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SECURE LAND RECORD MANAGEMENT THROUGH ARTIFICIAL INTELLIGENCE AND DECENTRALIZED BLOCKCHAIN ARCHITECTURE

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ABSTRACT:

The rapid digitalization of land registration processes has heightened apprehensions over data security, transparency, and fraud detection. Centralized databases used by traditional land registration systems are susceptible to data tampering, illegal access, cyberattacks, and fraudulent activities. To rectify these shortcomings, the developers of this initiative present GREENLAND, an intelligent and secure land registration system using Blockchain, IPFS, ML, and XAI. The proposed system guarantees immutability, transparency, and decentralized governance by securely archiving user data and land transaction records on the Ethereum blockchain via the use of smart contracts. To safeguard vast land-related records and minimize storage requirements, IPFS archives them with their associated hash values documented on the blockchain. A variety of machine learning models are created and assessed on a dataset of real transactions to identify fraud. The models include Logistic Regression, Support Vector Machine (SVM), Random Forest, XGBoost, and LightGBM. LightGBM outperforms its competitors with an accuracy of 99.35%. Utilizing SHAP and LIME to clarify fraud predictions bolsters confidence and improves interpretability for human understanding. A scalable, safe, transparent, and contemporary system for digital land registration and governance is built via the combination of Blockchain, IPFS, machine learning, and explainable artificial intelligence.

Keywords: Blockchain, Land Registration, Ethereum, Smart Contracts, InterPlanetary File System (IPFS), LightGBM, Explainable AI (XAI), Decentralized Governance.

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I.INTRODUCTION

Land registration is a crucial process for affirming legal rights and ownership of real estate. Historically, centralized systems have been used to manage property records; nevertheless, they possess considerable shortcomings, including vulnerability to data manipulation, lack of transparency, slowness, and risk of fraud. Conflicts, corruption, and prolonged verification procedures often emerge from the obstacles presented by these limitations, affecting both people and

governmental entities.

A safe, transparent, and efficient system for handling land transactions is more essential as digital technologies progress. Blockchain, artificial intelligence, and decentralized storage systems are nascent technologies that may rectify the shortcomings of conventional land registration practices. Blockchain technology guarantees security, trust, and transparency via its decentralized and immutable ledger, in which data becomes unchangeable upon recording. Likewise, IPFS enables decentralized storage of comprehensive land-related records, improving data accessibility and diminishing reliance on central servers.New land management systems must have safe data storage and possess the capacity to identify fraudulent actions. Machine Learning (ML) systems can examine transaction data to detect fraudulent patterns. The project's fraud detection algorithms include XGBoost, LightGBM, Logistic Regression, Support Vector Machine (SVM), and Random Forest, with LightGBM exhibiting higher performance.

The system utilizes Explainable Artificial Intelligence (XAI) methodologies, including SHAP and LIME, to improve the transparency and dependability of prediction results for users. The suggested solution for next-generation digital governance incorporates Blockchain, IPFS, ML, and XAI to provide a safe, transparent, and user-friendly land registration system.

II.LITERATURE REVIEW

Early land registration systems were mostly centralized and government-administered, relying on manual verification and paper-based procedures. Research examining the difficulties of land administration in underdeveloped nations has shown that these systems are susceptible to corruption, document falsification, and data discrepancies.Early land registration systems were mostly focused on manual verification and paper-based procedures, predominantly controlled and regulated by the state. Research on the difficulties of land administration in poor nations has shown that these systems are susceptible to corruption, document fabrication, and data inconsistency [1, 3]. In response, alternative digital land management platforms were created; nevertheless, several systems still depend on centralized databases, limiting their transparency and rendering them susceptible to security risks [4,5].Researchers investigated decentralized land registration solutions to enhance transparency and security using Blockchain technology. Shrivastava and Dwivedi [6] established a land registry on the blockchain to illustrate how Ethereum smart contracts may improve transaction security and efficiency.

