Blockchain-Based LSTM Approach for Secure Data Transmission in IoT-Enabled Healthcare System

Aakansha Soy[1], Sutar Manisha Balkrishna[2]

[1]*Assistant Professor, Department of CS & IT, Kalinga University, Raipur, India.*
[2]*Research Scholar, Department of CS & IT, Kalinga University, Raipur, India.*

KEYWORDS

Health, AI, data. Transmission, security

ABSTRACT

Blockchain technology can help with a number of issues facing the healthcare sector. Its potential as trust brokers includes the provision of incentive machines and the facilitation of innovative healthcare solutions. Additionally, its potential as trust brokers includes the facilitation of novel business models that offer fresh perspectives on the interactions between patients and providers, among other diverse healthcare stakeholders. Blockchain, for instance, makes incentive structures easier to implement and promotes decentralised trust in patient-centered healthcare models and global health information exchange (HIE). On the other hand, blockchain is characterised as a decentralised network or service that can help remove obstacles in the healthcare sector. The healthcare sector has benefited greatly from the effective resolution of problems relating to adoption and technological obstacles, interoperability and integration with current systems, cost unpredictability, scale, and regulatory compliance through the use of Blockchain technology. This work proposed discusses fault tolerance techniques in relation to sharing health-related data.

1. Introduction

Sensitive data, which implies a high degree of privacy and secrecy, includes healthcare records. But because today's healthcare systems lack interoperability, there are times when you have to share them with someone. Because most systems use data types that are incompatible, data sharing is not possible. Blockchain systems are built on "open-source software, commodity hardware, and open APIs (application programming interfaces)". Large volumes of data and more users can be handled more easily and interoperably with the help of an open-source blockchain in the healthcare industry [1].

Data sharing and integration between blockchain applications and other systems are easier to access because to open APIs. Updates on all nodes exchanging data within the same network can be obtained almost instantly thanks to the distributed ledger technology of Blockchain. Conventional healthcare systems are centralised, meaning all data is controlled and stored by an intermediary. Because Blockchain relies on consensus, every node maintains a copy of the Blockchain's data and participates in deciding what information is shared and with whom. Decentralised systems also reduce transaction costs [2]. A blockchain is an encrypted list of information that is constantly growing and connected. These records are called blocks. Each block contains transaction data, a timestamp, and a cryptographic hash of the previous block. Here, data modification is prohibited by design. It gives the system integrity. A distributed ledger known as a blockchain keeps track of transactions in the form of Pow-related blocks. Every block contains a timestamp, the hash value of the previous block, a nonce, and details about the transaction records that are part of the current block. Blocks containing transaction data for a given amount of time (approximately 10 minutes for Bitcoin) are linked to form a chain [3].

A date, the hash value of the preceding block, a nonce, and details about the transaction records contained in the matching block are all provided in each block. The process of verifying each step of a transaction is known as blockchain mining. The people involved are referred to as blockchain miners. Their main objective is to verify financial transfers between computers within the network by utilising a complex system of hardware and software. Blockchains are named for the structure of their "blocks" and "chains." The blocks are made up of several bitcoins, which are discrete units that each separately contain all of the data code [10]. The links that link one neighbourhood block to the next are referred to as the "chain." Every Blockchain signifies a distinct code authentication that is stored in the network software and is expressly encrypted. [11]. The work is described as follows: Introduction part is portraying in section 1 as well as the studies of several research papers portrayed, part 2 highlights the suggested method and defines the performance metrics in part 3. Part 4 describes the results of the research and the work is completed in part 5.

2. Methodology

One sector where blockchain is regarded to have a lot of potential is healthcare [5]. To transform healthcare, more focus needs to be on data management, integrating fragmented systems, and enhancing EHR accuracy [6]. Blockchain technology can facilitate data sharing, access control, and the maintenance of an audit trail of medical activity. In addition, it can help with data sharing, access control, medication prescriptions, supply chain management, pregnancy and risk data monitoring, and maintaining an audit record of medical activities [7]. Other industries where blockchain technology may be useful include clinical trials, medical billing, contracting, medical record interchange, provider credentialing, and anti-counterfeit pharmaceuticals. A more patient-centered approach is becoming possible with the evolution of healthcare services. Blockchain-based healthcare solutions could increase the security and dependability of patient data because individuals would have control over their medical information [12]. These systems might also help with patient data consolidation, which would make it possible for various healthcare facilities to share medical records. Medical records of patients must be kept up to date in the healthcare industry. Since these are extremely sensitive data, cyberattacks are likely to target them. Safeguarding all sensitive data is essential. Data management is an additional factor to take into account, which the patient should preferably handle. Thus, gaining control over and sharing patient healthcare data is another use case that can benefit from cutting edge current technologies. Blockchain technology provides a range of access control options and is highly resilient to failures and attacks. Blockchain is a great framework for healthcare data as a result. [8][13].

