DRLAS: Digital Record Keeping in Land Administration System Relying on Blockchain

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Abstract On every developed or developing world, the Land Administration System (LAS) is a salient infrastructure. Both the digital (traditional database system) and the manual methods are applied in the LAS (paper-based documentations). Both of these systems provide an authority with monopoly power that can increase unethical conduct in land administration. Again, while the Blockchain technology was initially used to maintain a financial ledger, it is possible to expand the use of this technology to incorporate any decentralized computing structures, including the automated record keeping and management framework. Recent studies have found that the new and largely untested applications of Blockchain technology in land administration remain. In this work, the implementation of a blockchain-based system is proposed to build a System for Land Administration. In the Ethereum blockchain platform, the proposed framework was simulated and showed that the framework contributed to developing a stable, secure, effective and efficient system of land administration.

Keywords Blockchain · Smart contract · Land administration system · Mutation

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1 Introduction

One of the most important divisions of any nation is land administration. The system of land administration (LAS) keeps a record of real (land) properties, primarily of location, (historical) possession, value and usage. Often, the LAS Maintain data on physical, spatial, and topographical property characteristics. Long-term availability, reliability and compliance with proper law should be available in the LAS documents [19]. The main threats to the digital land management system are networks, cyber attacks, and data leakage as well. A blockchain is a time-stamped collection of permanent data records that are maintained by computer clusters that do not belong to any single entity. Blockchain technology is tied to paper published in 2008 by person or persons under the alias of Satoshi Nakamoto [16]. Blockchains are decentralized, distributed, and fault-tolerant databases that can be shared by any network user, but no individual can share them. Controlling.

The purpose of this paper is to propose a blockchain-based platform for the creation of a safe, trusted, and effective system of land administration. A structure is proposed for LAS to achieve this goal, considering the related properties of blockchain technology and main LAS functionalities. Centered on the proposed structure and then a prototypical system is also built Via simulation, assessed its performance.

2 Related Works

According to a recent study [14], blockchain can be defined as "A concept map of Blockchain which represents that a Blockchain consists of blocks containing messages, proof of work, and reference of previous block and stored in shared database, which is able to perform transactions over P2P network maintaining irreversible historical records and transparency". Blockchain technology has attracted tremendous interest from wide range of stakeholders, which include finance, healthcare, utilities, real estate, and government agencies [12]. A very few studies show integration of blockchain technology in LAS [17]. A number of studies have been conducted on IT-based Land Management System, where the database systems and web-based technologies were the key concern to make it automated as well as hyper ledger system is also introduced [15]. Choudhury et al. [9] proposed a web-based land management system for Bangladesh which could scan the paper-based land maps. In an another work [21] proposed an automated digital archival system for land registration and keeping records. Talukder et al. [20] Introduced digital land management system which included GPS-based land surveying. A few studies introduced the Blockchain technology in land administration systems [19] and proposed a blockchain-based Land Administration System to increase its transparency, immutability, security, and accountability. Authors of [11] proposed a blockchain-based E-voting system to reduce database manipulation and maintain data integrity. The study by [13] proposed a framework to develop and evaluate a tamper-resistant m-Health system using blockchain technology which enabled trusted and auditable computation using a decentralized network. Peterson [17] proposed an idea of implementing the blockchain in health information sharing. In this recent world, everything is automated like E-voting [6, 18], stock market [7], NID managements [10], Hotel managements [8], Poultry farm [4], virus affected people management [2], remote sensing [3], secure payment [1], supply chain management [5], and so more. Why not automate the management of the land? A new consensus algorithm was implemented in this research to promote interoperability of data. With some pseudo code of mining, the solution was theoretically defined.

3 Proposed Framework

In order to create a realistic system,the system is proposed to take three problems into account. Second, the main LAS features, which include land-related updating, Data, verification of land information, application for a mutation, and transfer process of ownership. Second, the LAS stakeholders, i.e., the owner of the land, consumers, the authority (LAS management representative), and the government. Third, the blockchain technology's assets.

The Blocks and the nodes are the two key components of the proposed system. The blocks are the data structures that hold information about any land transaction and changes. In the proposed framework, the blocks include:

1. Previous hash—creates link to previous block;
2. Seller ID—user ID of the seller of the land of this particular transaction;
3. Purchaser ID—user id of the purchaser of the same land;
4. Land ID—the ID of the land in question;
5. Transaction money—price of the land according to market value; and
6. Hash—unique ID for a particular block.

