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Creating Organ Donation System with Blockchain Technology

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ABSTRACT: Organ donation being the most noble deed requires revolutionization. One cannot imagine the urgency and desperation a person feels when his/her loved one is in need of such act and they could not locate an appropriate donor. On the other hand, people who wish to donate worries about the privacy, security and authenticity. The Proposed System is a web-based Application which uses FIFO approach to select an organ donor for each genuine patient requiring a transplant and if there is an emergency case then the priority is given to that patient. It provides an efficient platform for potential organ doners and those who need the organs to connect. It uses Blockchain as its underlying Technology. Blockchain Technology is as it is known a decentralized and distributed network which stores records that are immutable as in cannot be altered once saved. The Immutability of Blockchain Technology provides the required security to the application. Blockchain Technology uses digital documents which are digitally signed by the user so that they are timestamped at the time of saving the document and cannot be changed after that. It solves the issue of authenticating the same user again and again. It uses smart contracts and RSA algorithm as well which are explained further in the paper.

Keywords – FIFO, Blockchain Technology, Immutability, Timestamped, Smart Contracts, RSA Algorithm.

I. INTRODUCTION

The human body can be extremely fragile. It needs a lot of care and precaution but many times situations can take unfortunate turns which might lead to organ failure. There can be a number of reasons for this such as an accident, a disease or old age which affects the vital organs, heart, lungs, kidney to name a few. Statistics suggest that there are countries in which people needing organs are added to a waiting list every 10-15 minutes [1]. In the year 2018, 17 people died every day from this waiting list of organ recipients and in the month of June 2019, the count reached 113,340 of the waiting list in the US [2].

Organ Donation is treated as a highly noble and crucial act but it carries a lot of complications. There can be different types of donors, living donors who register themselves as donors meaning they are willing to donate their organs when they die, deceased donors whose family members or closed ones decides to donate their organs, those living donors who decides to donate a non-crucial organ while they live and in some cases a person who is brain-dead. There are applications which enables the user to pledge for organ donation after their death [3]. There is also no age-limit for organ donation as long as the organ is in a perfect condition. Although consent is required from the guardian in case of a minor donor.

Before 1950s there was no procedure for organ transplantation but as things are getting modernized the whole transplant process has become a lot easier. Though, because of lack of communication and linking platforms the ratio of donors to recipients of the organ is not very impressive [1] and most of the time it is found that the recipient could not reach an appropriate donor in time. The donors concern themselves with the issue of corruption. As the doctors or/and hospitals many times get involved in unlawful trading of organs which results in hyping the price of the organs. As this happens most people who cannot afford are denied the organs and those much lower in the waiting list who can bear the expense get the organ which is extremely unfair and unfortunate. These mis-happenings creates an even more urgent need for a transparent platform for organ donation.

II. BACKGROUND THEORY

Blockchain Technology is a distributed and decentralized system for storing records in interconnected nodes [1,5] unlike most of the existing system which are centrally operated. The list of features also includes Transparency, immutability, peer2peer storage, digital trust and scalability [13]. Blockchain Technology is playing a major role in getting the real and the digital world closer by strengthening internet security and providing an independent platform which does not require any human support
[4]. Blockchain Technology uses hash chain as the underlying architecture for the storage of the data. Hash pointers and Merkel tree are the two fundamental components which together form the hash chain [8,10,11]. Hash pointers works in the similar manner as any other pointer, it points towards the locale where the data is residing and is cryptographic in nature whereas the Merkel tree is simply a binary search tree whose nodes are connected with the help of the hash pointers.

Whenever a new node is added in the system instead of being stored centrally its information is circulated within the chain. While the addition of a new node or user the transition is verified using a digital signature [6]. This signature consists of two keys namely – private key and public key. Now, as the name suggest the private key is kept as a secret whereas the public key is distributed among the existing nodes in the system. The public key is shared with the other nodes so that every node can help in verifying a particular node in the chain.