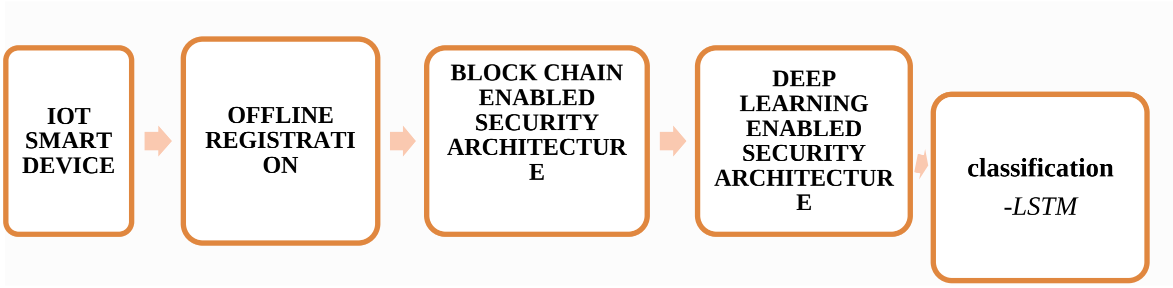


Figure 1. Overall, View of Proposed Work

MedRec is a decentralised management system that runs on blockchain technology. It keeps track of all data activities and permissions before they are implemented. To guarantee data security, authentication, auditing, and exchange, it has partnered with medical information. It has the capacity to produce unchangeable data services. With minimal effort, the author might be able to address the user's concerns over a lack of control by utilising a managed data management system in the cloud environment [9]. It might have been designed to help users prevent malfunctions during significant attacks by building confidence. Blockchain will enable the user to maintain their entire medical history in tandem with the data management system. Furthermore, no access control or authorisation design is used at the deployment stage [4]. This decentralised management system can be used thanks to a consensus-building technique that has been developed. Blockchain technology is utilised for secure data transmission and IoT device registration. This architecture also provides information on associated performance and network activity. As a result, this level helps to prevent data poisoning attacks and keeps track of the data source, owner, ultimate destination, alternate routes, security measures, and security enabling authority [14]. A DSAE technique is used in the DL enabled security architecture to transform original data into a new for-mat that significantly minimises the datasets' dimensions. The expected output at each time step is represented by (z_g), and the actual output is represented by $\overline{z_g}$. Next, every time, the mistake is supplied by

$$E_g = z_g \log z_g \qquad (1)$$

Total error of each step is given by:

$$E = \sum_t E_g \Rightarrow z_g \log z_g \quad (2)$$

The summation of the each step gradient is given by,

$$\frac{\partial E}{\partial W} = \sum_t \frac{\partial E_g}{\partial W} \quad (3)$$

$$\frac{\partial E_g}{\partial W} = \frac{\partial E_g}{\partial \overline{z_g}} \frac{\partial \overline{z_g}}{\partial h_g} \frac{\partial h_g}{\partial c_g} \frac{\partial c_g}{\partial c_{g-1}} \frac{\partial c_{g-1}}{\partial c_{g-2}} \dots \dots . . \frac{\partial c_0}{\partial W} \quad (4)$$

Thus the total error gradient is given by:

$$\frac{\partial E_g}{\partial W} = \sum_t \frac{\partial E_g}{\partial \overline{z_g}} \frac{\partial \overline{z_g}}{\partial h_g} \frac{\partial h_g}{\partial c_g} \frac{\partial c_g}{\partial c_{g-1}} \frac{\partial c_{g-1}}{\partial c_{g-2}} \dots \dots . . \frac{\partial c_0}{\partial W} \quad (5)$$

The gradient equation involves a chain of ∂c_g for an LSTM deep learning while the gradient equation involves a chain of ∂h_g.

3. Results and Discussion

But the amount of data created in this day and age keeps growing, even with the abundance of healthcare institutions. On the other hand, security and privacy are purposely avoided in this instance. Numerous organisations could sustain serious financial and reputational damage in the process. It's likely that various healthcare users will have specific responsibilities, in which case data access needs to be tailored. Blockchain technology could offer this kind of access mechanism. The suggested approach accomplishes better than earlier models in healthcare data management since blockchain technology is still developing based on blockchain generation, validation, and assessment. Figure 2 depicts the functionality across nodes, which is used to provide security and prevent fraud.

