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Blockchain-Based Property Transfer System Using Smart Contracts and IPFS

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Abstract

Property registration and ownership transfer systems in many countries still rely on centralized databases and manual verification processes, which are vulnerable to fraud, data manipulation, and operational inefficiencies. This paper presents a blockchain-based property transfer system that provides a decentralized, transparent and tamper-proof platform for property registration, document verification and ownership transfer. The proposed system utilizes Ethereum smart contracts for secure transaction execution and InterPlanetary File System (IPFS) for decentralized document storage. A web-based application built using React and Spring Boot enables interaction between property owners, buyers and government authorities. Smart contracts enforce access control, verification rules and ownership transfer automatically. Experimental evaluation conducted on a prototype implementation demonstrates that the system ensures strong data integrity, reliable audit trails and efficient transaction processing. The proposed architecture improves transparency, reduces dependency on intermediaries and provides a trustworthy digital ecosystem for property management.

Keywords: *Blockchain, Property transfer, Smart contracts, IPFS, Decentralized applications, Land registry.*

1. Introduction

The **Blockchain-Based Property Registration System** is a decentralized platform designed to transform conventional methods of property registration and ownership management. By utilizing blockchain technology, the system establishes a secure, transparent, and reliable digital environment for recording property transactions.

Traditional property management systems rely heavily on centralized databases, which are vulnerable to data breaches, unauthorized modifications, and potential record loss. The proposed solution addresses these limitations by integrating the Ethereum blockchain, locally simulated using Ganache, to maintain immutable transaction records. Every registration and ownership transfer is permanently stored on the blockchain, ensuring that once data is recorded, it cannot be altered or removed.

To further strengthen data integrity, the system incorporates the InterPlanetary File System (IPFS) for decentralized storage of critical documents such as title deeds, ownership certificates, and verification records. This approach safeguards sensitive files from tampering while enhancing accessibility and reliability.

The application backend is developed using **Spring Boot (Java)**, which delivers RESTful APIs to manage property information, user roles—including buyers, sellers, and verifiers—and communication with the blockchain network. Core functionalities such as property registration, validation, and ownership transfer are governed by **Solidity-based smart contracts**, enabling automated and trustless execution of transactions. The user interface is built with **React.js** and integrated with **MetaMask**, allowing users to securely connect their Ethereum wallets, authorize transactions, and interact with the blockchain infrastructure with ease.

By implementing this architecture, the system enhances security, traceability, and operational efficiency in property management while minimizing dependence on intermediaries and significantly lowering the risk of fraudulent activities. Each blockchain entry serves as permanent and verifiable evidence of ownership, fostering greater trust and transparency within the real estate ecosystem.

2. Related Work

Several studies have explored the application of blockchain technology in land registry and real-estate management. Blockchain-based land record systems have demonstrated the feasibility of using distributed ledgers to store ownership information and automate transactions using smart contracts. Previous research highlights the advantages of immutability, transparency and reduced fraud in decentralized property systems.

Some works propose hybrid blockchain frameworks where property data is stored off-chain and cryptographic hashes are recorded on-chain to reduce storage costs. Other studies emphasize the role of permissioned blockchains such as

