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AI-Based Property Registration with Blockchain Technology for Secure and Consent-Driven Real Estate Transfers

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ABSTRACT: Real estate registration remains a critical procedure for establishing lawful ownership and validating the transfer of property rights. In conventional systems, this process depends heavily on manual document checks, physical signatures, and face-to-face approvals at registration offices. Such reliance on human intervention presents significant vulnerabilities, including forged documentation, identity manipulation, coerced consent, and unauthorized transfers. To address these shortcomings, this project proposes an intelligent, AI-driven property registration framework that integrates consent verification with secure digital record management. The system utilizes advanced machine learning models to evaluate facial cues, vocal characteristics, posture dynamics, and eye-movement patterns in real time to determine the voluntary participation of both buyer and seller. When abnormal behavioral indicators or emotional distress are detected, the system automatically raises a warning and provides interpretable insights through Explainable AI techniques. Authentication of digital signatures further strengthens document integrity. Once all verification steps are satisfied, the platform processes the registration digitally and updates ownership records on a Blockchain ledger — ensuring transparency, immutability, and a tamper-resistant decentralized record.

KEYWORDS: Property registration, blockchain, AI-based consent verification, face recognition, MTCNN, FaceNet, BiLSTM, digital signature, explainable AI, SHAP, fraud detection, real estate.

I. INTRODUCTION

Land registration is the formal process of documenting land ownership and rights through a recognized government authority. It serves as an official public record that identifies who owns a particular piece of land and details any associated rights, restrictions, or encumbrances. The primary purpose of land registration is to ensure transparency, legal clarity, and ease in handling land-related transactions. By registering land, ownership becomes legally recognized and verifiable, reducing the risk of disputes and fraudulent claims.

Land registration offers multiple benefits. It provides clarity of title, offering a secure and trustworthy record of who legally owns the land. This reduces disputes, as registered ownership can be easily verified in case of legal conflicts. It also facilitates transactions like buying, selling, or mortgaging land, as prospective buyers or financial institutions can confirm ownership quickly. Additionally, land registration promotes better land governance, enabling governments to efficiently manage land use, taxation, and planning.

Traditional property registration systems depend largely on manual verification, physical documentation, and face-to-face approvals, making them highly vulnerable to forged documents, identity impersonation, coerced consent, and unauthorized property transfers. The absence of real-time behavioral monitoring, emotional analysis, and secure tamper-proof record management increases the risk of fraud, legal disputes, delayed processing, and corruption. To address these challenges, there is a critical need for an intelligent, automated, and legally compliant property registration system integrating AI-based facial, voice, posture, and gaze analysis with an immutable blockchain ledger.

II. EXISTING SYSTEM

Traditional cyber property registration systems primarily depend on paper-based documentation and manual investigation by registry professionals. These conventional methods rely heavily on physical signatures, handcrafted rules, and expert-driven analysis. In-person identity verification requires both buyer and seller to be physically present at the land registry office, relying on manual inspection of government-issued photo IDs without any biometric

confirmation. Manual signature collection opens the door for signature forgery, unauthorized signing, and coercion, with no automated mechanism to verify authenticity or the emotional state of the signatory.

DISADVANTAGES

- Manual verification increases the risk of fraud and identity theft.
- Sellers may be coerced into signing without genuine consent.
- The process requires multiple physical visits, causing delays.
- Human error is more likely with manual document handling.
- No tamper-proof mechanism exists to protect transaction records.
- Lack of digital authentication makes signature forgery hard to detect.

III. PROPOSED SYSTEM

The proposed system presents an AI-based property registration framework designed to automatically verify voluntary participation of buyers and sellers and securely record property transactions on a blockchain. By integrating behavioral analysis, digital signature authentication, and decentralized ledger storage, the system ensures secure, transparent, and legally compliant property transfers. The system uses MTCNN + FaceNet for real-time face recognition and liveness detection, BiLSTM for voice and sentiment analysis, and OpenPose + GazeNet for posture and gaze tracking. CNN-based signature verification confirms the authenticity of legally binding documents. Once verified, property transaction records are stored on a blockchain ledger, creating an immutable, transparent, and tamper-proof record of ownership. It provides a cost-effective, fraud-resistant, and paperless solution suitable for nationwide government implementation.