The substantial expense of direct on-chain data storage constituted a hurdle for the decentralized land registration system developed by Kusuma et al. [7], notwithstanding its improvement of transparency. While Dubey et al. [8] examined the speed and latency of Ethereum-based land registries, they failed to discuss strategies for fraud prevention or scalability enhancement.Sidharthan and Balasaraswathi [9] used IPFS in conjunction with Ethereum to keep just cryptographic hashes on-chain, hence alleviating the storage strain on the blockchain. Their system demonstrated shortcomings in sophisticated data validation and security analysis, although enhanced scalability.

Ncube et al. [10] suggested a permissioned, distributed ledger system for land records to restrict access and participation from the general public. Previous studies[11–15] neglected to include methodologies for identifying fraud using artificial intelligence, concentrating instead on the blockchain-based digitalization of land records.Recent research indicates that artificial intelligence (AI) is becoming more relevant in categorization, anomaly detection, and decision support [16], [17]. Nevertheless, the majority of land registration systems do not use artificial intelligence in conjunction with blockchain to authenticate transactions before their storage. To address this information deficiency, we present the GREENLAND architecture, a sophisticated land registration system that integrates Blockchain, IPFS, Machine Learning, and Explainable Artificial Intelligence. It is safe, scalable, transparent, and utilizes machine learning.

III.EXISTING SYSTEM

Presently, land registration systems mostly preserve property ownership records in centralized databases or use frameworks that only implement blockchain technology. Although blockchain systems improve transparency, they often lack AI-driven validation tools to identify fraudulent transactions prior to data storage, making traditional centralized systems susceptible to data tampering, unauthorized modifications, insufficient transparency, and security breaches. This allows for the inclusion of inaccurate or deceptive land records into the system, so limiting its ability to identify fraud.

DISADVANTAGES

- The amalgamation of IPFS, smart contracts, blockchain, and AI contributes considerable complexity to the implementation process.
- The training of AI models and the upkeep of blockchain infrastructure may involve significant processing demands and an initial implementation cost.

IV.PROPOSED SYSTEM

To overcome the shortcomings of current centralized methods, the author of the proposed solution utilizes Blockchain and Artificial Intelligence (AI) to improve the security of land registration. Conventional land registration systems use centralized servers, enabling administrators or unauthorized persons to modify database information undetected. In contrast, blockchain technology offers decentralized, encrypted, and immutable storage, guaranteeing the security, transparency, and permanence of property ownership information.

The proposed architecture includes an artificial intelligence (AI) fraud detection component. It examines the raw data of blockchain transactions, including elements such as sender and recipient details, transaction type, land ownership records, and more transaction characteristics. To prevent the persistence of fraudulent transactions on the blockchain, machine learning algorithms analyze previous transaction data to detect patterns of fraud.

Diverse machine learning techniques, such as XGBoost, LightGBM, Random Forest, Support Vector Machine (SVM), and Logistic Regression, are used and fine-tuned with many hyperparameters to achieve precise fraud detection. They are assessed based on criteria like ROC analysis, accuracy, precision, recall, and F1-score. LightGBM outperformed all other models in classification accuracy, making it the superior option for fraud detection.

We save the unprocessed data of land transactions in the InterPlanetary File System (IPFS) to alleviate blockchain storage burdens. Consequently, for safe future retrieval, we save just the generated cryptographic hash on the blockchain. Smart contracts, written in the Solidity programming language, provide safe and automated management of land transactions. These contracts govern data storage and retrieval processes using established features.

ADVANTAGES

- It uses distributed ledger storage and blockchain technology to make land registration safe, transparent, and unchangeable.
- Identifies fraudulent transactions using AI-driven fraud detection, which improves accuracy, efficiency, and reduces storage expenditures.