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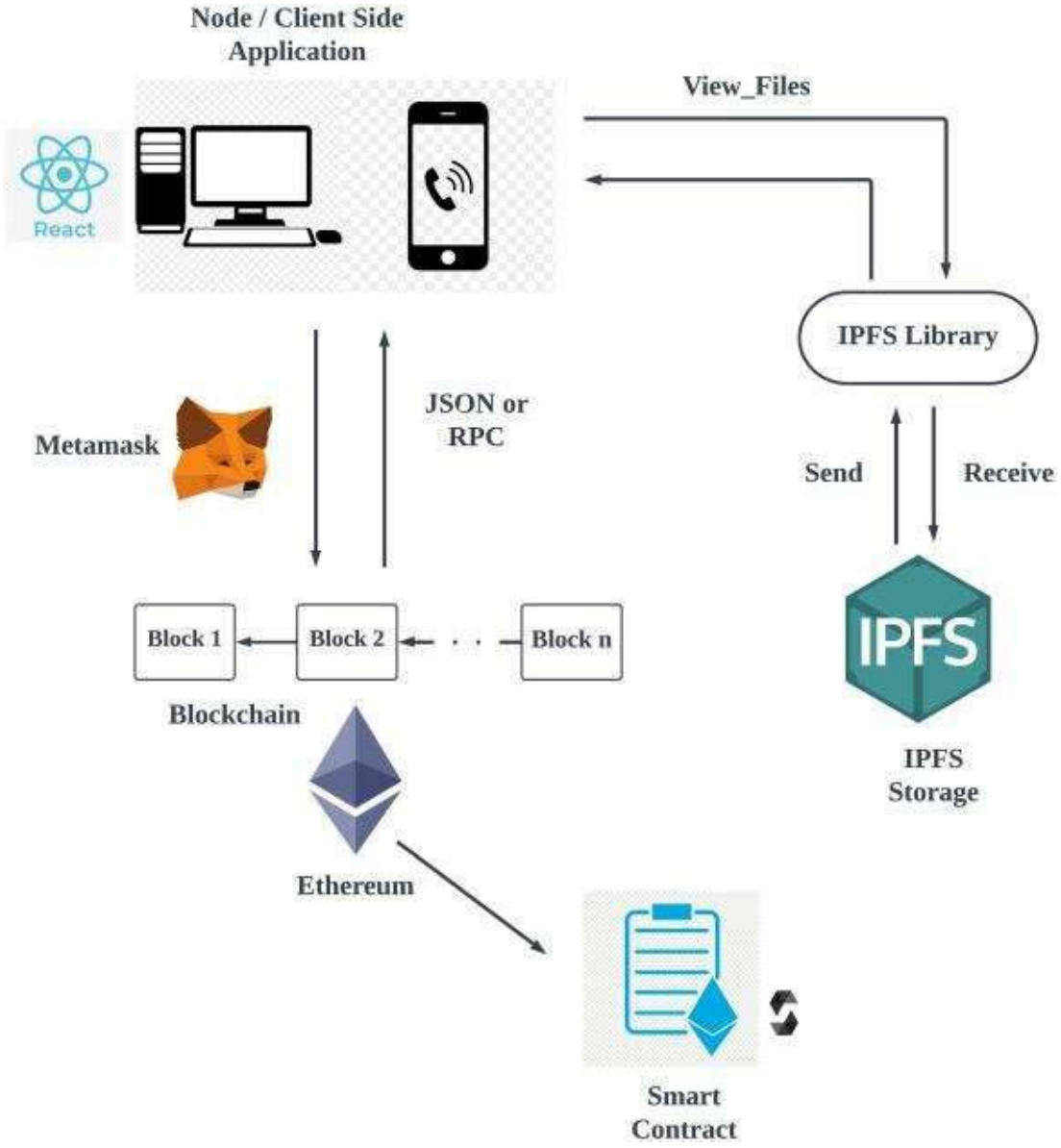
Hyperledger Fabric for government-controlled registries.

However, many existing systems focus primarily on conceptual models and lack end-to-end integration of decentralized storage, smart contract enforcement and practical user interfaces. Moreover, limited attention is given to role-based verification workflows and document integrity validation. The present work addresses these limitations by providing a complete architecture that combines smart contracts, IPFS storage and a web application with clearly defined operational roles.

3. System Architecture

The proposed system follows a layered decentralized architecture consisting of a presentation layer, application layer and blockchain layer.



4. Architectural Overview

The presentation layer is implemented using a React-based web interface that allows property owners, buyers and government authorities to interact with the system. Wallet-based authentication is used to securely identify users.

The application layer is developed using Spring Boot and provides REST APIs for user management, property registration, document upload and interaction with the blockchain network. It also manages off-chain metadata storage.

