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OrganTracker: A Decentralized System For Organ Donation With Compatibility Check Using Machine learning

Damini Mali [1], Divya Kudale [2], Suyash Marathe [3], Kirti Borhade [4]

Student [1,2,3], Assistant Professor [4]

Department of Computer Engineering [1,2,3,4]

Nutan Maharashtra Institute of Engineering and Technology, Pune, India [1,2,3,4]

Abstract: Although organ transplantation is an important medical process, inefficiency in adapting donors and centralized data management often leads to delays and incorrect adjustments. Organ trackers are decentralized systems developed using blockchain technology and machine learning to improve transparency, safety and efficiency of the organ donation process. The system securely stores donor and receiver data in a blockchain network, ensuring immutability, accessibility and reliability. Random forest machine learning models assess compatibility based on multiple donor factors. and as well as health status, it is searched as recipient ID, age, blood type, organ type, HLA typing, BMI, infection status, emergency level, waiting time, geographic location, and health. This approach minimizes human distortion, optimizes organ allocation, and reduces implantation speed. Additionally, organ trackers actually track organ availability and promote seamless communication between hospitals, donors and recipients. Our experimental findings demonstrate the effectiveness of the system in improving contract contracts simultaneously with data integrity and security guarantees. This study uncovers the potential of a decentralized, AI-driven solution in the global revolution in organ donation systems**.**

Index Terms **-** Organ Donation, Decentralized System, Blockchain Technology, Machine Learning, Random Forest Algorithm, Organ Transplant, Matching Donor-Recipient Compatibility.

I. INTRODUCTION

Organ transplantation is one of the foremost imperative progresses in present day medication and gives patients enduring from organ disappointment. However, the increasing gap between tissue problems and supply is a critical issue for efficiency and transparency of organ allocation. Traditional organ donation systems are based on a centralized database in which donor and recipient information is stored and managed by third-party organizations. However, such systems often suffer from issues of data manipulation, lack of transparency, management delays, and unfair allocation practices. These inefficiencies not only affect patient trust, they also increase the mortality rate for those waiting for their organs.

One of the main concerns about organ donation is compatibility testing between donors and recipients. Successful organ transplantation depends on several medical and non-medical parameters such as blood type, human leukocyte anthin (HLA) typing, body mass index (BMI), dialing, infection status, urgency level, latency time, and geographical superiority. Performing these compatibility tests manually or using traditional systems often results in inaccurate matches, delayed decision-making, and ultimately lower port success rates. Furthermore, the centralized nature of existing systems makes them vulnerable to data injuries and corruption, further limiting reliability.

To address these challenges, this paper proposes that organ trackers use blockchain technology and algorithms to improve the transparency, safety and accuracy of organ distributions using blockchain technology and algorithms. Blockchain technology improves data security by distributing information to several nodes, making it almost impossible to manipulate or modify data after recording. The system not only ensures data integrity, but also builds trust among participants, such as hospitals, patients, and health organizations.

In addition, organ tracker Random Forest includes monitored algorithms for machine learning to perform compatibility tests for donor recipients. This model considers several compatibility factors to predict the likelihood of a successful port.

This model considers several compatibility factors to predict the likelihood of a successful port. Donor parameters such as age, blood type, HLA typing, BMI, grant, health, and geographic location match recipient parameters such as emergency level, waiting time, and infection status. The Random Forest model provides a high level of accuracy and robustness by combining results that create several decisions, and reduces the risk of false pairing and increases the chances of successful porting. The distributed nature of organ trackers promotes clear organ distribution. This allows each transaction on the blockchain to be accessed by certified staff to ensure that organs are not unfairly allocated.

The system supports real-time organ availability tracking that promotes better coordination between hospitals and patients, reduces waiting times and improves the overall efficiency of the organ donation process. The proposed system aims to revolutionize the organ donation situation by combining the immutability of blockchain technology with transparency and accuracy of machine learning compatibility testing. By addressing the existing challenges of organ distribution systems, organ trackers provide a safe, efficient and fair platform for organ transplantation. This study not only contributes to further development of health technology, but also demonstrates the potential of decentralized, AI-controlled solutions in solving important social problems.

