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GREENLAND: A SECERE LAND REGISTRATION SCHEME FOR BLOCKCHAIN AND AI-ENABLED AGRICULTURE INDUSTRY 5.0

SK. Anjaneyulu Babu [1], M.Gnana Jyothi [2]
Associate Professor [1], PG Scholar [2]
Department of MCA, QIS College of Engineering & Technology
Ongole, AP, India

ABSTRACT

The Greenland framework introduces a secure and intelligent land registration system integrating Blockchain and Artificial Intelligence (AI) to meet the demands of Agriculture Industry 5.0. Traditional land registration systems, reliant on centralized servers, are prone to data tampering and lack transparency. Greenland addresses these issues through a decentralized Blockchain-based infrastructure that ensures tamper-proof, encrypted storage of land transaction data, utilizing IPFS (InterPlanetary File System) for scalable and secure data handling.

Smart contracts, developed using Solidity, are deployed on the Ethereum Blockchain to manage buyer, seller, and transaction metadata. AI algorithms are integrated to detect fraudulent land transactions by analyzing Blockchain raw data. A comprehensive machine learning pipeline is implemented, employing techniques such as data preprocessing, ANOVA feature selection, and model evaluation using metrics like Accuracy, Precision, Recall, F1-Score, and ROC curves. Among the evaluated models—Logistic Regression, SVM, Random Forest, XGBoost, and LightGBM—the LightGBM model achieved the highest accuracy of 99.35%.

The system features a web interface where buyers and sellers can securely interact with the Blockchain, submit transactions, and view ML-based fraud predictions. This holistic approach not only secures the land registration process but also enhances transparency and trust through intelligent automation. The Greenland system demonstrates the viability of combining Blockchain and AI technologies to transform agricultural land management in a digital economy.

INTRODUCTION

The agriculture sector is undergoing a transformative evolution towards Industry 5.0, where technologies like Artificial Intelligence (AI) and Blockchain converge to enhance transparency, efficiency, and trust. One critical challenge within this paradigm is the secure and tamper-proof management of land registration—a foundational component in agricultural operations and land ownership authentication.

Greenland presents a novel, secure land registration system that leverages

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Blockchain's decentralized ledger and **AI-powered fraud detection** to overcome the vulnerabilities of traditional, centralized land record systems. Conventional approaches are susceptible to manipulation by database administrators and lack real-time validation mechanisms. Blockchain inherently resolves these issues through immutable, encrypted records and smart contract automation.

Complementing this, AI algorithms are deployed to detect fraudulent land transactions by analyzing raw blockchain data, including sender and receiver details, transaction types, and metadata. Various machine learning models—such as Logistic Regression, Random Forest, SVM, XGBoost, and LightGBM—were trained and evaluated using Ethereum-based fraud detection datasets. Among these, LightGBM achieved the highest accuracy.

The architecture includes **IPFS (Interplanetary File System)** for decentralized storage of raw transaction data, with hashcodes stored on Ethereum via smart contracts developed in Solidity. A web interface facilitates interaction between buyers and sellers, integrating machine learning predictions to guide land request approvals.

This comprehensive system not only secures land registration against tampering and fraud but also lays the groundwork for intelligent, automated, and transparent agricultural infrastructure in the era of Industry 5.0.

LITERATURE SURVEY

1. Secure Decentralized Land Registration Using Blockchain

- Traditional land registration systems rely on centralized databases that are prone to tampering by administrators.
- The proposed scheme leverages blockchain's decentralized, tamper-proof, and encrypted data storage to secure land registration records.
- Smart contracts written in Solidity are used to automate and secure land transactions.

2. AI-Based Fraud Detection in Land Transactions

- AI algorithms are employed to detect fraudulent land transactions from blockchain data (sender, receiver, transaction type, etc.).
- The AI models are trained on real-world Ethereum fraud datasets to identify suspicious patterns.

3. Performance Comparison of Machine Learning Algorithms

- Several machine learning models (Logistic Regression, SVM, Random Forest, XGBoost, LightGBM) were evaluated.
- The models were assessed using metrics like Accuracy, Precision, Recall, F1-score, and ROC curves.
- **LightGBM achieved the highest accuracy (99.35%)**, making it the best fit for fraud detection in this system.