As Blockchain Technology is decentralized, it uses consensus algorithm to reach a mutual agreement among all the node in the system to change or modify anything within the chain [7,9]. Ethereum is the utmost used platform for Blockchain Technology and is apt for the healthcare industry because of its use of Smart Contracts [14]. The use of smart contracts eliminates the interference of any third party in the process of authentication. Smart Contracts consist of pre-sanctioned provisions which consequently approves the nodes/user when it satisfies the condition. The schema of a blockchain system consist of three layer – 1. Framework, 2. Application middleware and 3. Smart Contracts [12].

III. IMPLEMENTATION

The proposed system consists of four active participants namely – Administrator, Hospital/Doctor, Donor and Receiver.

1. Administrator – The Administrator registers and manages the hospitals, doctors

and donation centers. It manages the general information, helps in searching and matching the donor and the recipient.

2. Hospital/Doctor – The Organ Donation System contains a list of hospitals, donation centers and the doctors who can introduce a donor in the system. Supervise the donor and the recipient and carry out the transplant once appropriate organ becomes available.

3. Donor – A donor is the person who wishes to donate his/her organ. The donor can get themselves registered or can get in the system through hospital/doctor. The donor simply needs to signup using the details. If they are registering by themselves, they need to visit any listed nearby doctor/hospital to get approved. Then sign-in using the primary key and wait for a recipient to be allotted for donation.

4. Recipient – Recipient is the one who is in need of the organ. A recipient can simply sign-up in the system using the details which can be approved by the hospital/doctor. Once the recipient has an account, he/she can fill out the requirements (organ, blood group, etc.) and then wait for the system to provide a match. When the recipient is matched with the organ donor the recipient needs to make the payment through the system to the donor/hospital.

Figure 1. shows the elaborated framework of the proposed system. As shown, there are 4 distinguish tiers/layers of in the system. These layers are discussed briefly below.

1. Layer 1. ***The Browser*** - The user interface of the system deals with the 4 participants namely – The administrator, the Hospital/Doctor, the donor and the recipient. The listed hospitals/doctors can include a donor or the donor can register themselves and get approved by visiting any nearby hospital or

doctor. The receivers can be registered by the hospital/doctor or from the waiting list. The user interface of the system has different pages all the four users.

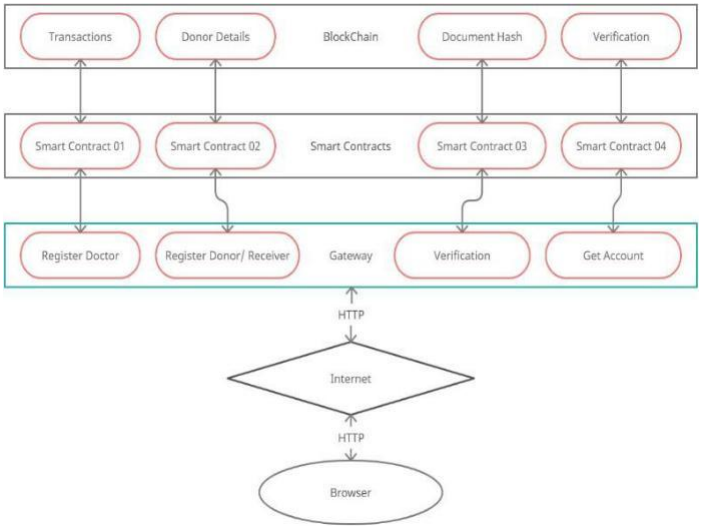

Figure 1. Framework of Organ Donation System using Blockchain Technology

2. Layer 2. ***The Internet*** - The system and blockchain is linked with the browser via this layer. It is basically a gateway which equips various contracts and algorithms for the system.

The registration and verification are gone through this layer. It takes care of authorization and tamper-proofing. And provides an uninterrupted connection between all the users in the system.

3. Layer 3. ***Smart Contracts*** – these are used for the elimination of any third party in the process of authentication. Smart Contracts consist of pre-sanctioned provisions which consequently approves the nodes/user when it satisfies the condition.

