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Secure Organ Donation System using Blockchain

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ABSTRACT: Organ donation must be confidential and timely, and the identity of the donor and recipient must be kept confidential. When it comes to privacy and trust, we provide a medical blockchain-based solution to address these challenges. To have a secure and immutable ledger system, it is important to use reliable technology such as blockchain technology. The number of organ donors is much lower than the number of recipients. The main reason behind this is the lack of communication between the provider and the beneficiary. In the absence of a matchmaking platform, beneficiaries cannot contact donors. The main goal of this project is to facilitate easy allocation between donors and recipients by providing verified data and avoiding data redundancy while maintaining confidentiality and authenticity of personal data. This project includes the proposal of a decentralized organ donation system using blockchain technology that ensures data authenticity.

KEYWORDS: Blockchain, Kidney, Organ donation, smart contracts.

I. INTRODUCTION

Organ donation is one of the most noble forms of donation to have existed. Organ donation can take place from a conscious human to a conscious human or maybe from a dead, brain dead human to a conscious human. Minors can also participate in the organ donation as long as their guardian agrees to it. The organs of a dead human however can only be used for donation if he/she has agreed to do so when they were alive.

Blockchain has been the buzz word lately, its decentralised nature, immutability is quickly catching the eyes of traditional web 2.0 users which is leading to an increasing demand for blockchain applications. The system we propose plans to make the use of blockchain for an organ donation system. Once implemented it'll provide a secure alternative to the traditional technologies used for this task.

II. RELATED WORK

In paper [1], the main focus is on the frontend and basic segregation of the departments. The proposed system is an organ donation decentralised app using blockchain technology. It would be a web application for patients to register their information— most importantly medical ID, blood type, organ type and state. The system would work on a first-in, first-out basis unless a patient is in critical condition.

This paper is based on problem facing organ donation systems around the world is the same, more people on the waiting list than actual donors, and the gap is widening each year [1]. The length of the waiting list means that patients die before donation takes place. The technology-driven demand for the extraction of human organs—mainly kidneys, but also liver lobes and single corneas—has created an illegal market in body parts [2].

In this paper, the extension of kidney system [3] is introduced. Kidney is a blockchain-based kidney donation system that proposes a Kidney Paired Donation module instead of using the usual kidney waiting list. The advantage of this system is that it is decentralised. Authenticity exists due to the nature of blockchain, which does not allow unnoticed changes. Using blockchain technology also increases speed and efficiency.



The shortcomings of this system can be explained by the first-in, first-out method and the cost of using a centralised database. The "first come, first serve" principle can be very problematic for hospital patients for a variety of reasons because their health can change very dramatically and become very dangerous. In spite of using blockchain technology, other databases are also used. Using blockchain technology as well as maintaining and regulating other databases is a bit cumbersome.

From this paper [1], we can get the better idea of the workflow of the system and the UI design of the system. UI design is good which helps us to understand the segregation and administration process in greater depth.

From paper [4], we get to know different variables involved in organ transplantation. The proposed system in paper [4] is very helpful for creation of the chain of the hospitals. The connections of the hospitals are effectively mentioned in the diagram, but the overall system is very complex as each and every hospital has its own blockchain and the communication is required after every request. This is time consuming as time is a major factor in organ transplantation. Better and efficient system can be proposed keeping the proposed system in paper [4] as reference architecture of the system. The basic algorithms and constraints of organ matching is discussed in paper [4], which is genuinely helpful for the matching process.

In paper [5], the focus is on filling the communication gap between the donor and the recipient. For any organ, the number of donors is very less than the number of recipients. No connecting platform between the two leads to lack of communication. Illegal sale of organs is on a rise. The amount charged by the hospitals may sometimes be way higher than the actual amount. To solve all these issues, a decentralised system which would help in increasing transparency between the donor, the recipient and the hospital was proposed.

The proposed model is a decentralised application using Ethereum [6] blockchain technology. Firstly, all the hospitals eligible for carrying out organ donation were registered on blockchain. An Ethereum address was provided to each hospital. Donor signs up using his/her details and visits the nearby hospital from the given list. It's the responsibility of the hospital to check if that donor is eligible to donate or not. If yes, his/her electronic medical records are uploaded on blockchain. EMRs are hashed using security algorithms before uploading the data on the blockchain which ensures additional security. Algorithms like double hashing or hashing by IPFS [6] using SHA-256 hash algorithm are used. Once a recipient is found, his/her electronic medical records are also uploaded on blockchain. Smart contracts are used to find a match between the donor and recipient. Once match is found, recipient's details are displayed to the donor and then the hospital carries out the transplant.