V.SYSTEM MODEL

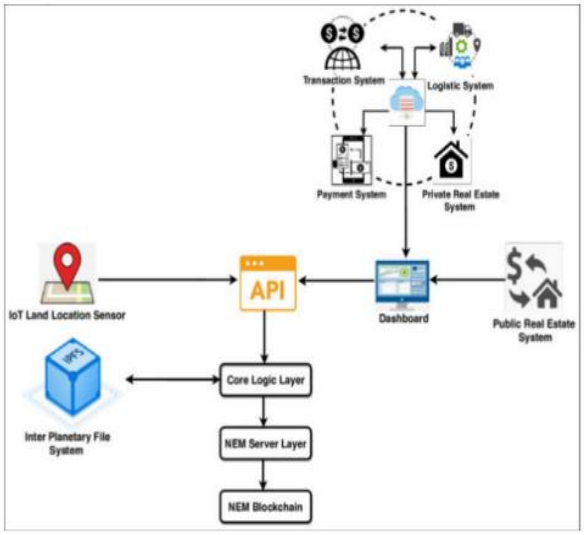


Fig 1.System Model

The system design shown in figure (1) demonstrates the layered integration of data sources, AI-based fraud categorization, blockchain smart contracts, and IPFS storage. To improve scalability and save computing costs, the AI layer communicates only verified land data to the blockchain.

ARCHITECTURAL LAYERS

1. Data Layer: Collects land ownership paperwork, transaction information, geographical attributes, and user credentials.

2. AI Validation Layer: Employs supervised machine learning methods to classify transactions as fraudulent or legitimate.

3. Blockchain Layer: Enables the implementation of smart contracts for ownership verification and the creation of immutable records.

4. Storage Layer (IPFS): Maintains original land documents off-chain while securing cryptographic hashes on the blockchain.

VI.MODULES

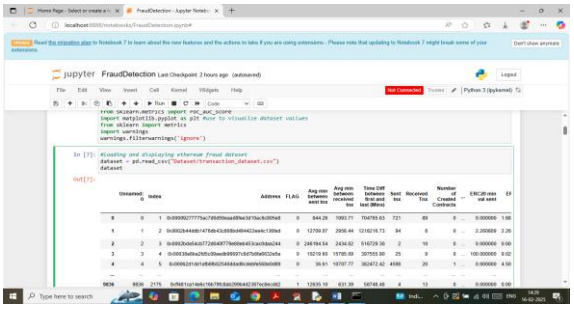
The following descriptions pertain to the various buyer and seller modules we have developed, together with the prediction modules.

1) New User Sign up: This module enables the linkage of buyers and sellers inside the blockchain.

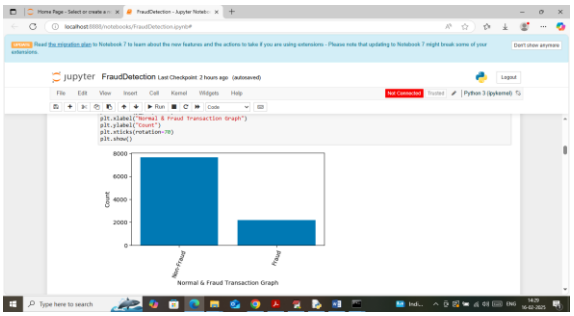
2) Buyer Login: Buyers may use Blockchain for verification before submitting land requests that include raw transaction data, which machine learning algorithms may then analyze to determine the authenticity or fraudulent nature of the data. The purchaser may see the accepted or rejected status of the seller's transactions.

3) Seller Login: Upon accessing the system, the seller will get a detailed summary of all buyer queries, along by the machine learning anticipated status denoting either legitimate or fraudulent behavior. Vendors may approve or reject customer requests based on machine learning forecasts.

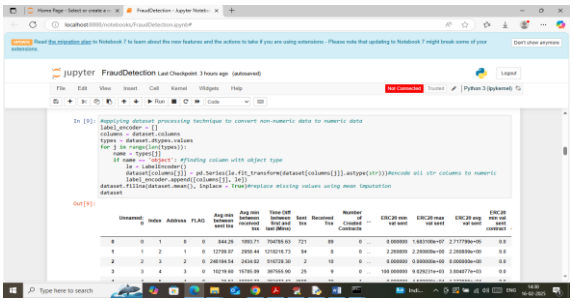
VII.SCREENSHOTS



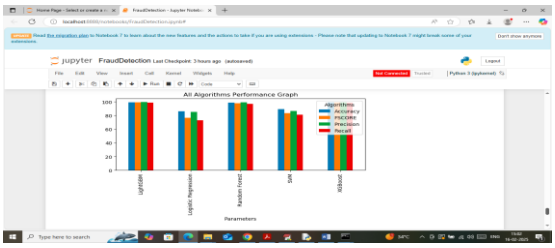
The dataset values have been imported and are shown on the screen above.