Again, the nodes are the networks' endpoints. As the nodes, the stakeholders involved in the network act. It is possible to classify nodes into two classes. First one: standard nodes that can only make requests for mutation and are unable to engage in the verification process and Second one: nodes that can be authenticated, which are capable of Authenticate a block, which means that it can mine a block that mines them. New transactions are verified by miners and reported on the global ledger. He smart contract is the software where the blockchain behavior is written. After mining one block, it essentially determines the steps needed. It may, under certain circumstances, directly regulate the transfer of digital currencies or assets between parties.

The key tasks that are required for LAS are included in Fig. 1 and gives a graphical representation.

Updating data related to land: It may be appropriate to adjust from time to time general information that includes measurement, climate, infrastructure and price

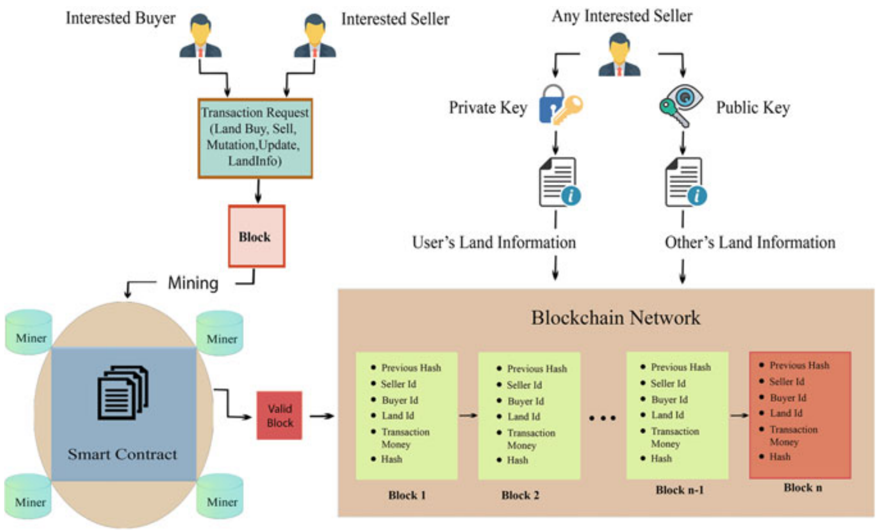

Fig. 1 Proposed framework for blockchain-based LAS

related information. It will be checked by valid and precise modification to ensure valid and precise change.

Informational Checking: Before buying a house, any buyer would like to check the details relating to the land which would be secured by a private key inside the proposed scheme. The private key is open to the owner only.

Request for Mutation Submission: The order for mutation relates to the beginning of the transfer process of ownership. Both parties can file a digital application in the proposed system using their corresponding private key. A block will be generated after that, containing all the details about the phase of land transfer and will be broadcast for mining.

Phase for Ownership Transfer: In this method, the block generated containing mutation information is checked by consensus algorithm miner nodes and it is checked if the value of the created block is compatible with the current blockchain. Finally, the distributed ledger structure and the central blockchain would be added to it.

4 The Proposed Framework Simulation

The section covers from setting up the environment to coding and deploying the smart contract.

4.1 Simulation Environment

In order to simulate the proposed framework in local environment, the following steps are followed:

1. *Setting up personal blockchain*: A local personal blockchain Ganache was used to simulate the proposed framework.
2. *Setting up development environment*: Truffle development environment creates the local environment and the file system for blockchain project.
3. *Opening digital wallet*: Digital wallet allows the accounts in the personal blockchain to connect with the browser and finally to the blockchain network.
4. *Creating project and initiating truffle*: The next step is to create the project directory and initiating truffle environment in the directory.
5. *Adding project to ganache*: After the project is created, it has to be added to Ganache in order to visualize the current state of the blockchain.

4.2 Deployment and Features of Smart Contract

Solidity programming language, which specializes in the creation of blockchain. After establishing the contract features, such as updating information, verifying information, sending requests for mutation and transfer of ownership, As the member method of the contract. The smart contract's member methods and block structure are as follows:

1. *Block*: The next step is to create the structure of the blocks. The blocks are basically a type data structure. In solidity, it is declared as *struct*.
2. *Posting a free land for sell*: Initially, if any land has a survey mechanism, it can be posted for sale by the survey office or other government entity without a real owner. The selling feature is called Createland and looks like an Algorithm 1. The role obtains the position of land and the price of land and as parameters.
3. *Posting a land for sale by its owner*: If the owner of a land wants to sell the land, it can be posted. To post it, land for sell function is called. This function makes the land block available for potential buyers to create the buying block and put up for mining. The function is shown in Algorithm 2.
4. *Purchase land and mutation*: The purchase land function is the function that actually performs the mutation operation. Once any buyer puts in a mutation request, purchase Land function gets called. The mutation block created by the function is uploaded via metamask for mining in Ethereum. The process of mutation is shown as a pseudo code in Algorithm 3.

