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Blockchain Based Land Registry System for Secure Ownership Tracking and Transfer

Indu Sahu[1], Laxmi Dhiman[2], Er. Mahesh Bahadur Singh[3] Er. Bhim Nath Tiwari[4]

[1]Student, Dept. of Computer Science and Engineering, SRMCEM, Lucknow, India
[2]Student, Dept. of Computer Science and Engineering, SRMCEM, Lucknow, India
[3]Assistant Professor, Dept. of Computer Science and Engineering, SRMCEM, Lucknow, India
[4]Assistant Professor, Dept. of Computer Science and Engineering, SRMCEM, Lucknow, India

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Abstract - *The traditional land registry system suffers from issues such as lack of transparency, fraud, data manipulation, and inefficiency due to its centralized nature. This paper proposes a blockchain-based system for tracking land registry that ensures secure, transparent, and tamper-proof management of land ownership records. The proposed system uses Ethereum blockchain and smart contracts to automate land transactions and eliminate intermediaries. Additionally, the Inter Planetary File System (IPFS) is used for secure storage of land documents. The system enhances trust among stakeholders, reduces fraud, and improves efficiency in land ownership transfer. The results demonstrate that the proposed system significantly improves data integrity, transparency, and transaction speed compared to traditional systems.*

Key Words: **Blockchain, Land Registry, Ethereum, Smart Contracts, IPFS, Decentralization, Security**

1.INTRODUCTION

Land is one of the most important and valuable assets for individuals as well as governments and keeping accurate ownership records is essential for legal security and economic stability. However, traditional land registry systems are mostly centralized and controlled by government authorities. Because of this centralized nature, these systems are often vulnerable to problems such as fraud, data manipulation, corruption, and loss of records. In many cases, verifying ownership or transferring land takes a long time due to manual processes and the involvement of multiple intermediaries like brokers, agents, and officials. This not only increases the overall cost but also reduces trust among stakeholders.

With the rapid advancement of technology, there is a growing need for a more secure, transparent, and efficient way to manage land records. Blockchain technology offers a promising solution to these challenges. It is a decentralized system where data is stored across multiple nodes, making it extremely difficult to alter or tamper with records. Each transaction is recorded permanently, ensuring transparency and accountability. This helps build trust among users, as all participants can verify the authenticity of the data without relying on central authority.

By integrating blockchain technology into land registry systems, many of the existing issues can be addressed effectively. The use of smart contracts allows automatic execution of agreements, reducing the need for manual intervention and minimizing delays. Additionally, decentralized storage systems can securely store important documents such as land deeds and certificates, ensuring they are always accessible and protected from loss or damage.

In this paper, we propose a blockchain-based system for tracking land registry that combines smart contracts and decentralized storage technologies. The goal is to create a reliable, secure, and efficient platform for managing land ownership and transactions, ultimately reducing fraud, increasing transparency, and simplifying the entire process of land transfer.

2.RELATED WORK

In recent years, blockchain technology has gained significant attention in the field of land registry and property management. Many researchers have explored its potential to overcome the limitations of traditional centralized systems. Several studies have proposed the use of private and permissioned blockchain frameworks, such as Hyperledger, to

enhance data security, privacy, and controlled access [1], [2]. These systems allow only authorized participants, such as government officials, to validate and update land records, thereby reducing the chances of unauthorized access and data tampering.

Other research efforts have focused on the use of smart contracts to automate key processes in land registration, such as ownership verification, transaction validation, and property transfer. By eliminating manual intervention, these systems reduce delays, minimize human errors, and improve overall efficiency [7], [10]. Some solutions also integrate identity verification mechanisms to ensure that only legitimate users can perform transactions, thereby increasing trust in the system [4].

Despite these advancements, existing approaches still face several challenges. One major issue is scalability, as blockchain networks may experience delays when handling many transactions. Additionally, many systems are complex to implement and require technical expertise, making them difficult to adopt in real-world scenarios [8], [15]. Another limitation is the lack of efficient storage solutions for large documents such as land deeds, maps, and certificates, which cannot be stored directly on the blockchain due to size constraints.

To address the storage issue, some researchers have suggested integrating decentralized storage systems such as IPFS (InterPlanetary File System). IPFS allows large files to be stored securely off-chain while maintaining their integrity through unique cryptographic hashes stored on the blockchain [12].

