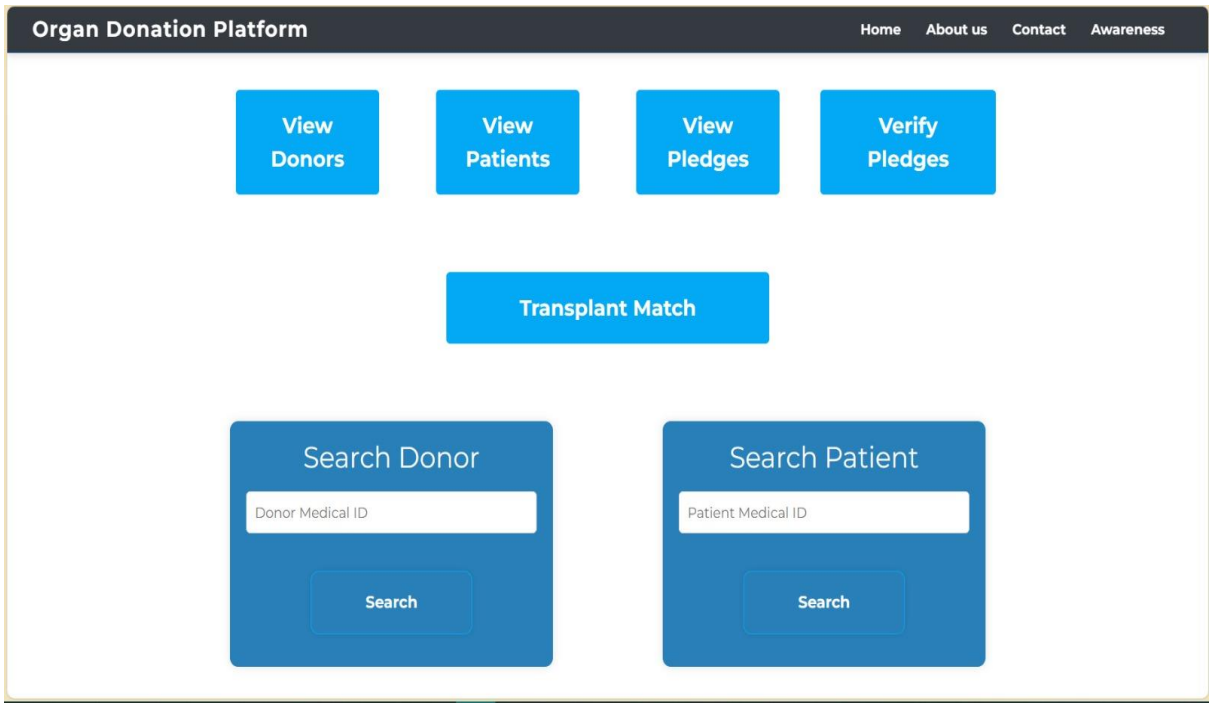

Fig. Administrator Dashboard

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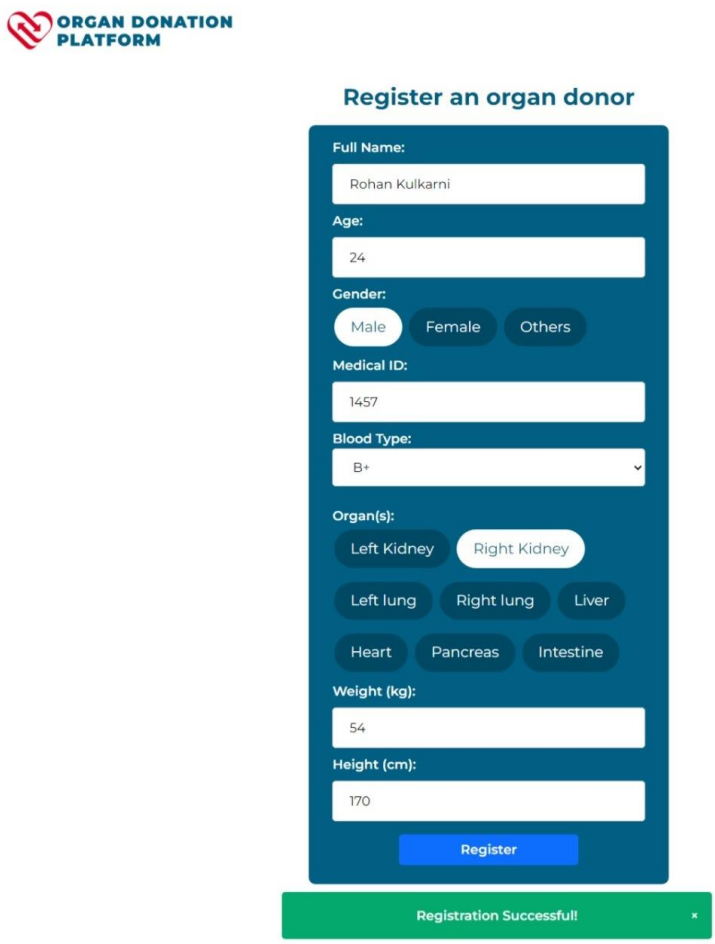