The blockchain layer is built on Ethereum. Smart contracts written in Solidity store cryptographic

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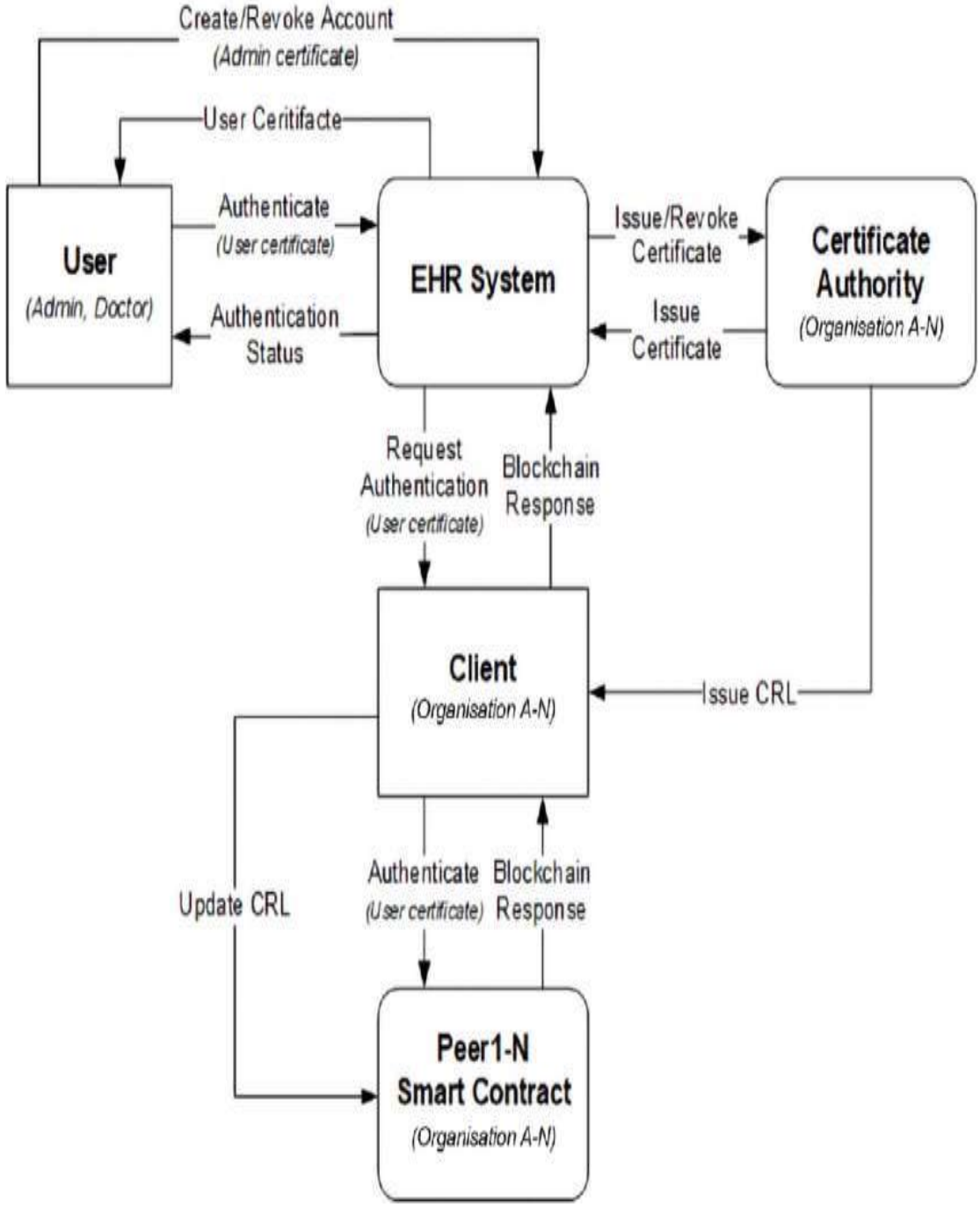
hashes of property documents, ownership information and transaction records. IPFS is used to store actual property documents in a decentralized manner, while their hashes are stored on the blockchain to ensure integrity.