Building upon these existing works, several modern studies have proposed decentralized frameworks for secure land registration and fraud prevention [19]. However, there is still a need for a more practical, scalable, and user-friendly system. Therefore, this paper proposes a comprehensive and fully decentralized land registry system that combines blockchain technology, smart contracts, and IPFS. The aim is to create a more secure, scalable, and practical solution for managing land records, ensuring transparency, reducing fraud, and simplifying the process of ownership transfer.

3.PROBLEM STATEMENT

The existing land registry system suffers from multiple challenges that reduce its efficiency, reliability, and trustworthiness. Most traditional systems are based on centralized databases maintained by government authorities or administrative bodies. This centralized approach creates a single point of failure, meaning that if the system is compromised, corrupted, or attacked, the entire database can be affected. Such systems are also more vulnerable to data loss due to technical failures or cyberattacks.

Another major issue is the high risk of fraud and unauthorized data manipulation**.** Since records can be altered by individuals with access privileges, there have been many cases of illegal property transfers, duplicate ownership claims, and forged documents. This undermines trust in the system and often leads to legal disputes that take years to resolve.

The verification and approval process in traditional systems is often slow and inefficient. It involves multiple steps, including manual document verification, approvals from various authorities, and physical visits to offices. This not only increases the time required to complete a transaction but also adds to the overall cost for users.

Additionally, there is a significant lack of transparency among stakeholders**.** Buyers, sellers, and other parties do not have realtime access to reliable land records, making it difficult to verify ownership history or transaction details. This lack of visibility further increases the chances of fraud and miscommunication.

The system also heavily relies on intermediaries such as brokers, agents, and officials**,** which increases complexity and operational costs. These intermediaries may introduce delays, errors, or even corrupt practices, making the process less efficient

and less trustworthy. Considering all these limitations, there is a strong need for a modern solution that ensures security, transparency, efficiency, and trust. A decentralized approach using blockchain technology can effectively address these issues by providing a tamper-proof, transparent, and automated system for managing land registry records.

4.PROPOSED SYSTEM

The proposed system introduces a blockchain-based platform designed to securely manage land ownership records and property transactions. Unlike traditional systems that rely on centralized databases, this solution leverages blockchain technology to create a decentralized and tamper-proof environment. The system is built on the Ethereum blockchain, where all land-related transactions are recorded in a transparent and immutable manner. Smart contracts are used to automate various processes such as ownership verification and transfer, reducing the need for manual intervention and minimizing delays.

The primary objective of this system is to provide a secure, efficient, and trustworthy platform for land registry management. By using blockchain, each transaction is permanently recorded and cannot be altered, ensuring the authenticity and integrity of data. Additionally, decentralized storage mechanisms such as IPFS are used to store large documents like land deeds, maps, and certificates, making the system more scalable and efficient.

4.1 Key Features

- **Decentralized Storage of Land Records:** Land data is stored across multiple nodes in the blockchain network, eliminating the risk of a single point of failure and ensuring high availability.
- **Immutable Transaction History:** Once a transaction is recorded on the blockchain, it cannot be modified or deleted. This ensures complete transparency and prevents fraudulent activities.
- **Smart Contract-Based Ownership Transfer:** Smart contracts automatically execute transactions when predefined conditions are met, ensuring secure and error-free ownership transfer without the need for intermediaries.
- **Secure Document Storage Using IPFS:** Important documents such as land deeds and certificates are stored on IPFS, which provides decentralized and secure storage. Only the hash of the document is stored on the blockchain, ensuring data integrity.
- **Transparent and Traceable Transactions:** All transactions are visible to authorized participants, allowing easy tracking of ownership history and improving trust among stakeholders.

4.2 System Participation

- **Government Authority:** This entity acts as a trusted verifier responsible for validating user identities and land documents. It ensures that only legitimate data is added to the system.
- **Seller:** The seller registers their land on the platform by providing necessary details and uploading relevant documents. Once verified, the land can be listed for sale.
- **Buyer:** The buyer can view available properties, verify ownership details, and initiate the purchase process. The ownership is transferred securely through smart contracts after successful verification.

4.3 Working Principle

The system operates in a decentralized manner where users interact with the platform through a web-based interface (DApp). When a seller uploads land details, the information is verified by the government authority and then stored on the blockchain. If a buyer is interested in purchasing the land, they can initiate a request. Once all conditions are met, the smart contract automatically executes the transaction and transfers ownership to the buyer. The entire

process is recorded on the blockchain, ensuring transparency and security.

4.4 Advantage of Proposed System

- Eliminates the need for intermediaries
- Reduces transaction time and cost
- Enhances data security and integrity
- Provides real-time access to land records
- Minimizes fraud and disputes

This proposed system provides a modern and efficient solution for land registry management by combining blockchain technology, smart contracts, and decentralized storage, ultimately improving trust, transparency, and reliability in the system.