Algorithm 1 Add New Record of Land

function CREATELAND($\_landLocation, \_landPrice$)
  Require $landLocation.length > 0$
  Require $\_landPrice > 0$
  $landCount = landCount + 1$
  $lands[landCount] \leftarrow$ $Add\ New\ Record\ of\ Land$endtate emit $LandCreated$

Algorithm 2 Change Land Status For Sell

function LANDFORSELL($landID$)
  Require $Land\ ID\ is\ valid$
  $purchase\ flag \leftarrow\ false$
  emit $LandforSell$

Algorithm 3 Purchase Land

function PURCHASELAND($landID$)
  Require $Land\ ID\ is\ valid$
  $CurrentLand \leftarrow Fetch\ Land\ from\ given\ Land\ ID$
  $Owner \leftarrow Get\ the\ Land\ owner$
  Require $Account\ Balance\ land\ Price$
  Require $Land\ is\ not\ Purchased$
  Require $Seller\ and\ Buyer\ are\ not\ same$
  $CurrentLand.Owner \leftarrow Change\ the\ Owner$
  $Transfer\ the\ fund$
  $purchase\ flag \leftarrow\ true$
  $emitLandPurchased$

4.3 Ethereum Cost and Gas Fee

To deploy the smart contract in Etheruem, a certain amount of computing power is required. Similarly, calling every function also requires some computing power. In Ethereum blockchain platform, the computing power is measured as gas fee. Also, for issuing a block by triggering a function call, the concerned user must spent some Ether, which is treated as a digital currency. Computing power for five operations has been calculated. They are: deploy migration function, deploy LAS smart contract, create land function, purchase land function, and land for sell function. The histogram in Fig. 2 shows the gas use for each function and also showed that deploying the contract consumes the maximum amount of computing power. The next histogram in Fig. 2 represents ether costs of the same functions. As observed in the Fig. 2, deploying the contract consumes more power, as a result, this is the most costly function.

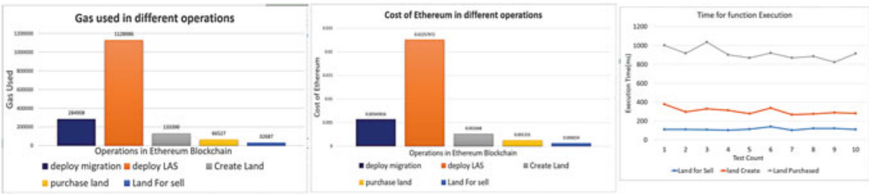

Fig. 2 Gas used for each functions, ether used for each functions, execution for each functions

4.4 Execution Time

The graph in Fig. 2 shows the execution time of the following functions for several test cases in milliseconds: (1) Land for sell, (2) Land create, and (3) Land purchase

It is evident from the test vs time graph that purchasing land takes the most amount of time and it spans around 900 ms. The second most execution time is taken by creating land which spans around 300–400 ms. Then the lowest execution time is taken by land for sell function.

5 Results Discussion

A local web application was developed on the basis of the proposed framework using Ganache to host the blockchain locally. The simulation results showed that the blockchain-based proposed LAS system would bring the following benefits:

1. The proposed architecture provides LAS with extensive security features. The consensus algorithm used in the proposed system ensures that the blockchain does not add an invalid block. In addition, it also guarantees that a consumer may only access his or her details.
2. In an ethereum blockchain platform that utilizes proof of work consensus algorithm, the proposed architecture is simulated. Every change of knowledge is then checked and then updated using the evidence of work in every local copy of the blockchain.
3. Suggested framework stores change logs in the form of chain blocks that often ensure the system's trustworthiness.
4. The computing power needed to mine each block is considerably lower than the smart contract being uploaded. For example, the createLand, purchase land (mutation), land for sale showed less computational power in Fig. 2, for instance.
5. Finally, such practices like posting a (land) sale notice and creating a new one an average execution time, that is, less than 400 milliseconds, was shown by the land block. Again, a comparatively higher execution time is showed for the land purchase (mutation), see Fig. 2, it is around one second (1000 milliseconds), and can still be treated as relatively faster.

6 Conclusion

A blockchain-based framework is proposed for land administration system. The functionality includes updating land-related information, checking land information, submitting the mutation request, and transferring process of land ownership. The proposed framework is evaluated through simulation. The simulation results showed that a secure, reliable, effective, and efficient land administration system could be developed based on the proposed framework. However, the performance of the system in real-time transaction is yet to be tested. Our future work will focus on this direction.

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