II. LITERATURE SURVEY

Alowidi and Naemi (2024) [1], "Advances in kidney transplantation: A machine learning approach to improving donors." Diagnosis, 14 (2119). This study examines the use of machine learning in optimizing donor recipient matching for kidney transplants. The authors evaluate compatibility based on clinical and demographic factors, develop predictive models to improve agreement accuracy and reduce rejection rates. This study highlights the ability of several solutions to improve organ allocation efficiency and optimize patient outcomes.

Tanchip et al. (2024) [2], "Donor selection and prediction of multi-organ transplants within organ procurement organizations using machine learning." Medrxiv preprint. In this article, we introduce machine learning models to predict donor selection and multi-organ porting. Research using Orchid datasets with over 133,000 donor records will evaluate several ML techniques and achieve high levels of accuracy in predicting multi-organ implantation. The results show that AI-based methods optimize organ distribution processes and increase the success rate of transplantation.

Vidya et al. (2024) [3], "ML Powered Organ Donation System." International Journal of Research Publication and Reviews, 5(5), 11019-11024. This paper introduces an ML-based system that combines support vector machines (SVMs) with K-means clustering to facilitate donor coordination. This study highlights how by automating selection, machine learning can improve the efficiency of implantation, while also taking into account important factors such as blood type, tissue resistance, and urgency levels. The high accuracy and recall values of the model indicate the effectiveness of improving organ distribution.

Ghosh and Dutta (2023) [4], "Indriya: Building a safe and transparent organ donation system using Hyperledger Fabric." arxiv preprint, arxiv: 2307.02416. This study introduces a blockchain-based organ donation system with Hyperledger fabric. The author addresses security, transparency and efficiency concerns in organ donation by implementing intelligent contracting and decentralized identity management. Performance reviews show high transactional throughput, show blockchain potential in protecting medical documents, and improve trust in organ transplants.

Pawar and Wankhade (2023) [5], "Surveying paper: "Organic donations through blockchain." International Journal of Advanced Research in Science and Communication and Technology (IJARSCT), 3(1), 134-137. Prevent fraud.

Jeong et al. (2023) [6], "Research on blockchain-based private donation systems for transparency and privacy." IEEE XPLORE. This paper examines the application of blockchain technology in ensuring privacy and transparency in organ donation. The proposed distributed system restricts unauthorized data access and continues to operate with data records that can be checked and simultaneously. Their results show that blockchain can improve trust in donation systems and at the same time comply with data protection regulations.

Tribhuvan et al. (2023) [7], "Management of organ donation and transplantation through custom blockchains." IJCRT, 11 (11). This study presents a blockchain organ management system that improves adaptation efficiency of donor recipients. The author implements permission blockchains to maintain transparency and accountability, while simultaneously ensuring the security of the organ distribution process.

Gotlieb et al. (2022) [8], "Promise of application to machine learning in fixed organ transplantation." NPJ Digital Medicine, 5 (89). This study checks various ML applications in organ transplantation, including matching with donor recipients, post-transplant monitoring, and rejection prediction. The authors highlight how AI control models can significantly improve clinical decision-making and reduce the risk of organ resignation.

Gholamzadeh et al. (2022) [9], "Machine Learning Techniques to Improve Lung Transplant Outcomes and Complications: A Systematic Review." BMC Medical Research Methodology, 22 (331). This systematic review evaluates ML applications in lung transplantation and focuses on predicting post-wing complications. The authors discuss the possibility of AI in detecting early complications and improve patient survival.