5. METHODOLOGY

The proposed system is implemented as a Decentralized Application (DApp**)** that integrates a user-friendly frontend interface with backend smart contracts deployed on the Ethereum blockchain. The methodology focuses on ensuring secure data handling, automated transaction processing, and transparent record management. By combining blockchain technology with decentralized storage, the system provides a robust solution for managing land registry operations.

The architecture follows a modular approach where each component—frontend, blockchain, and storage—works together to perform specific tasks efficiently. The frontend allows users to interact with the system, while the backend smart contracts handle all critical operations such as verification, validation, and ownership transfer.

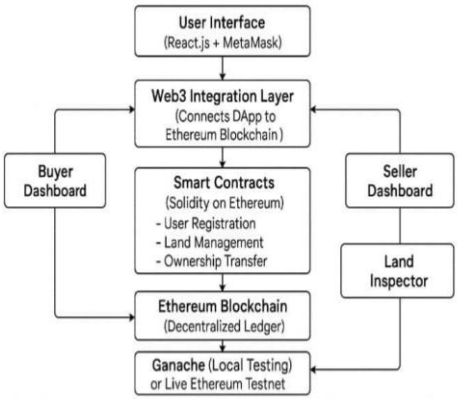

Fig -1: System Architecture of Blockchain-Based Land Registry System

5.1 Working Process

The overall workflow of the system is designed to be simple, secure, and efficient:

- **User Registration and Identity Verification:** Users (buyers and sellers) first register on the platform by providing their personal details. Identity verification is carried out by the government authority to ensure that only legitimate users can access the system.
- **Seller Uploads Land Details and Documents:** The seller enters land-related information such as location, size, and ownership details. Supporting documents like land deeds and certificates are uploaded to the system.
- **Government Authority Verification:** The uploaded data is verified by the government authority to confirm its authenticity. This step ensures that only valid and legally approved land records are stored in the system.
- **Data Storage on Blockchain and IPFS:** Once verified, the land details are stored on the blockchain, while large documents are stored on IPFS. A unique hash (CID) generated by IPFS is linked to the blockchain record to maintain data integrity.
- **Buyer Requests Purchase:** Interested buyers can view available land listings and initiate a purchase request. They can also verify ownership history and transaction details before proceeding.
- **Smart Contract Executes Ownership Transfer:** After successful verification and agreement between buyer and seller, the smart contract automatically executes the transaction. Ownership is transferred securely, and the transaction is recorded on the blockchain.

5.2 Smart Contract Function

Smart contracts play a crucial role in automating and securing the system. The main functions include:

- **RegisterLand():** Registers new land details along with the owner's information on the blockchain.
- **VerifyOwnership():** Validates the authenticity of land ownership before any transaction is initiated.
- **TransferOwnership():** Transfers ownership from seller to buyer once all conditions are satisfied.

- **RecordTransaction():** Stores complete transaction details permanently on the blockchain for future reference.

5.3 Key Methodological Advantages

- **Immutability:** Once data is recorded on the blockchain, it cannot be altered, ensuring data integrity.
- **Automation:** Smart contracts reduce manual intervention and speed up the transaction process.
- **Transparency:** All stakeholders can access and verify transaction records, increasing trust.
- **Security:** Cryptographic techniques protect sensitive data from unauthorized access.

Overall, the methodology ensures a secure, transparent, and efficient process for managing land registry operations by leveraging the combined power of blockchain, smart contracts, and decentralized storage systems.

6. IMPLEMENTATION

The proposed system is implemented as a Decentralized Application (DApp) using modern web technologies combined with blockchain infrastructure. The implementation focuses on creating a secure, user-friendly, and efficient platform for managing land registry operations. Each component of the system is designed to perform a specific role, ensuring smooth interaction between users and the blockchain network.

6.1 Technologies Used

- **Frontend (React.js, HTML, CSS):**The user interface of the application is developed using React.js, which provides a dynamic and responsive experience. HTML and CSS are used for structuring and styling the interface. The frontend allows users to register, log in, upload land details, view records, and initiate transactions in an intuitive manner.
- **Backend (Node.js /Flask):** The backend is responsible for handling application logic, user authentication, and communication between the frontend and blockchain. It manages API requests, processes user inputs, and ensures secure data flow within the system.
- **Blockchain (Ethereum – Ganache for Testing):** The Ethereum blockchain is used to store transaction records and execute smart contracts. For development and testing purposes, Ganache is used as a local blockchain environment, allowing fast and cost-effective testing without using real cryptocurrency.