Functional Workflow and Data Flow



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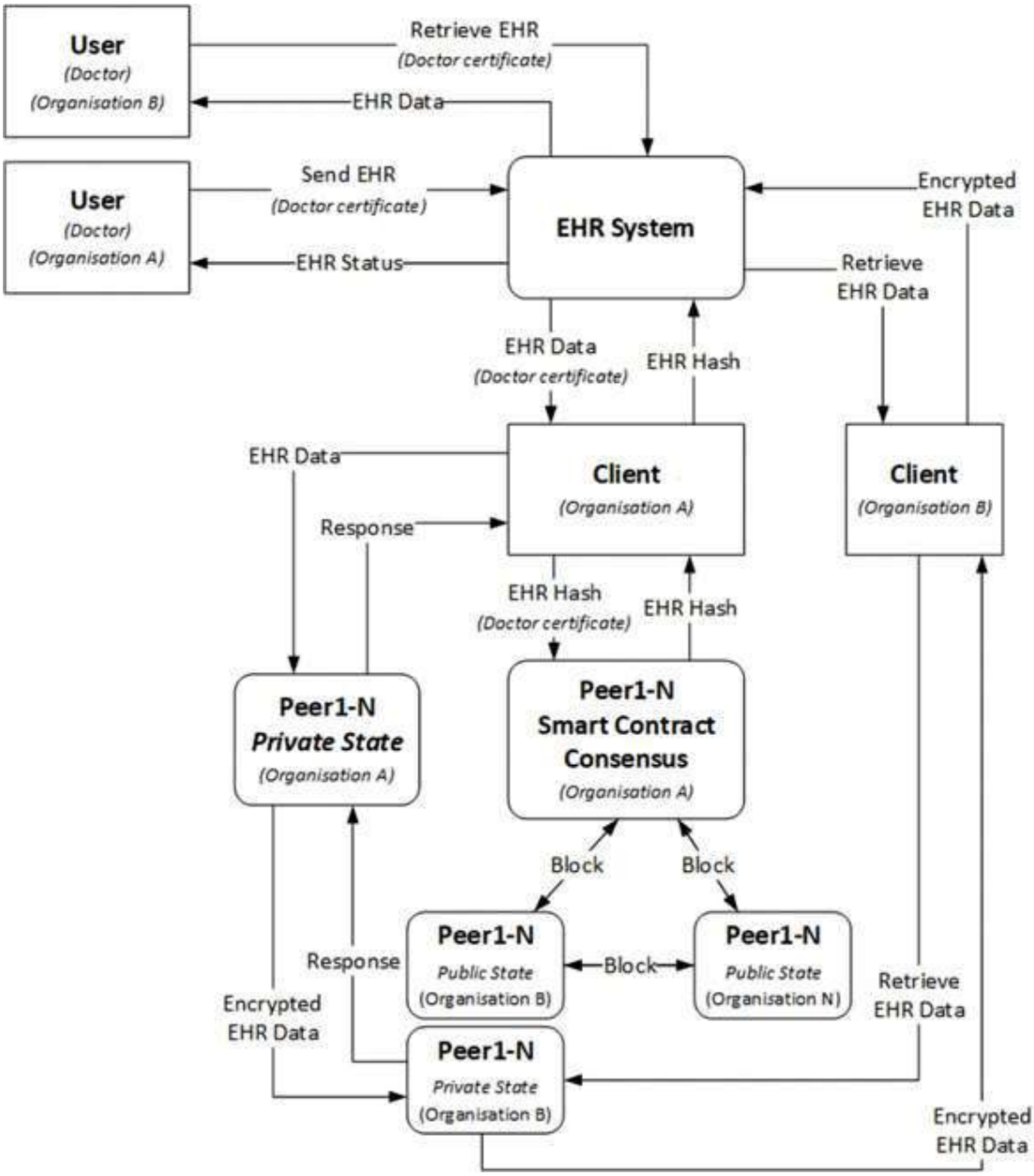

The operational workflow of the system can be summarized as follows:

1. The property owner submits property details and uploads supporting documents.
2. Documents are stored in IPFS and a content hash is generated.
3. The document hash and property metadata are recorded in the blockchain using a smart contract.
4. A government authority verifies the submitted property information.
5. Buyers can request property purchase and ownership transfer.
6. Smart contracts validate approval and execute ownership transfer.
7. All actions are recorded permanently on the blockchain.

This workflow ensures traceability, non-repudiation and strong integrity of property records.

UML-Based System Modeling

The system is modeled using standard UML representations.

The use-case model identifies property owners, buyers, government authorities and administrators as primary actors. Core use cases include property registration, document upload, verification, purchase request and ownership transfer.

The class model consists of entities such as Property, User, VerificationRecord, BlockchainService and IPFSService. The sequence model represents the interaction flow among users, backend services, blockchain and IPFS. The activity model captures

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the verification and approval workflow followed by authorities.