Fig. Registration Form

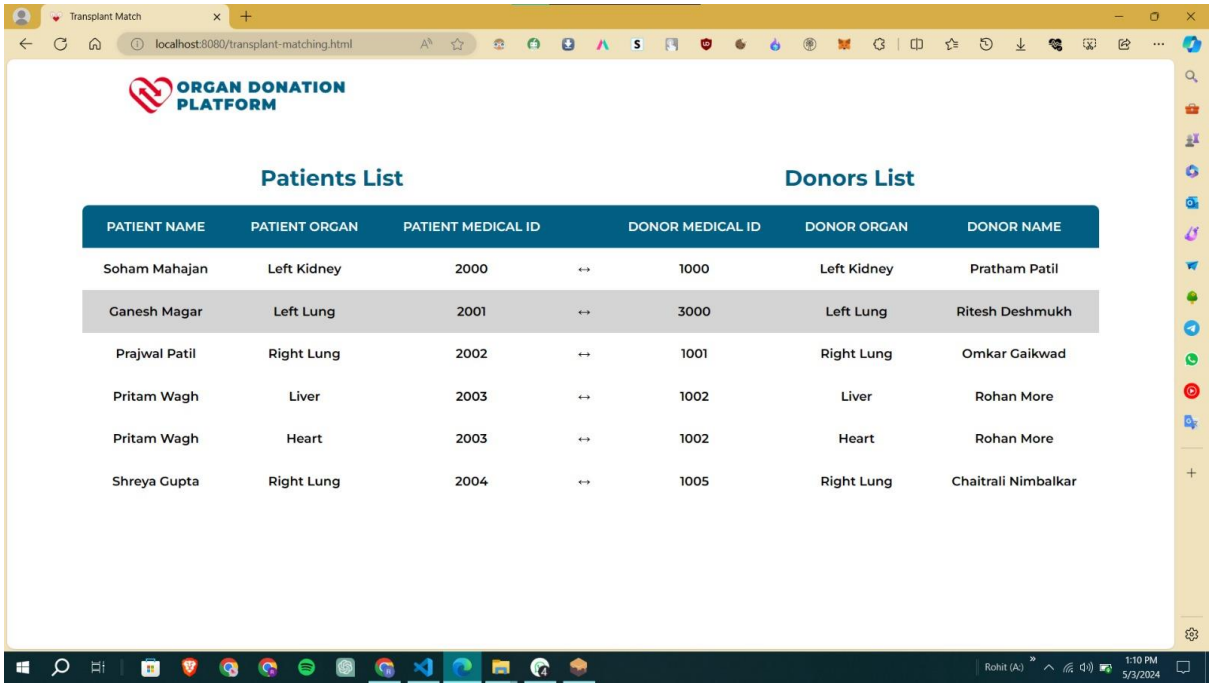

Fig. Transplant Match Page

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VI. CONCLUSION

This survey paper concludes by providing a comprehensive overview of the current state of organ donation and transplantation record systems and underscores the significance and efficacy of implementing advanced blockchain technologies, particularly Ethereum, for decentralized and cooperative management. This research paper emphasizes the pivotal role of Ethereum blockchain in securely recording and managing organ donation data, enhancing transparency, and facilitating trust among stakeholders involved in the transplantation process. By thoroughly investigating existing methodologies and proposing a decentralized approach based on Ethereum's blockchain, the project aims to streamline organ donation processes and improve overall infrastructure for organ transplantation.

VII. FUTURE WORK

In the future, the platform for organ donation and transplantation could focus on several areas to enhance its effectiveness and impact. This could include the development of advanced data analytics tools to optimize organ matching algorithms and predict transplant outcomes more accurately. Additionally, integration with emerging technologies such as Internet of Things (IoT) devices could enable real-time monitoring of donor and recipient health parameters, facilitating proactive interventions and improving post-transplant care. Furthermore, expanding the platform's reach through strategic partnerships with healthcare organizations and government agencies could help streamline regulatory processes, increase donor registration rates, and improve access to transplantation services for underserved populations.

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