4. Layer 4. ***The BlockChain*** – Blockchain works as a database in the system. It stores each user's information as an individual node and these nodes from a chain where every node carries a pointer to the next node similarly as the Linked list data structure. Only the pointer in the case of Blockchain are basically hashes which are calculated for every node at the time of creation. Every node is created using consensus algorithm.

Algorithm Used –

1. hashtoken ← timestamp + UserDetails
2. Append hashtoken to encrypted data
3. Send this hashtoken + data to the middleware gateway
4. UserList ← Array of all the UserDetails in the blockchain
5. i←0
6. flag ← False
7. while i←length (UserList) do
8. if Encrypt (decrypt (UserList[i] + timestamp)) == hashtoken then
9. flag ← True
10. break
11. end if
12. i←i+1
13. if flag == True then
14. send data to blockchain database
15. end if

The given algorithm is used to create a new node i.e., add a new user in the chain. First and foremost, a hash-token is calculated with the help of data, date and username. Further RSA is used to encrypt the hash.

After that we need to verify whether the user or the node has already been created in the system or not. If yes, the system simply aborts the transaction otherwise the node is added in the chain and the system gets updated by circulation of the information of the new node. The node contains data, time-stamp, username and crypted hash of its own.

IV.RESULT AND DISCUSSION

To create this Organ Donation system was to provide a system which is cost- effective, transparent and is responsible for the security as well as privacy of the data of each and every user of the system be the hospital or donor or recipient. The use of Ethereum has made it possible which uses the Elliptic Curve Digital Signature Algorithm. This digital signature is nothing but a pair of keys – private key and public key. The private key is kept a secret whereas the public key is shared to every node of the chain. Apart from this, the data is secured by using the RSA and the SHA-256 Algorithms.

The system ensures full transparency between the donor and the recipient hence, eliminating any chance of corruption and provides equal opportunity to people of every background to save their or their loved one's life.

Parameters	Existing System	Proposed System
Cost	The existing system is costly as there is no systematic platform and recipient need to relay on the doctor/hospital.	The proposed system is extremely cost-effective as it is powered by the internet (middleware gateway) and everyone have access to internet today.
Integrity	Misuse of the donor/recipient's data or fake information is seen in many cases.	The proposed uses smart contracts to authenticate a user in the system.
Accessibility	The donors with the appropriate organ are not very easily found.	The proposed system is accessible using the internet which is extremely easy these days.
Transparency	There is not transparency between the donor and the recipients and it mostly results in corruption and illegal selling of	The proposed system provides complete transparency between all the users of the system.

	organs. In some cases, the donor does not even know that his/her organ is being donated.	
Security	The existing system does not ensure the security of the donor/recipient's data.	Different algorithms are used to protect the user data the proposed system.
Speed	The existing system is time consuming because most of the work is done manually.	The proposed system is as fast as the user's internet.
Simplicity	The existing system is extremely complicated as it requires roaming around the doctors or hospitals or donation centers.	The proposed system is very easy to use. It has 2-3 steps to sigh-up on the system and the UI is also very user-friendly.

Table 1. Comparison between the Existing and the proposed system

Table 1. provides a comparison between the existing system and the proposed system on the basis of cost, integrity, accessibility,
transparency, security, speed and simplicity.

V. CONCLUSION

The proposed system digitalizes the process of Organ Donation, enhances the existing system by handling endless data and provides a transparent as well as cost efficient system. The proposed System is faster, more secure and more scalable. The organ receiver and donor can be sure of the authenticity of the other without hesitation. The Organ Donation System does not allow any third-party access. The system eliminates the corruption in department of organ donation through a transparent system and the patients will be able to get the organ before it is too late.

VI.FUTURE WORK

An auditable system can be developed using a better Ethereum blockchain model. Blockchain was initially designed to store small bits and data whereas the data of the health industry extremely vast and growing in large number every day. Future research can be done in this area to provide a more secure blockchain platform for enormous data.

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