Proposed Blockchain-Based Property Transfer Model

The proposed model uses smart contracts as the core execution engine. Each property is represented by a unique identifier and linked to document hashes stored in IPFS. Ownership and verification status are maintained within the contract state.

The smart contract enforces the following rules:

- only authorized authorities can verify properties,
- only verified properties can be listed for sale,
- ownership transfer is executed only after approval and payment confirmation, and
- every ownership change is recorded in an immutable history.

By decentralizing the execution logic, the system eliminates the need for trusted intermediaries and ensures consistent enforcement of business rules.

5. Implementation Framework

Technology Stack

The system is implemented using:

- Frontend: React.js
- Backend: Spring Boot (Java)
- Blockchain: Ethereum
- Smart contracts: Solidity
- Decentralized storage: IPFS
- Blockchain integration: Web3/Ethers libraries
- Local blockchain testing: Ganache

Module Design

The application is divided into the following major modules:

- User and authentication module
- Property registration module
- Authority verification module
- Blockchain interaction module
- IPFS storage module
- Ownership transfer module
- Audit and history module

Each module communicates through secure REST APIs and interacts with the blockchain using contract interfaces.

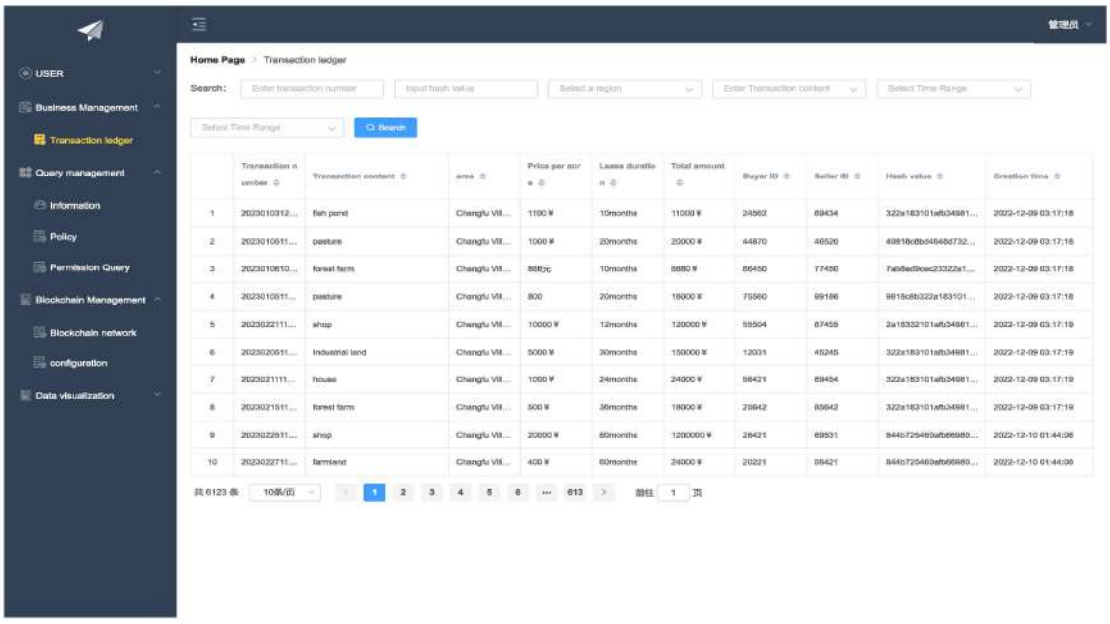
Experimental Setup and Evaluation Metrics

The prototype system is deployed on a local Ethereum test network using Ganache. Multiple user roles are simulated to validate real-world usage scenarios.

The following evaluation metrics are used:

- functional correctness of registration and transfer workflows,
- document integrity verification success rate,
- transaction execution latency,
- system response time, and
- reliability of audit trails.

