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Blockchain-Based Secure Land Registration System

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Abstract:

Land registration systems are fundamental for maintaining legal ownership records and ensuring property rights. However, conventional land registration systems rely on centralized authorities and manual record management, making them vulnerable to fraud, unauthorized modification, corruption, and data inconsistency. Manipulation of land records often results in ownership disputes, delayed transactions, and loss of public trust in land administration authorities.

This paper proposes a Blockchain-Based Secure Land Registration System that provides transparency, immutability, and integrity for land ownership records. The system records land transactions in a blockchain ledger where each transaction is cryptographically linked using the SHA-256 hashing algorithm. Smart contracts are employed to automate ownership transfer and enforce predefined rules, reducing reliance on intermediaries.The proposed framework ensures tamper detection, verifiable ownership history, and secure record management. The system is lightweight, cost-effective, and suitable for institutional and governmental land administration. The implementation demonstrates that blockchain technology significantly enhances trust, transparency, and reliability in land registration processes.

Keywords: Blockchain, Land Registration, SHA-256, Smart Contracts, Data Integrity, Tamper Detection, Distributed Ledger, Property Management

1. Introduction

Land ownership records serve as legal proof of property rights and play a crucial role in economic development and social stability. Traditional land registration systems are primarily centralized and rely on manual documentation or centralized databases. Such systems are prone to errors, delays, data manipulation, and corruption.

Centralized land record systems suffer from lack of transparency, single-point failure, and vulnerability to insider attacks. As land transactions increase, these systems become inefficient and difficult to manage. Verifying ownership history often requires manual inspection, leading to disputes and delays.

Blockchain technology offers a decentralized and immutable ledger that securely records transactions without relying on a single authority. Each transaction is validated and stored in a cryptographically linked block, making

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unauthorized modification practically impossible. By leveraging blockchain technology, land registration systems can achieve higher security, transparency, and trust.

2. Problem Statement

Despite digitization, land registration systems still face serious challenges. Records can be altered illegally, duplicate ownership entries may exist, and verification processes are slow and inefficient. Centralized control enables misuse of authority, while lack of transparency leads to fraudulent practices. Therefore, a secure, transparent, and decentralized system is required to maintain land records with verifiable proof of authenticity.

3. Objectives

The objectives of the proposed system are:

- To design a blockchain-based land registration framework
- To ensure immutability and integrity of land records
- To prevent unauthorized modification and fraud
- To provide transparent ownership verification
- To automate land ownership transfer
- To reduce time and cost in land registration

4. Literature Survey

Earlier land registration systems relied on centralized databases and paper records managed by authorities. Although secure databases and cryptographic hashing were introduced, administrators could still alter records along with hash values. Trusted timestamping systems improved authenticity but introduced dependency on third-party authorities.

Blockchain technology emerged as a decentralized solution capable of maintaining immutable records without third-party trust. Researchers have applied blockchain in supply chain management, healthcare, digital identity, and voting systems. Studies suggest storing transaction hashes rather than complete records to reduce storage overhead while preserving integrity.

However, many blockchain implementations rely on public networks such as Ethereum, which introduce transaction fees and complexity. This research focuses on a lightweight blockchain model suitable for land registration without cryptocurrency dependency.

5. Existing System

The existing land registration system is centralized and manually operated. Records are stored in government offices or centralized databases.

Limitations:

- High risk of data tampering
- Duplicate or forged ownership records
- Manual and slow verification
- Centralized authority control
- Lack of transparent ownership history

Integrity depends on trust rather than mathematical proof.

6. Proposed System

The proposed system introduces a blockchain-based land registration framework where land transactions are recorded as immutable blocks.

Key Concept

Instead of storing documents directly, land transaction data is hashed using SHA-256 and stored in cryptographically linked blocks. Any modification results in hash mismatch, enabling instant tamper detection.