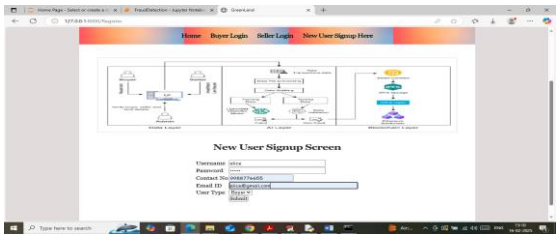
The designated panel displays a graph of transactions from the dataset entitled "Fraud and Non-fraud.



The subsequent screen demonstrates the results of a dataset processing technique: initially, employing Label Encoder to transform categorical data into numerical format; subsequently, replacing missing values with an imputed mean function; and finally, presenting the entire dataset converted to numerical format.



The graph above compares all the algorithms, displaying their names on the x-axis and colored bars representing various qualities, including accuracy and speed, on the y-axis.



After the consumer registers with the Blockchain on the previous screen, they may go to the next page by clicking the button

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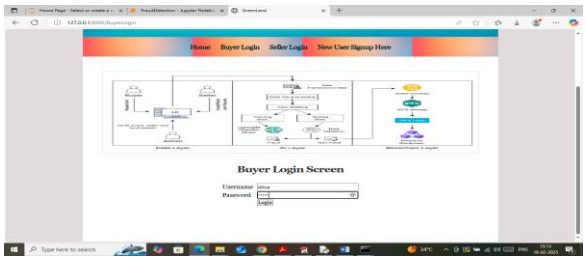
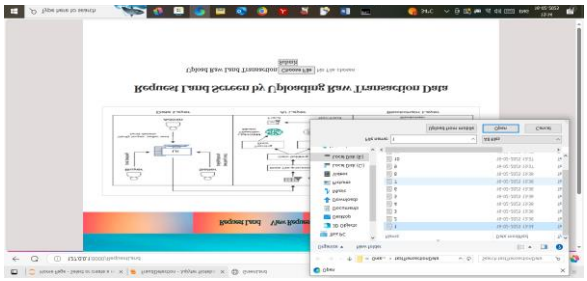
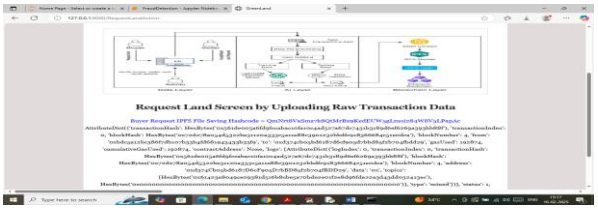
I have completed the registration process and will now provide the whole log obtained from the blockchain subsequent to storage in the ensuing lines. The log presents information including the transaction number, hash code, and block number. Vendor registration is also allowed.



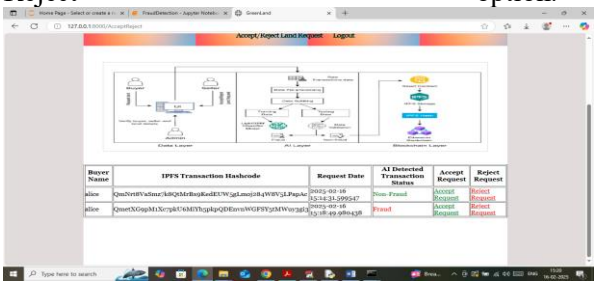
Upon check-in, the consumer will have access to the subsequent page



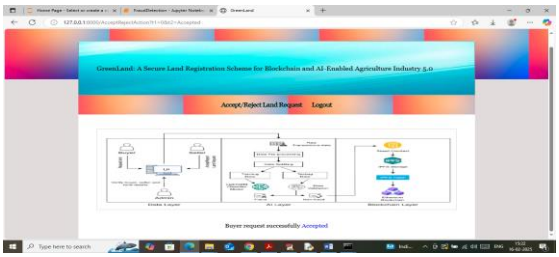
Employ the "Open and submit" option on the previous page to save the data in IPFS and Blockchain. Machine learning can determine the fraudulent nature of a transaction and hence forecast the subsequent outcome