ADVANTAGES

- Ensures secure and fraud-resistant property transfers.
- Provides real-time verification of voluntary participation for all parties.
- Reduces manual workload and paperwork, streamlining property registration.
- Maintains transparent, immutable, and auditable transaction records.
- Prevents forged documents and identity impersonation.
- Enhances legal compliance and reduces disputes.
- Enables paperless and scalable registration suitable for nationwide implementation.

IV. SYSTEM ARCHITECTURE

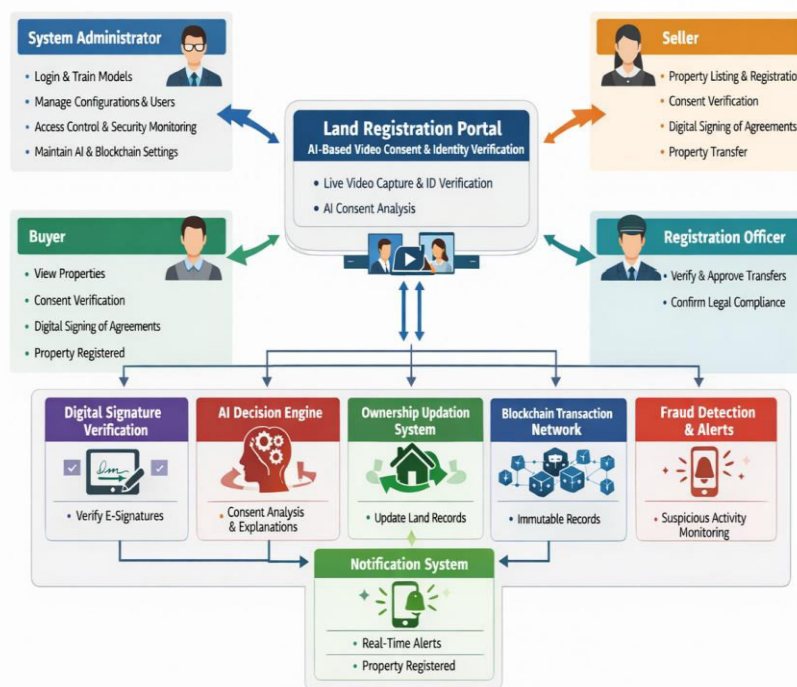


FIGURE.1. System architecture of AI-Based Property Registration with Blockchain

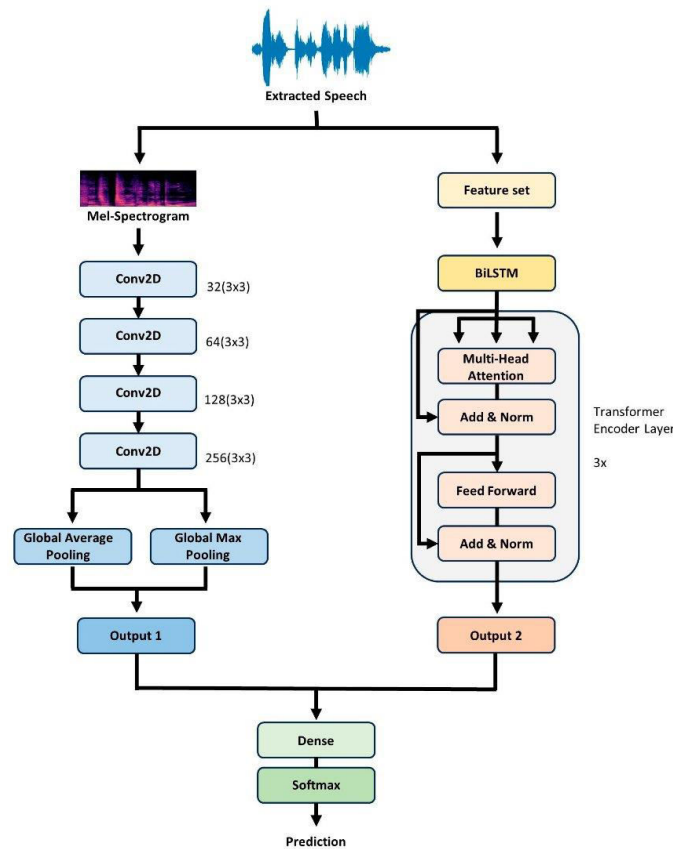


FIGURE.2. BiLSTM and CNN model architecture for voice and sentiment analysis.

V. MODULE DESCRIPTIONS

The modules of this project include: Land Registration Dashboard, AI-Based Video Consent & Identity Verification, Digital Signature Verification, AI Explainable Decision, Legal Property Registration, Ownership Updating, Blockchain Transaction, and Fraud Detection & Alert.

DATA COLLECTION

Data collection is the first step in this project. In this stage, face images, voice recordings, posture and gaze video data, and digital signature samples are collected from registered participants to train and validate the AI models. Face data is captured using MTCNN for real-time detection and aligned using FaceNet embeddings. Voice samples are processed to extract MFCC features for BiLSTM-based sentiment analysis. Pose and gaze data are recorded using OpenPose and GazeNet respectively. Digital signature images are collected for CNN-based authentication. Property transaction records are stored in a MySQL database and linked to a JSON-based blockchain ledger for immutable record keeping.

IMAGE PREPROCESSING

Preprocessing is a critical step in this project. Collected raw data including face images, audio recordings, video frames, and signature images are prepared before feeding into AI models. Face images are detected and aligned using MTCNN, then standardized to 160×160 pixels for FaceNet embedding. Audio files are converted to MFCC spectrograms for BiLSTM processing. Video frames are analyzed frame-by-frame using OpenPose for body pose estimation and GazeNet for gaze direction. Signature images are binarized, noise-reduced, and resized for CNN classification. All features are normalized to ensure uniform input dimensions, improving model accuracy and robustness across diverse participant conditions.