6. Results and Discussion



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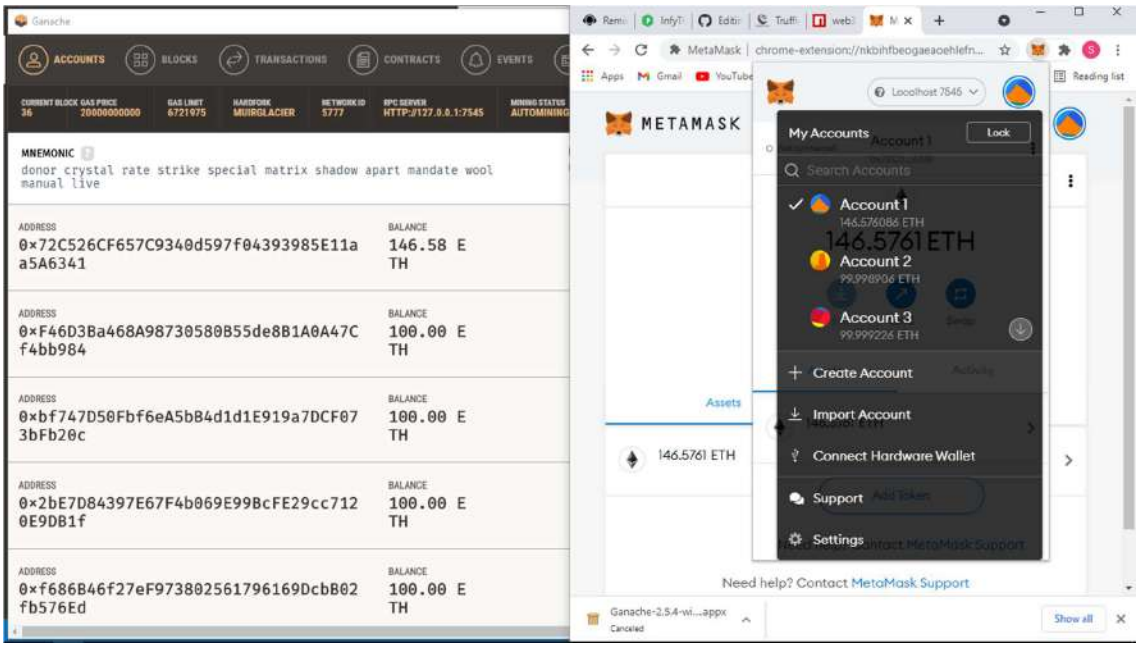

The implemented system successfully supports secure property registration, document upload to IPFS, verification by authorities and ownership transfer through smart contracts.

Functional Analysis

All core workflows, including property registration, verification and transfer, were executed correctly. Document hashes stored on the blockchain matched the hashes retrieved from IPFS, confirming data integrity.

Security and Integrity

The blockchain ledger ensured immutability of ownership records. Any attempt to modify stored data resulted in hash mismatches, which were immediately detected by the verification process.

Role-based access control restricted unauthorized operations. Smart contracts prevented invalid transfers and enforced verification requirements.

Performance Evaluation

The average backend response time for API requests was observed within a few hundred milliseconds under normal load. Blockchain transaction confirmation time ranged between several seconds and half a minute, depending on network conditions. Although this introduces slight delays compared to centralized systems, it provides significantly higher security and trust guarantees.

7. Discussion

The integration of IPFS and blockchain proved effective in separating large document storage from immutable record management. The system offers strong transparency, reliable audit trails and reduced dependency on intermediaries. However, public blockchain latency and transaction fees remain practical limitations.

Comparative Analysis

A comparative analysis with conventional centralized property systems shows that the proposed model offers:

- stronger tamper resistance,
- higher transparency,
- improved traceability of ownership history, and
- reduced administrative overhead after deployment.

While centralized systems may offer faster transactions, they lack cryptographic verifiability and strong protection against internal manipulation.

8. Conclusion

This paper presented a blockchain-based property transfer system that combines Ethereum smart contracts and IPFS to provide a secure, transparent and decentralized framework for property registration and ownership transfer. The proposed system eliminates single points of failure, reduces reliance on intermediaries and ensures immutable audit trails.

The experimental prototype demonstrates that blockchain technology can effectively support real-world property management scenarios while maintaining strong data integrity and accountability.

Future Scope

Future work may focus on:

- deployment over private or consortium blockchains to reduce latency and transaction costs,
- integration with government land record databases,
- mobile-based access for citizens and officials,
- adoption of layer-2 blockchain solutions for scalability, and
- incorporation of analytics and anomaly detection for fraud prevention.

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