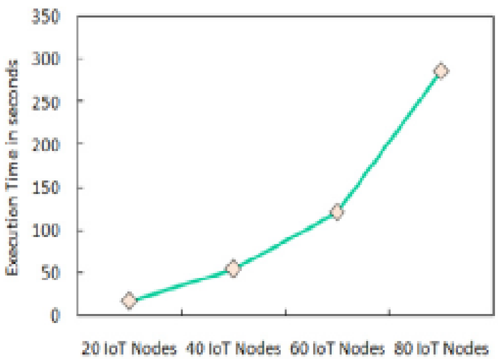
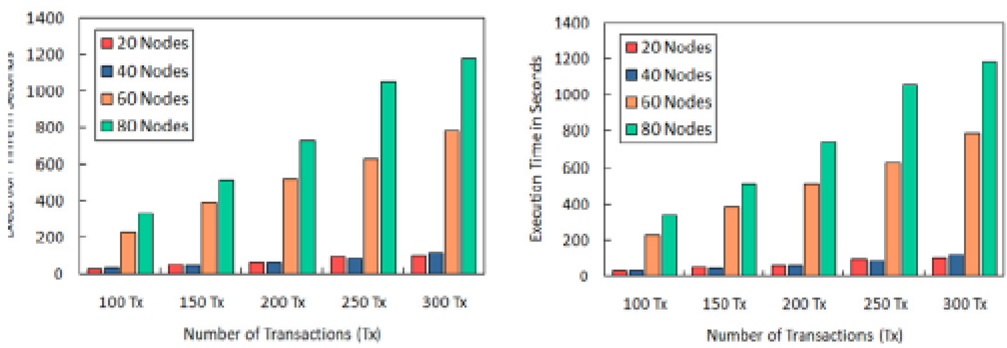


Figure 2. Analysis of registration time

The precision attained with enhanced data transmission between nodes is seen in Figure 3. This method shows more accuracy and security than the prior way by using the algorithm for hashing and creating puzzle answers. As a result, as seen above, "Proof of Word" works well in blockchain administration to provide consensus for accessing health care data.



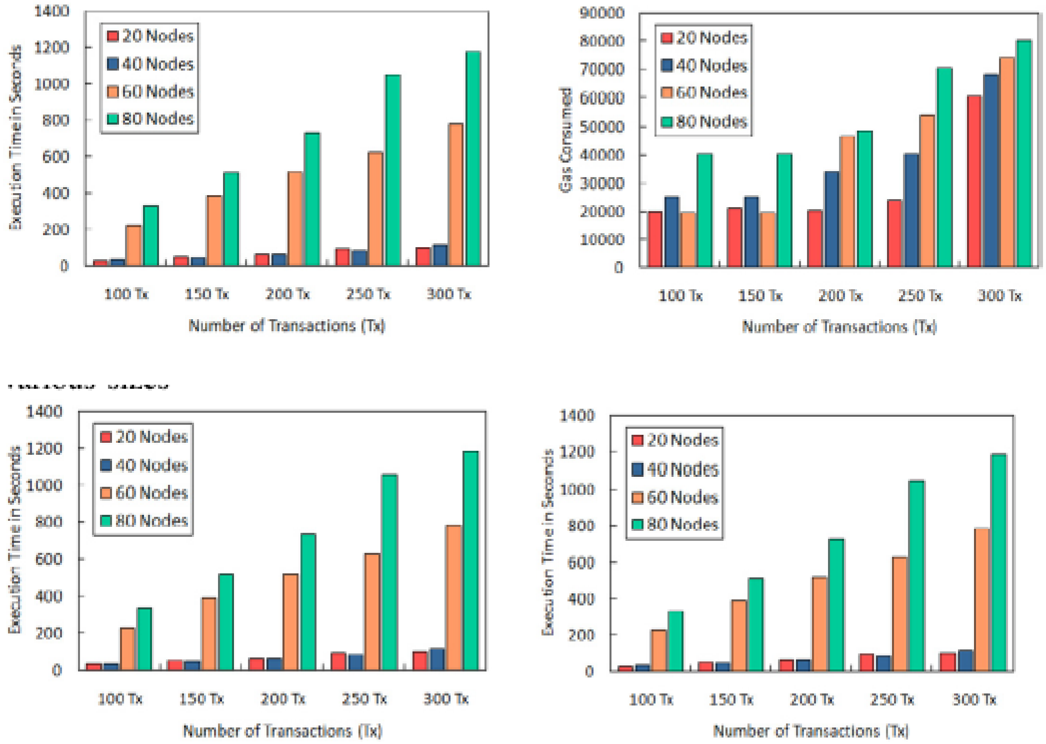


Figure 3. Result interpretation for blockchain-enabled security architecture

The functionality that is utilised to prevent fraud and ensure security is shown in Figure 4. The fault tolerance value of the suggested model is shown in Figure 5, where the delay during overlap is determined using the threshold value assigned to each block. Generally speaking, the make span gets longer with decreasing value and gets shorter with increasing value. Thus, it is possible to determine fault tolerance.