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6.2 System Functionality

The application provides a complete workflow for land registry management:

- Users can register and log in securely using the platform.
- Sellers can upload land details along with necessary documents.
- Government authorities can verify and approve submitted data.
- Buyers can browse available properties and request purchases.
- Smart contracts automatically execute transactions and transfer ownership.
- All transactions are recorded permanently on the blockchain.

6.3 User Interface and Experience

The system is designed with a focus on simplicity and usability. The interface provides clear navigation options,

making it easy for users to perform actions such as adding land, verifying records, and initiating transactions. Realtime feedback and status updates improve user experience and ensure transparency throughout the process.

6.4 Security Consideration

- All transactions are signed using cryptographic keys via MetaMask
- Data stored on blockchain is immutable and tamperproof
- IPFS ensures secure and decentralized document storage
- Access control mechanisms restrict unauthorized actions

Overall, the implementation integrates modern web technologies with blockchain to create a secure, transparent, and efficient land registry system. The use of decentralized architecture not only improves reliability but also reduces dependency on centralized authorities, making the system more robust and trustworthy.

7. RESULTS & OBSERVATIONS

The implementation of the proposed blockchain-based land registry system demonstrates significant improvements over traditional land management systems. By leveraging decentralized architecture, smart contracts, and secure storage mechanisms, the system addresses many of the existing challenges effectively. One of the major improvements observed is enhanced security. Since all transactions are recorded on the blockchain, the data becomes tamper-proof and cannot be altered once stored. This ensures that land ownership records remain accurate and protected from unauthorized modifications or cyber threats.

The system also provides a high level of transparency. All transactions are recorded on a distributed ledger and can be verified by authorized users at any time. Another key advantage is improved efficiency. Traditional land registry processes involve multiple manual steps, while the proposed system automates these processes using smart contracts. The system also helps in fraud reduction by preventing duplicate ownership and illegal modifications. Additionally, the system contributes to cost reduction by eliminating intermediaries.

Table -1: Results Comparison Table

Parameter	Traditional Land Registry System	Proposed Blockchain System
Security	Vulnerable to tampering	Tamper-proof and secure
Transparency	Limited visibility	Fully transparent
Processing Time	Days/Weeks	Minutes/Hours
Fraud Risk	High	Very Low
Record Storage	Centralized database	Decentralized blockchain + IPFS
Intermediaries	Required	Eliminated
Ownership Tracking	Difficult	Easy and traceable
Cost	High operational cost	Reduced transaction cost

7.1 Observations:

- Land records were stored securely without modification
- Ownership transfer was completed successfully through smart contracts
- Document storage using IPFS worked efficiently
- MetaMask enabled secure user authentication
- Transaction history remained transparent and traceable

Overall, the proposed system provides a reliable, secure, and efficient solution for land registry management. The results clearly indicate that blockchain technology can significantly improve the performance and reliability of land record systems.

8. CONCLUSIONS

This paper presents a blockchain-based system for tracking land registry that effectively addresses the major limitations of traditional land management systems. By leveraging blockchain technology, smart contracts, and decentralized storage through IPFS, the proposed system ensures that land records are secure, transparent, and tamper-proof. The use of a decentralized approach eliminates dependency on a single authority and significantly reduces the risks associated with data manipulation, fraud, and corruption.

The integration of smart contracts automates critical processes such as ownership verification and transfer, thereby reducing manual effort, minimizing delays, and improving overall efficiency. Additionally, the system enhances trust among stakeholders by providing a transparent and verifiable transaction history. Users can easily access and validate land records, which helps in reducing disputes and increasing confidence in the system. The results indicate that the proposed solution not only improves security and reliability but also reduces operational costs by eliminating intermediaries. It provides a modern, scalable, and user-friendly approach to managing land registry operations, making it highly suitable for real-world implementation.

For future work, the system can be further enhanced by integrating it with existing government record databases to enable seamless adoption. Advanced features such as AIbased fraud detection**,** GIS (Geographical Information System) integration for land visualization**,** and biometric or digital identity verification systems can also be incorporated to improve accuracy and usability. Moreover, scalability improvements and deployment on public blockchain networks can be explored to handle large-scale real-world data efficiently.

In conclusion, the proposed blockchain-based land registry system offers a promising solution for transforming traditional land management practices into a more secure, transparent, and efficient digital ecosystem.

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