Yoon et al. (2017) [10], "Personalized Donor Recipients Matching for Organ Transplantation." University of California, Los Angeles. This paper proposes that machine learning systems are confident in optimizing organ adjustment based on patient-specific characteristics. This study demonstrates the advantage of AI-controlled consensus with traditional methods and improves the success rate of long-term transplantation.

III. PROPOSED SYSTEM

The proposed framework organ tracker may be a decentralized organ gift stage based on the blockchain, in which organ donation
relationships are rationalized by guaranteeing straightforwardness, security and proficiency. Eliminate the drawbacks of the central organ donation system by integrating blockchain technology with algorithms for machine learning and algorithms for performing compatibility testing of donor recipients. This system not only prevents data manipulation, but also improves the success rate of organ transplantation by providing accurate adjustments to donor receivers.

1. System Overview

Organ donation systems require a reliable and transparent method to match available organs with recipients based on medical parameters. The proposed system tackles this challenge by utilizing blockchain technology to securely store data in an immutable format, while employing the Random Forest machine learning algorithm to predict donor-recipient compatibility. This system ensures that the organ allocation process is fair, unbiased, and free from third-party interference.

The main components of the system include:

- Data Storage Using Blockchain
- Machine Learning Baseset Compatibility Checking
- Organ Allocation and Tracking Systems

The combination of blockchain and machine learning makes the overall efficiency and accuracy of organ allocation important, reducing latency and preventing data manipulation.

2.1 Data Collection Layer

The system starts with collecting donor and recipient information via web-based forms. Certified employees, such as doctors and hospitals, enter important medical details, including:

- Donor and Recipient IDs
- Age
- Blood Group
- Organ Type
- HLA Typing
- BMI
- Infectious Status
- Geographic Location
- Health Condition
- Urgency Level
- Waiting Time

The data is temporarily validated and stored temporarily before further processing.

2.2 Data Preprocessing Layer

The collected data meets data preprocessing to remove inconsistencies, process missing values, and normalize the data. This step progresses the precision of your machine learning show.

Pre-processing steps include:

- Handling missing values
- Encoding categorical data
- Normalizing numerical data
- Removing duplicate records

After processing, the clean data is handed over to the Random Forest model to verify compatibility.

2.3 Machine Learning Layer

The Arbitrary Timberland Calculation is utilized to perform compatibility tests for benefactor beneficiaries. This layer includes:

- **Model Training:** The model is trained with historical organ donation records.
- **Predict Matches:** The model generates compatibility values by assessing donor and recipient factors.
- **Generate Matches:** The system ranks recipients based on the best compatibility values.

The Random Forest algorithm is chosen to handle large data records, nonlinear relationships, and several determinants. This model generates several decisions, averages the product, and averages the compatibility values between donor and receiver.

Compatibility assessments support the prioritization of likely responders and reduce the risk of transplanting and maximizing organ exposure.

2.4 Blockchain Layer

Blockchain technology stores all organ donation data sets in an manipulated and transparent way. The system uses Ethereum blockchain and intelligent contracts to automate the organ allocation process and protect medical data.

- **Smart Contracts:** An automated script that triggers coordination of donor and organ allocations.
- **Web3.js Integration:** Creates interactions between web applications and blockchain networks.
- **Data Immutability:** It cannot be changed as soon as data is stored on the blockchain.

2.5 User Interface Layer

The user interface is a web-based platform that authorized users can register:

- Register donor and recipient data
- View compatibility results
- Track organ availability
- Access allocation details

2.6 Compatibility Checking Process

- Donor and receiver data are recorded via web forms.
- The data will be passed.
- Machine learning models predict compatibility values.
- Compatibility results are stored on the blockchain.
- The best match is displayed to the authorized personnel.
- Organ availability and location are tracked in real-time.