Working Steps

1. User submits land registration details
2. Identity verification is performed
3. SHA-256 hash is generated
4. Block is created with transaction data
5. Block is linked to the blockchain
6. Ownership transfer is executed using smart contract
7. Verification can be performed anytime

7. Advantages of Proposed System

- Tamper-proof land records
- Transparent and verifiable ownership history
- Automated ownership transfer
- Reduced fraud and disputes
- No reliance on intermediaries
- Strong cryptographic security

8. System Architecture

The system follows a private blockchain architecture focused on security and transparency rather than cryptocurrency.

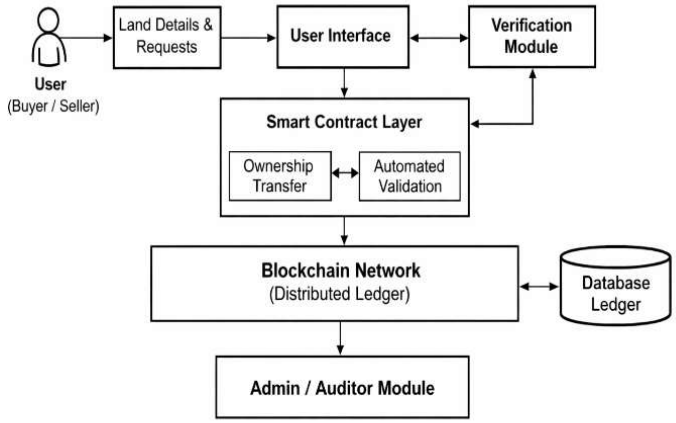

Fig. 1. System Architecture of Blockchain-Based Secure Land Registration System

Main Components:

- User Interface
- Verification Module
- SHA-256 Hash Generator
- Block Creation Module

- Blockchain Ledger
- Admin Monitoring Module

9. Block Structure

Each block contains essential metadata that ensures immutability and traceability.

Table 1. Block Structure of the Proposed System

Field Name	Description
Block Index	Position of block in the blockchain
Timestamp	Date and time of land transaction
Land Details	Survey number, location, area details
Owner Details	Information of landowner
Previous Hash	Hash of previous block
Current Hash	SHA-256 hash of current block

10. Implementation

The system is implemented using a lightweight private blockchain.

Software Requirements:

- Programming Language: Python
- Hash Algorithm: SHA-256
- Blockchain Type: Private

Functional Modules:

- User Registration Module
- Land Registration Module
- Ownership Transfer Module
- Block Creation Module
- Verification Module

11. Mathematical Model

Let:

- L = Land transaction data
- H(L) = SHA-256 hash of land data
- B_n = nth block
- P_n = Previous hash
- C_n = Current hash

Hash Function:

H(L) = SHA-256(L)

Block Formation:

B_n = {Index, Timestamp, H(L), P_n}

Verification:

If H(L_new) = H(L_stored) → Authentic

Else → Tampered

12. Security Analysis

- **Immutability:** Any change breaks the blockchain
- **Integrity:** Single-bit change alters hash
- **Transparency:** Ownership history is verifiable
- **Non-repudiation:** Records cannot be denied
- **Tamper Detection:** Hash mismatch reveals manipulation

13. Performance Characteristics

The system performance is summarized below.

Table 2. Performance Characteristics

Parameter	Observation
Storage Requirement	Low (hash-based storage)
Verification Speed	Fast

Security Level	High
Transparency	High
Operational Cost	Low (no intermediaries)
Scalability	Moderate (institutional deployment)

14. Conclusion

Land registration integrity is essential for legal and economic stability. Traditional centralized systems cannot guarantee security due to reliance on trust. The proposed blockchain-based land registration system provides a secure, transparent, and tamper-proof solution by storing cryptographic proofs of ownership in an immutable ledger. The system reduces fraud, enhances trust, and improves efficiency in land administration.

15. Future Scope

- Integration with government land portals
- Mobile application support
- Smart contract-based legal approvals
- AI-based fraud detection
- Cloud-based blockchain deployment
- Nationwide blockchain land registry

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