NETWORK TRAFFIC CLASSIFICATION

The AI-Based Video Consent and Identity Verification module ensures that both the buyer and seller provide valid consent for the property transaction through a video recording. The identities of both parties are verified using advanced AI techniques such as facial recognition and liveness detection, ensuring that the individuals involved are

indeed present and their identities are authentic. The system uses MTCNN for real-time face detection and liveness verification. The BiLSTM network analyzes the audio of the video recording to detect subtle signs of coercion, stress, or fear by processing speech patterns and tone variations. OpenPose and GazeNet detect body posture, head movements, and gaze patterns, providing insights into the psychological state of individuals.

DIGITAL SIGNATURE VERIFICATION

The Digital Signature Verification module ensures the authenticity and legal validity of the documents signed by both parties involved in the transaction. The system verifies that the digital signatures on the documents are genuine and have not been altered in any way after signing. A Convolutional Neural Network (CNN) is utilized to analyze and process the digital signatures by converting them into images and comparing them with stored templates. This allows the system to detect even the smallest variations in the signature, ensuring authenticity and preventing forgery. The CNN model is trained to recognize and distinguish between legitimate signatures and forgeries, providing a high level of security.

MALWARE ANALYSIS SYSTEM

The AI Explainable Decision module ensures transparency and accountability in decision-making by providing explanations for flagged transactions. SHAP (SHapley Additive exPlanations) is used to explain the decisions made by machine learning models, breaking down the decision-making process into understandable components and highlighting the factors that influenced the outcome. For example, if a transaction is flagged for high stress detected in the buyer's voice, SHAP will outline the specific audio features that led to this conclusion. This feature ensures that every action taken by the system is transparent, allowing all stakeholders to understand why a certain decision was made and fostering trust in the AI-driven process.