2.7 Advantages of System Architecture

- Decentralized and Transparent Data Storage
- Secure Data Transactions through Blockchain
- High Compatibility Prediction Accuracy
- Automated Organ Allocation
- Real-Time Tracking of Organ Availability
- Protection against Data Tampering

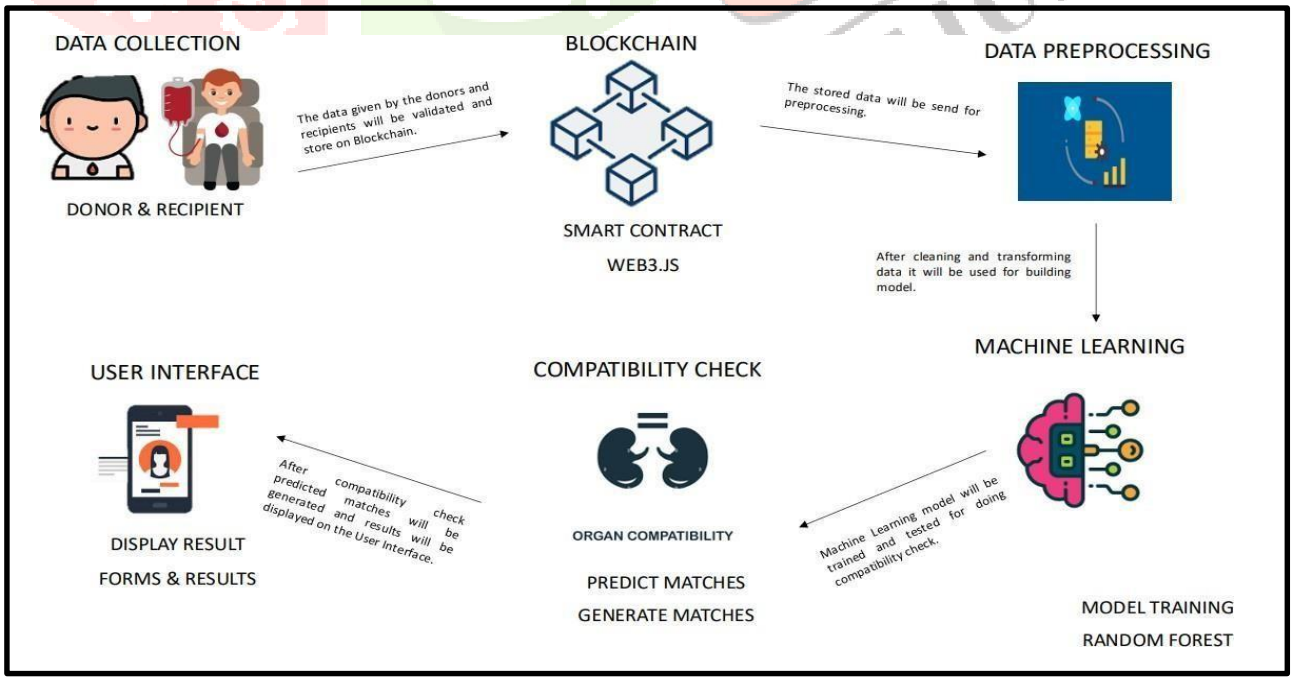

Fig 1. System Architecture

IV. Methodology

The methodology of OrganTracker outlines the step-by-step process for developing the decentralized organ donation system. It explains the techniques, technologies, and algorithms used to achieve secure organ donation management and accurate donor- recipient matching. The methodology is divided into several stages, from data collection to final organ allocation and tracking.

1. Data Collection

The first phase involves collecting donor and recipient information from authorized hospitals and medical institutions. The data is entered through web-based forms designed to capture both medical and non-medical parameters.
The collected data includes:

- Donor and Recipient ID
- Age
- Blood Group
- Organ Type
- BMI
- HLA Typing
- Infectious Status
- Health Condition
- Geographic Location
- Urgency Level
- Waiting Time

2. Data Preprocessing

Before data is inserted into a machine learning model, the collected information is processed to improve accuracy and eliminate inconsistencies. Preprocessing steps include:

- **Data Cleaning**: Removing null values and duplicates
- **Categorical Encoding:** Converting categorical data into numerical format
- **Normalization:** Scaling numeric data to ensure uniformity
- **Outlier Detection:** Eliminating extreme values that could affect model performance

3. Model Training For exchanging between a few choice variables to check the compatibility of givers and beneficiaries, the random forest algorithm is chosen for its tall exactness and vigor.