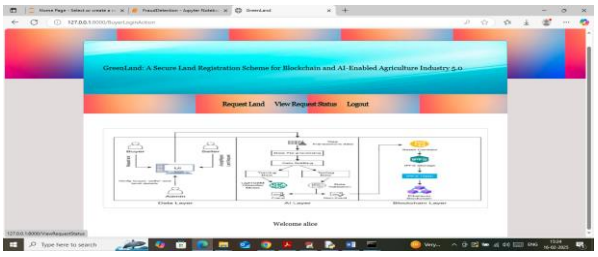
The blue text above indicates the status of the transaction's output, and you may submit an unlimited number of transactions. Log onto your seller account and choose the "Accept or Reject" option.



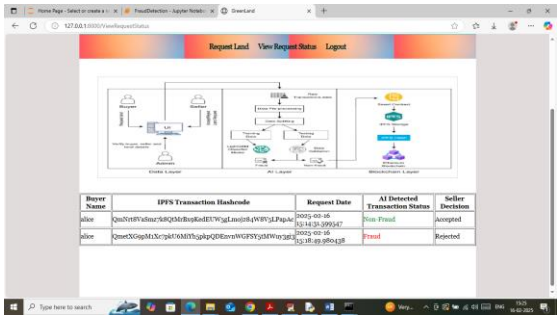
A compilation of land requests, with buyer identities and IPFS storage hashes of unprocessed transactions, is shown on the upper screen. The projected condition of the ML is also shown. To approve or decline a request, use the corresponding link at the bottom of the page.



To track the progress of a request, the seller on the specified site must first log out and then log in as the buyer.



To access the next page, buyers may choose the "View Request Status" option on the preceding screen.



The buyer may see the raw data hash codes in the transactions on the designated screen, while the seller can examine the machine learning projected output and has the option to accept or reject it.

All potential module outputs are shown in the panels above.

VIII.CONCLUSION

This paper presents an advanced and safe framework for land registration that integrates Blockchain, Machine Learning, IPFS, and Explainable AI to rectify the deficiencies of conventional land registration systems. To minimize unnecessary smart contract transactions and enhance system efficiency, the proposed solution included an AI-driven fraud detection layer that identifies fraudulent land transactions prior to blockchain deployment. The deployed LightGBM model effectively differentiated between legitimate and fraudulent transactions, as shown by experimental evaluation, which demonstrated a classification accuracy of 99.35%. The decentralized storage of IPFS enabled the effective administration of extensive land-related documents without compromising data security, while smart contracts on the Ethereum blockchain facilitated automated, transparent, and immutable certification of property title. This integration decreased dependence on centralized systems and improved scalability.

Additionally, by using Explainable AI techniques such as SHAP and LIME, we were able to provide customers with clear and intelligible justifications for fraud predictions. This enhanced user trust and made decision-making more transparent. The proposed architecture improves transaction efficiency, reduces manual labor, and offers real-time fraud detection capabilities. The results indicate that the GREENLAND system is an outstanding option for sustainable land management and sophisticated governance applications, owing to its cost-effectiveness, scalability, security, and transparency in digital land administration.

IX.FUTURE ENHANCEMENTS

To enhance the planned GREENLAND design, we will examine forthcoming update scans using advanced deep learning algorithms, satellite imagery, and real-time geospatial data for predictive decision-making and dynamic land monitoring. The integration of AI methodologies with satellite data enables real-time surveillance of land-use alterations, agricultural conditions, border infringements, and unlawful land encroachments. The accuracy of land classification and anomaly detection may be enhanced by the use of deep learning models, such as Convolutional Neural Networks (CNNs) and hybrid geospatial analytics. Moreover, the amalgamation of IoT sensors with GIS technology might enhance sustainable land management by delivering real-time agricultural and environmental data.

The use of privacy-preserving AI algorithms and federated learning to improve fraud detection while protecting sensitive user data is a viable avenue for future research. These advancements may enhance the system's intelligence, predictive capabilities, and adaptability, while significantly boosting practical applications such as intelligent agricultural governance and secure land management.

X.REFERENCES

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