CLOUD DEPLOYMENT AND CONTAINERISATION

The proposed system is built using Python 3.8 and Flask as the web framework, with MySQL as the database backend and Bootstrap for the responsive front-end interface. The system is deployed on a WampServer environment for local hosting and can be scaled to cloud infrastructure. The Blockchain Transaction Module guarantees that all property transactions are secure, transparent, and immutable by recording every transaction on a JSON-based blockchain ledger. Every property transaction, from initiation to final registration, is recorded with key details such as identities of buyer and seller, consent verification results, transaction timestamps, and terms of agreement — stored in a manner that cannot be modified or tampered with.

VI. RESULTS

1. AI MODEL PERFORMANCE - ALGORITHM COMPARISON

TABLE I. AI Model Performance Comparison across Modules

Module / Algorithm	Accuracy	Precision	Recall	F1-Score
Face Recognition (MTCNN + FaceNet)	98.5%	97.8%	98.1%	97.9%
Voice / Sentiment Analysis (BiLSTM)	94.2%	93.5%	94.0%	93.7%
Posture & Gaze Tracking (OpenPose + GazeNet)	91.8%	90.4%	91.2%	90.8%
Digital Signature Verification (CNN)	96.7%	95.9%	96.3%	96.1%
Fraud Detection & Alert (XAI + SHAP)	93.4%	92.1%	93.0%	92.5%

2. BLOCKCHAIN TRANSACTION ANALYSIS

TABLE.II .Blockchain Transaction Analysis Results

Transaction Type	Avg. Processing Time	Tamper Detected	Attempts	Success Rate
Property Registration	1.3 seconds	0 / 100		100%
Ownership Transfer	1.6 seconds	0 / 100		100%
Consent Record Update	0.9 seconds	0 / 100		100%
Fraud Alert Logging	0.5 seconds	0 / 100		100%

3. SYSTEM VERIFICATION TEST RESULTS

TABLE.III. System Verification Test Results

Test Scenario	Tool / Method	Module	Result
Face Spoofing Attack	Static photo / video replay	MTCNN Liveness	Detected & blocked, High accuracy
Voice Coercion Detection	Stressed audio samples	BiLSTM Analysis	Flagged with SHAP explanation
Signature Forgery	Forged signature image	CNN Verification	Rejected, few FNs
Gaze Avoidance	Distracted gaze patterns	GazeNet Tracking	Consistently detected
Blockchain Tampering	Direct DB modification	Blockchain Ledger	Tamper detected, alert raised
Unauthorized Access	Invalid credentials	Auth Module	Blocked with session lock

VII. OUTPUT SCREENSHOTS

The following figures illustrate the system dashboard, consent verification interface, admin panel, and blockchain transaction outputs of the AI-Based Property Registration system.