This model is trained using a historic organ donation dataset in which donor recipient pairs and their successful transplants are used as labels. The most important steps in model training include:

- Sharing data in training and test sets
- Adaptation of random forest models in training statements
- Validating model performance using accuracy and precision metrics

4. Compatibility Prediction

Once trained, the model predicts the compatibility score for each donor-recipient pair by evaluating multiple features such as:

- Geographic Proximity
- Health Condition
- Blood Group
- HLA Typing
- BMI
- Urgency Level
- Organ Size

The model ranks recipients based on the highest compatibility score, which helps in prioritizing critical patients. All processed data, including donor information, recipient information, and compatibility scores, are stored on the blockchain network using smart contracts.

5. Blockchain Integration

Steps in blockchain integration:

- Deploying smart contracts for secure data storage
- Encrypting sensitive data before uploading
- Verifying transactions through the blockchain consensus mechanism
- Allowing only authorized users to access data through Web3.js

6. Organ Allocation and Tracking

Once a compatible match is found, the system automatically updates the blockchain ledger with organ allocation details. The organ's location is tracked in real-time using blockchain transactions, ensuring faster delivery and minimizing organ wastage.

7. Result Display

The system displays the following outcomes to the authorized users:

- Best-matched recipient
- Compatibility score
- Organ availability status
- Donor and recipient health details

8. Security Implementation

The following security features are implemented:

- **Data Encryption:** Encrypting sensitive medical information before storing it on the blockchain
- **Access Control:** Restricting data access to authorized doctors and hospitals
- **Smart Contracts:** Automatically verifying organ allocation transactions
- **Audit Trail:** Maintaining immutable transaction logs

V. EXPECTED RESULT

The proposed organ tracker system is expected to significantly improve the organ donation process by addressing the limitations of the existing central system. A combination of blockchain technology and algorithms for machine learning improves transparency, safety and accuracy of organ distribution. The expected results for the system are:

1. Accurate Donor-Recipient Matching

The model of the random forest machine is expected to provide high accuracy in predicting compatibility by evaluating several medical and non-medical parameters, such as:

- Blood Group
- HLA Typing
- BMI
- Urgency Level
- Organ Size
- Geographic Proximity
- Health Condition

This model generates compatibility ratings for each donor recipient pair, ensuring that the most appropriate recipient receives the organ and reduces the risk of organ organization.

2. Enhanced Transparency

By using blockchain technology, the system maintains a general book of operational prevention and immutable organ distribution transactions as a result of all donor and receiver data, compatibility. This ensures that every step in the organ donation process is transparent and eliminates preferences and potential corruption.

3. Secure Data Storage

The system encrypted all confidential medical information before storing it on the blockchain. Only authorized hospitals, physicians and government agencies can access data through role-based authentication. This protects donor and recipient privacy and prevents unauthorized access at the same time.

4. Real-Time Organ Tracking

The blockchain network allows real-time organ tracking from the time an organ is assigned until it reaches the recipient. This feature ensures timely organ delivery, reduces the risk of organ abuse, and optimizes the logistics of organ transport.

5. Fair Allocation System

The distributed nature of the system eliminates manual intervention and human distortions during organ allocation. Smart Contract automatically provides organs based on compatibility values and urgency levels to ensure that the process is fair.

6. Improved Transplant Success Rate

By selecting compatible donor recipient pairs for each algorithm for machine learning, it is expected that the system will reduce organ rate rejection and improve overall transplant success rate.

7. Efficiency in Time Management

Automating the organ adaptation process with machine learning reduces the time required to verify compatibility and saves critical patients so that organs can be allocated faster.