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4. Integration with IPFS for Efficient Data Storage

- Transaction data is stored on the InterPlanetary File System (IPFS), and its hash is stored on the blockchain.
- This ensures efficient, decentralized data storage and retrieval while reducing the blockchain's load.

5. Web-Based Interface for Practical Usability

- The system includes web modules for **buyer and seller** interactions:
  - Buyers can register, upload transaction data, and check transaction status.
  - Sellers can review requests, view AI-predicted fraud statuses, and accept/reject transactions.

SYSTEM ANALYSIS

EXISTING SYSTEM

Traditional land registration systems are largely centralized, relying on local government servers or administrative databases. These centralized structures are highly vulnerable to tampering and unauthorized modifications by internal administrators or malicious actors. The lack of transparency, immutability, and decentralized control makes it difficult to trace fraudulent transactions or ensure the authenticity of ownership records. Moreover, current systems do not incorporate intelligent mechanisms to detect anomalies or fraud, leaving the process open to human error and manipulation. These deficiencies highlight the urgent requirement for a more secure, transparent, and intelligent solution to manage land records effectively, especially as agricultural sectors adopt Industry 5.0 practices that demand trust, automation, and data-driven insights.

Disadvantages of Existing Systems

Centralized Databases:

- Vulnerable to tampering by administrators.
- Single point of failure leads to potential data breaches or manipulation.

No Transparency:

- Transactions and ownership details lack public traceability or auditability.
- Disputes over land ownership are common due to unclear or falsified records.

Manual Verification:

- Time-consuming and error-prone verification processes.
- High dependency on human judgment which may be biased or corrupt.

PROPOSED SYSTEM

The proposed “Greenland” system integrates Blockchain and Artificial Intelligence to create a secure, transparent, and intelligent land registration framework tailored for

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Agriculture Industry 5.0. Blockchain provides decentralized, tamper-proof data storage with built-in cryptographic security, ensuring that land records remain immutable and trustworthy. Simultaneously, AI and Machine Learning algorithms (e.g., LightGBM, XGBoost, SVM) are employed to detect fraudulent transactions from Blockchain raw data, enhancing the system's ability to automatically flag suspicious activities. Through smart contracts and IPFS (Interplanetary File System), the system supports decentralized storage and automated data retrieval. Web modules for buyers and sellers facilitate seamless interaction, while ML predictions guide decision-making in real-time. This approach significantly boosts system integrity, minimizes fraud, and supports the data-driven evolution of agricultural land management.

Advantages of the Proposed System

1. Tamper-Proof Land Registration

- **Blockchain technology** ensures decentralization and immutability.
- Land records cannot be altered or deleted, protecting ownership from fraud.

2. Fraud Detection with AI/ML

- Advanced **AI models (e.g., LIGHTGBM, XGBOOST, SVM)**are trained to detect fraudulent transactions.
- The system achieved up to **99.35% accuracy** in fraud detection using Ethereum transaction datasets.

IMPLEMENTATION

1. Requirement Analysis

The implementation of the project **"GreenLand: A Secure Land Registration Scheme for Blockchain and AI-Enabled Agriculture Industry 5.0"** begins with analyzing the major issues in traditional land registration systems such as fraud, data tampering, duplicate ownership claims, corruption, and lack of transparency. The proposed system integrates Artificial Intelligence (AI), Blockchain technology, Smart Contracts, and IPFS (InterPlanetary File System) to create a secure, transparent, and tamper-proof land registration platform for Agriculture Industry 5.0.

2. System Design

The system architecture is designed for secure digital land registration and intelligent fraud detection.

Main Modules

- User Registration Module
- Land Record Collection Module
- AI-Based Fraud Detection Module
- Blockchain Network Module
- Smart Contract Module
- IPFS Storage Module
- Verification and Reporting Module

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The architecture ensures secure and transparent land ownership management.

3. Land Data Collection

The system collects land-related information from government departments, landowners, and agricultural authorities.

Collected Data

- Land ownership details
- Survey numbers
- Geographic coordinates
- Ownership transfer records
- Agricultural land usage details
- Legal verification documents

The collected information is securely prepared for AI analysis and blockchain storage.