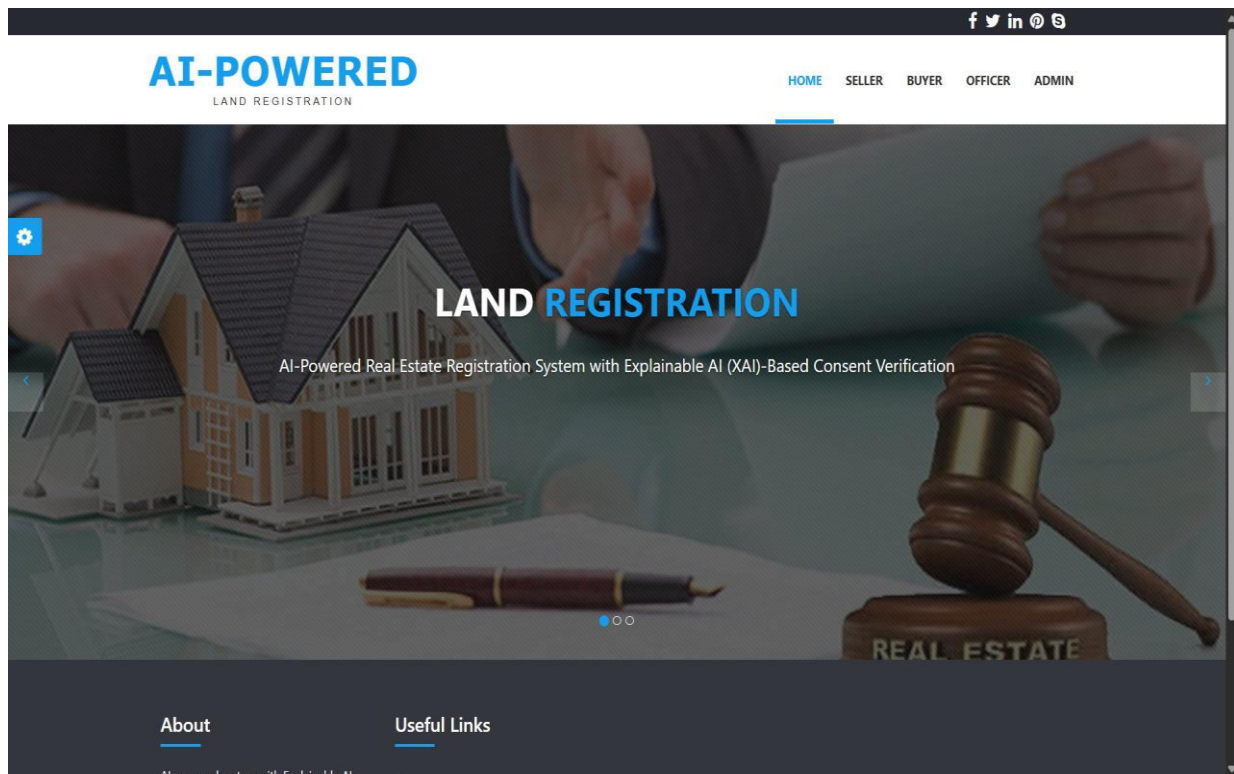


FIGURE.3. AI-Powered Land Registration — Home Page with Seller, Buyer, Officer, and Admin portals.