In paper [4], a very similar kidney donation model was proposed. They discussed about the shortcomings of a centralised system for organ donation and thus came up with a decentralised kidney donation model.

The advantage of the model proposed in paper [5] is that a way for the donor and recipient to connect is created. People are charged the actual price of the organ and the illegal sale of organs has been reduced to a greater extent.

In paper [7], "LifeShare" system, a web application has been proposed through which users can register and check availability of their blood/organ requirement. It is a system which introduces a good quality framework to cross any barrier between blood benefactors, the individuals deprived of, and keen on blood and organ donation. The model mainly focuses on the Automated blood group matching with location tracking, Blockchain based tracing and generating a smart ID and predicting the future demand. The users are mainly donors, seekers, and healthcare generals. The proposed system bridges the gap between the recipient, donor, and the hospitals. In paper [7], the methodology used is that the donor and the receiver registers to a certain hospital and after matchmaking the donor and the receiver get's each other's details. The main drawback of the system is that the receiver get the details of the donor which at times could be harmful and dangerous for the donor. So, the system should be such that only the donor should get the details of the concerned receiver. Paper [7] gives the workflow and the integration of the organ donation system.

Paper [8], the system has 3 modules which are Admin, Patient, and System. It is a web application for patients to register their information like medical ID, organ type, state and works in first in first out basis unless a patient is in critical condition. Paper [8], the focus is in differentiating centralised, decentralised, and distributed systems and finding out which is the best for implementing the organ donation system. It gives us the use and the advantages of the blockchain and reasons why blockchain should be used for the application. We get to know why a decentralised and distributed system is required for implementing the organ donation system.



Paper [9], aims at exploring the extent in which social media, such as twitter, may be used to sense the population regarding organ donation awareness.

In paper [10], the focus is on how the patient’s critical data can be shared using blockchain. This paper [10] proposes an EMR data sharing mechanism which uses blockchain technology to address the security and privacy concerns. The system makes use of a private cloud for storage purposes. The hospital’s own private cloud storage is where the encrypted EMR data is stored. The medical blockchain simultaneously preserves the identity of the hospital, the identification of the EMR, and the access policy. The patient can use his private key to access his own EMR data when he goes to other hospitals to see a doctor, but he must provide permission for other hospitals to access his EMR data.

Paper [11] discusses a new system for EHR (Electronic Health Record) using blockchain. The paper discusses problems in the traditional centralised EHR systems, it briefly touches upon the HIPAA act which states rules for transmission of health information in the electronic form. It also discusses the various cryptographic tools and smart contracts. The paper basically introduces a new approach to manage patient’s health data.

Paper [12], deals with supporting the distributed transaction of EMR between medical staff of the emergency ward in GalyaniVadhana Karun Hospital, which is located in Narathiwat Province in the south Thailand insurgency. It basically uses a distributed data storage system and blockchain to ensure that data integrity and eventually data security is maintained.

III. METHODOLOGY

The traditional system currently in use is centralised in nature, which is not the best for this type of system. This has a few flaws which can be solved if we use a decentralised system. The major advantage of using a decentralised system is that it provides immutability. Meta-data from the hash output of the previous block is always included into the hashing process of a new block. Since following blocks in the chain will reject any attempted change, it is difficult to manipulate or delete data once it has been authenticated and added to the blockchain due to this link in the hashing process.

We studied a few papers, and they were using a partially decentralised system wherein blockchain technology was paired with some other technology like cloud computing. This paper aims to propose a system which only uses blockchain technology.