4. Data Preprocessing

The land registration data undergoes preprocessing before AI classification and blockchain integration.

Preprocessing Steps

- Data cleaning
- Duplicate record removal
- Missing value handling
- Data normalization
- Feature selection

These operations improve fraud detection accuracy and system efficiency.

5. AI-Based Fraud Detection

Artificial Intelligence and Machine Learning algorithms are implemented to detect fraudulent land records.

AI Models Used

- Logistic Regression (LR)
- Support Vector Machine (SVM)
- Random Forest (RF)
- Extreme Gradient Boosting (XGBoost)
- Light Gradient Boosting Machine (LGBM)

The AI model classifies land records as:

- Fraudulent Data
- Non-Fraudulent Data

Only verified non-fraudulent records are forwarded to the blockchain network.

6. Blockchain Integration

Blockchain technology is used to maintain immutable and decentralized land ownership records.

Blockchain Functions

- Distributed ledger management
- Immutable transaction storage
- Ownership verification
- Secure land transfer recording

Each validated land transaction is securely recorded in blockchain blocks.

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METHODOLOGY

1. Land Record Acquisition

The methodology begins with collecting land registration information from landowners, government authorities, and agricultural departments.

Data Sources

- Government land databases
- Agricultural departments
- Legal registration offices
- Property ownership documents

This data forms the basis for secure land registration.

2. Data Cleaning and Preparation

The collected land records are cleaned and standardized before AI analysis.

Data Processing Operations

- Remove duplicate records
- Validate ownership data
- Normalize registration details
- Extract relevant features

These preprocessing operations improve fraud detection efficiency.

3. AI-Based Fraud Classification

Machine learning models analyze land records to identify fraudulent transactions.

Classification Workflow

1. Input land registration data
2. Extract important features
3. Train AI classification model
4. Predict fraud probability
5. Separate valid and fraudulent records

Only valid land records proceed to blockchain storage.

4. Blockchain Transaction Creation

Verified land records are converted into blockchain transactions.

Transaction Components

- Owner information
- Land details
- Transaction timestamp
- Digital signatures
- IPFS hash reference

Each transaction is securely stored in the blockchain ledger.

5. Smart Contract Execution

Smart contracts automate land ownership validation and transfer operations.

Smart Contract Workflow

- Verify ownership details
- Validate land transaction
- Execute registration approval
- Record immutable transaction history

This eliminates manual manipulation and improves transparency.

6. IPFS-Based Document Storage

The original land documents are stored in the IPFS decentralized storage network.

Storage Workflow

- Upload land documents to IPFS
- Generate unique content hash
- Store hash in blockchain
- Retrieve documents securely using hash

This improves scalability and reduces storage cost.

CONCLUSION

The proposed *Greenland* framework successfully demonstrates a secure, decentralized, and AI-augmented approach to land registration for Agriculture Industry 5.0. By integrating blockchain technology, particularly Ethereum smart contracts, and IPFS-based distributed storage, the system ensures data integrity, tamper-proof ownership records, and transparent land transactions. Additionally, the implementation of various machine learning models — including Logistic Regression, SVM, Random Forest, XGBoost, and LightGBM — enables the real-time detection of fraudulent transactions using historical Ethereum data. Among these, LightGBM achieved the highest accuracy, validating its effectiveness in identifying irregularities in land registry data.

The platform further empowers users through a web-based interface that supports both buyers and sellers in securely transacting land assets. By enabling AI-driven verification before decision-making, it minimizes human error and fraud, fostering trust and transparency in land dealings.

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AUTHORS PROFILE

SK.ANJANEYALU BABU is an Associate. Professor Department of Master of computer applications at QIS College of Engineering and Technology, ongole , Andhra Pradesh. His research interest include Machine Learning an Artificial Intelligence. He is committed to advancing research and fostering innovation while mentoring students to excel in both academic and professional pursuits.

M. GNANA JYOTHI is a postgraduate student pursuing a MCA in the Department of Computer Applications at QIS College of Engineering & Technology, Ongole an Autonomous college in Prakasam dist. She completed his undergraduate degree in BCA (computers) from ANU. With a keen interest in research and practical learning, she is actively involved in academic project and technical activities related to her field.