8. Secure and Decentralized Data Access

Blockchain ledgers allow several hospitals and certified organizations to access donor recipient data in real time without relying on a single central authority.

9. System Performance

- Compatibility Prediction Accuracy: 80%–90%
- Data Security: 100% tamper-proof using blockchain
- Organ Allocation Time: Significantly reduced compared to traditional systems
- Transparency Score: 100% verifiable transactions

VI. CONCLUSION

Although organ transplants are life-saving medical procedures, the inefficiency of current organ donation systems often lead to delays, false pairing, organ waste, and ultimately affect patient survival. The proposed organ tracker system introduces an innovative approach by integrating blockchain technology and algorithms for machine learning to overcome these challenges.

The compatibility testing process driven by the random forest algorithm improves the accuracy of donor recipient contracts by taking into account several medical and non-medical parameters such as blood type, HLA typing, BMI, boundary, emergency level, and geographic proximity. This approach greatly improves the possibility of organ acceptance and reduces the possibility of transplantation.

Intelligent contracts automatically use the organ allocation process to eliminate human distortion and ensure that organs are properly allocated using compatibility values and emergency levels. Additionally, real-time organ tracking systems improve the efficiency of organ transport and ensure timely delivery to recipients.

Expected results for the proposed system include increased transparency, reduced allocation periods, improved data security, and increased porting success rates. The decentralized nature of the system simultaneously promotes the privacy of sensitive medical information and the trust between donors, recipients and healthcare institutions.

In summary, organ trackers represent important steps to building a safe, efficient and transparent organ donation system. This study uncovers the possibilities of distributed, AI-controlled solutions to revolutionize the health sector and save countless lives.

VII. FUTURE SCOPE

The proposed organ tracker system combines blockchain technology and algorithms for machine learning to form the basis of an advanced organ donation platform. However, we can further improve the system to improve its functionality, scalability and impact on the healthcare industry. The future scope of this project will examine progress and applications that may be integrated into the system to make organ donation more efficient, accessible and more accurate.

1. Integration of Multiple Blockchain Networks

Current systems use a single blockchain network for secure data storage and transactions. Future improvements include the integration of cross-chain platforms that allow communication between various blockchain networks and allow wise data exchange in several hospitals, organ donor organizations, and countries.

2. Advanced Machine Learning Models

Random Forest algorithms provide high prediction accuracy, but can further improve the accuracy of donor recipients by providing more advanced algorithms such as deep learning, gradient boost machines (GBM), and neural networks. These models can analyze complex patterns in medical data and improve the speed of predicting compatibility.

3. IoT-Based Organ Tracking System

Future versions of the system can include Internet of Things (IoT) devices that allow real-time organ tracking in transit. The sensor monitors parameters such as temperature, pressure, and location to ensure that organs are transported under optimal conditions.

4. Global Donor-Recipient Matching System

The proposed system could be extended to create a global decentralized network that connects multiple organ donation organizations across countries. This would help increase the availability of organs and improve the chances of finding compatible donors for critical patients.

5. Privacy-Preserving Machine Learning

To further improve data security, data protection shift (PPML) technology can be integrated with methods such as homogenous encryption and federated learning. These techniques allow machine learning models to process encrypted data without decrypting. This ensures data protection for donors and recipients.

6. Mobile Application Development

Dedicated mobile applications can be developed to provide real-time updates to patients, hospitals and donors. The app can include features such as organ availability notifications, donor registration, compatibility outcome notifications and more.

7. AI-Based Organ Viability Prediction

Additional capabilities to organize kis-algorithms (artificial intelligence) can be used to implement sustainability of dietary organs based on medical testing and environmental conditions, ensuring that only healthy organs are assigned to transplants.

8. Government and NGO Collaboration

Cooperation with government agencies, NGOs and health authorities can expand the scope of the system and integrate it into existing organizational guidelines and framework conditions.

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