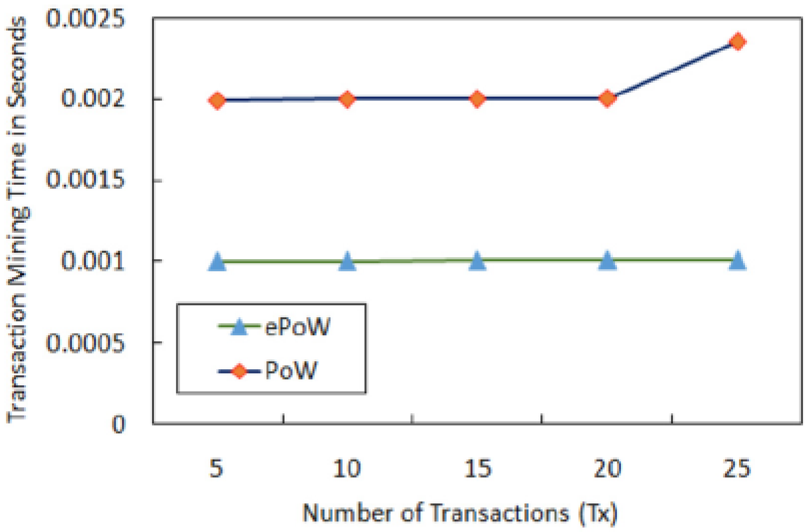


Figure 4. Block mining time comparison of proposed ePoW with existing PoW at difficulty level 1.

The obtained accuracy of proposed classifier is 96.6%. The performance metrics of Accuracy, Sensitivity and Specificity of proposed with the existing model is shown in figure 5.

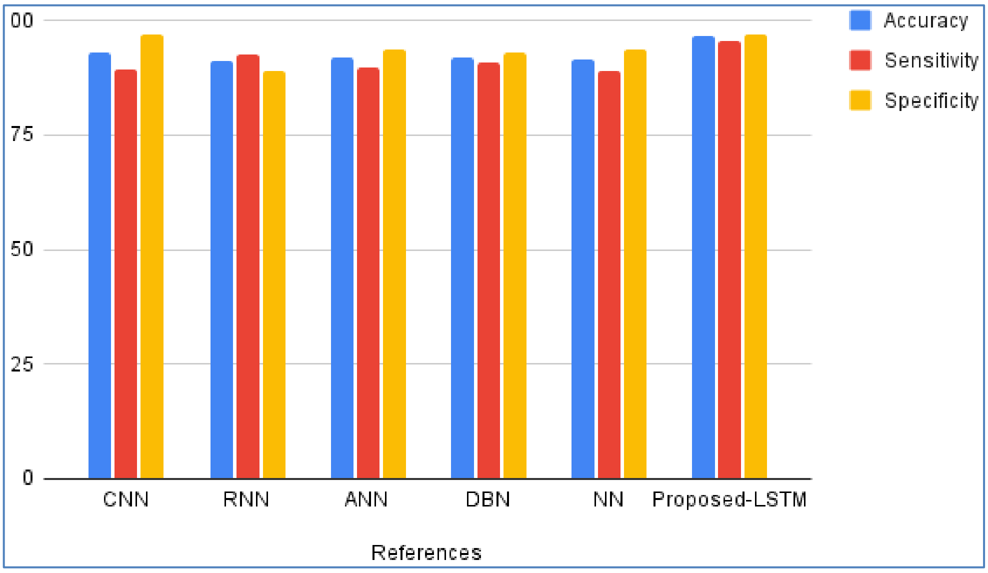


Figure 5. Performance Comparison

4. Conclusion and Future Scope

According to this report, a significant quantity of blockchain is employed in a number of fields, such as supply chain management, analytics, medication adherence, insurance and billing administration, and healthcare information management. For instance, the business might occasionally be entrusted with creating blockchain-based applications. In addition to more specific uses like data provenance, consent management, and counterfeit drug detection, common applications include initiatives to establish a distributed healthcare ecosystem. Actually, the field of blockchain technology is quite exciting and talented. This model uses a deep learning architecture wherein the bidirectional long short-term memory uses the features collected from the original data using a deep sparse autoencoder technique to detect network intrusions. In addition, we leverage off-chain storage based on IPFS to increase the scalability of BDSDT. The results demonstrate that, in both a blockchain and non-blockchain environment, the suggested framework performs better than competing solutions. In order to formally test the framework's effectiveness, future research will involve implementing a prototype of the suggested model in an IoT-based healthcare context.

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