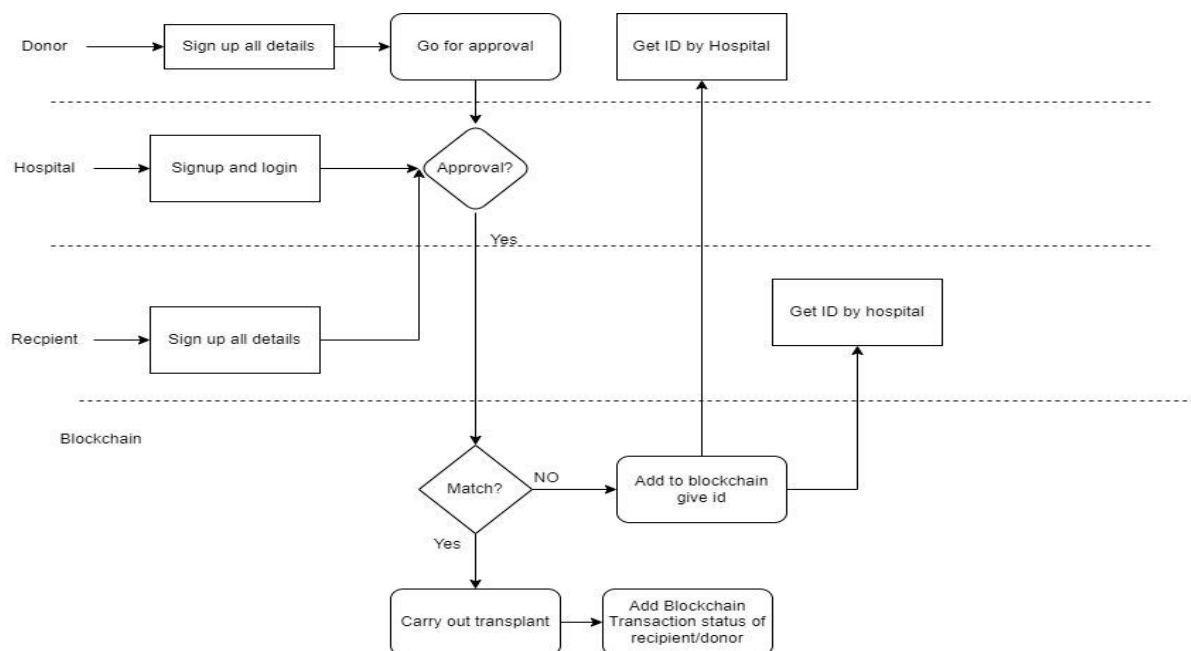


Figure 1: System Architecture



The system consists of four main components, the donor, the receiver, the hospital and blockchain. The donor signs up using his/her details. A list of hospitals which carry out transplantation is maintained. Donor visits one of the enlisted hospitals and gets himself/herself verified. Once the donor is verified it implies that the donor is ready and fit to donate that organ. Using smart contracts, it will be checked if a compatible recipient is present on the blockchain or not.

If a match is found, the EMRs and personal information of the donor does not get added to the blockchain. This will help in saving block's space. If a match is not found, the donor is added to the blockchain.

Recipient also signs in using his/her details. If the recipient is advised to undergo transplant, we can check in the blockchain for a compatible donor. If a match is found, the recipient's EMRs and personal details are not added to the blockchain thus saving the block's space.

Considering the case where the donor is alive, and a match is found using smart contracts. In this case, the donor will receive a token. Token is generated by hashing the recipient's ID. Donor receives the details i.e., name, location, etc. of the hospital. The donor then reports to the hospital to donate that particular organising smart contract; if a match is not found, the donor's details are added to the blockchain. Same for the recipient.

When the donor is dead, the hospital contains the body. After post-mortem, the details are fed into smart contracts and then matchmaking takes place.

After transplantation, it is necessary to remove the donor and the recipient who have already donated or received an organ from the blockchain. Deleting a block in a blockchain is very tedious. Thus, these data fields can be kept as Boolean and can be changed to not available once transplant is done.

IV. CONCLUSION

In this paper, we proposed a private Ethereum blockchain-based solution to manage organ donation and organ transplantation in a decentralised, accountable, auditable, traceable, secure and trustworthy manner. We have developed smart contracts that ensure data lineage by automatically recording events. We introduce the algorithm for testing and validation details. Analyse the security of the proposed solution to ensure that smart contracts are accurate and time efficient. Compare our solution with other blockchain-based solutions available today. Learn how to customise the solution with minimal effort to meet the needs of other systems with similar problems.

V. FUTURE SCOPE

In- the future, we can improve the solution by developing an end-to-end DApp of his. Additionally, smart contracts can be deployed and tested on the real private Ethereum network. Transactions between two participants are viewed by other actors endorsed on a private blockchain.

The basic premise is that hospitals do not cheat, cooperate, and always work for the benefit of their patients. The scope of the DApp is defined such that Headquarters has full authority to connect and disconnect hospitals from the blockchain. This DApp can be extended and used for many organ transplant sites and is very useful for creating faster alternatives to traditional systems. This DApp concept can be used for many aspects. This concept and implementation can be used to develop many other systems such as Management of public files and documents, management of vaccination verification, etc.

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