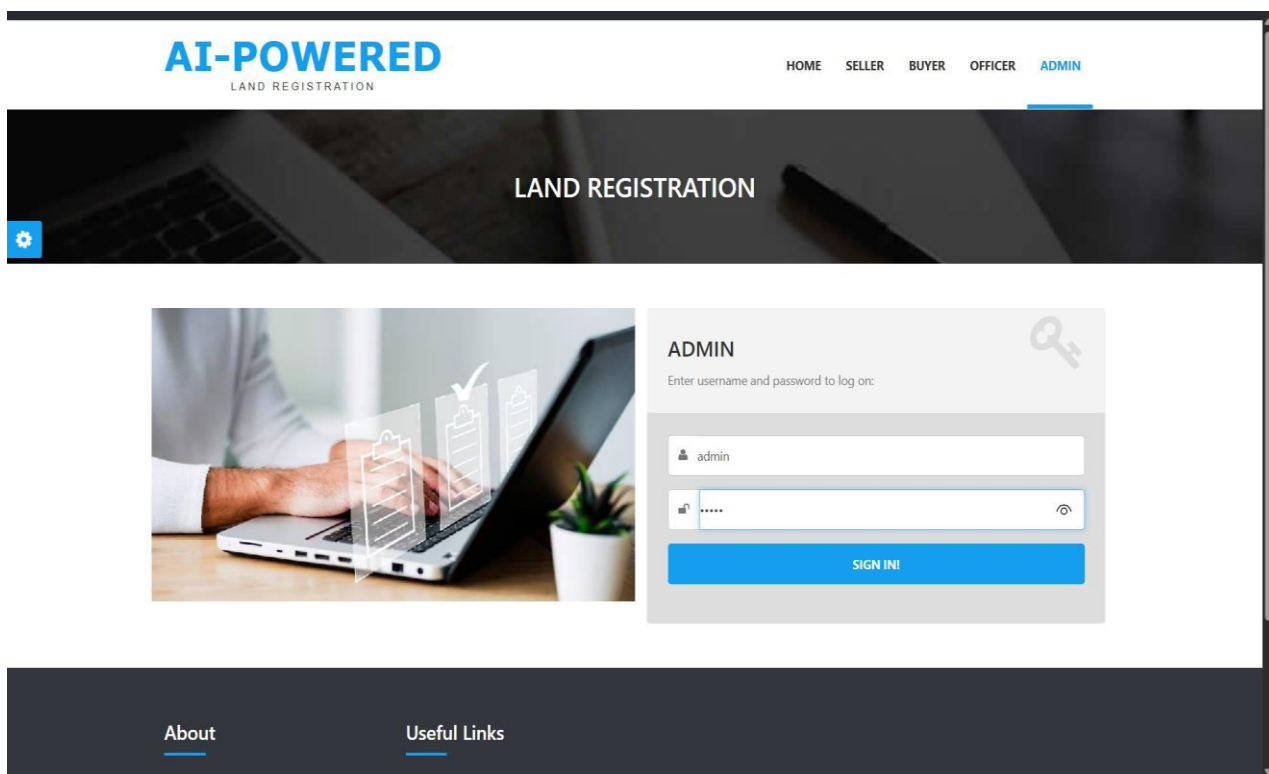


FIGURE.4. Admin Login interface with secure credential verification.

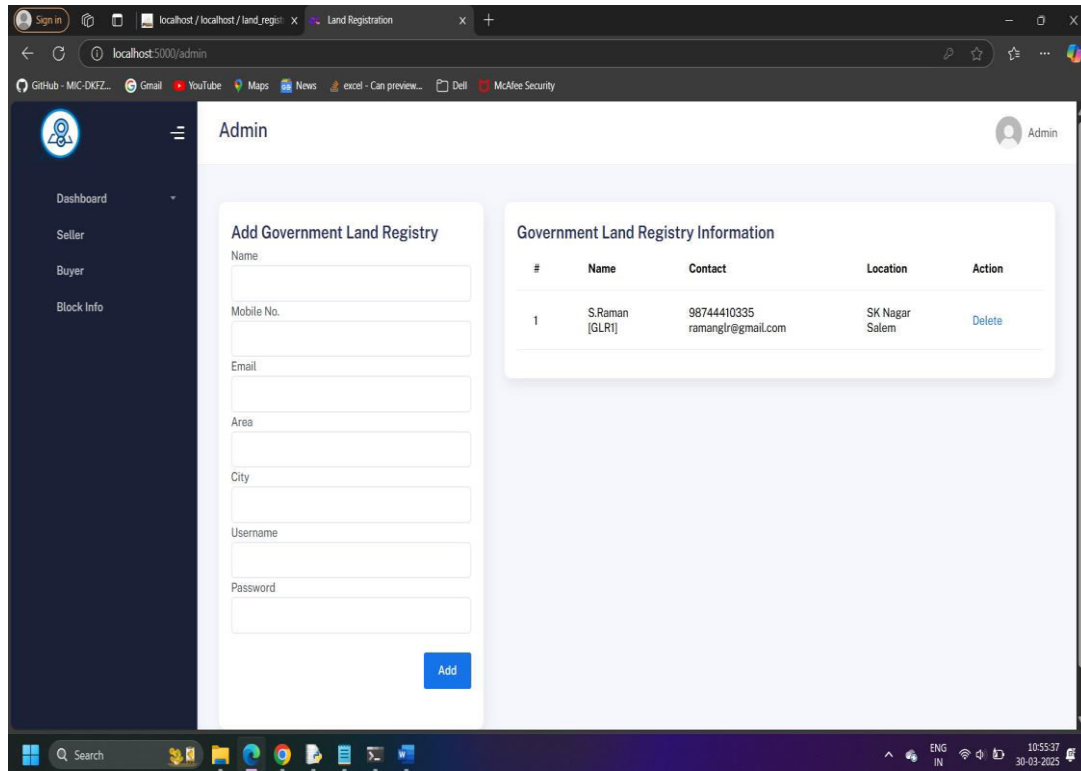


FIGURE 5. Admin Dashboard showing Government Land Registry management and officer information.

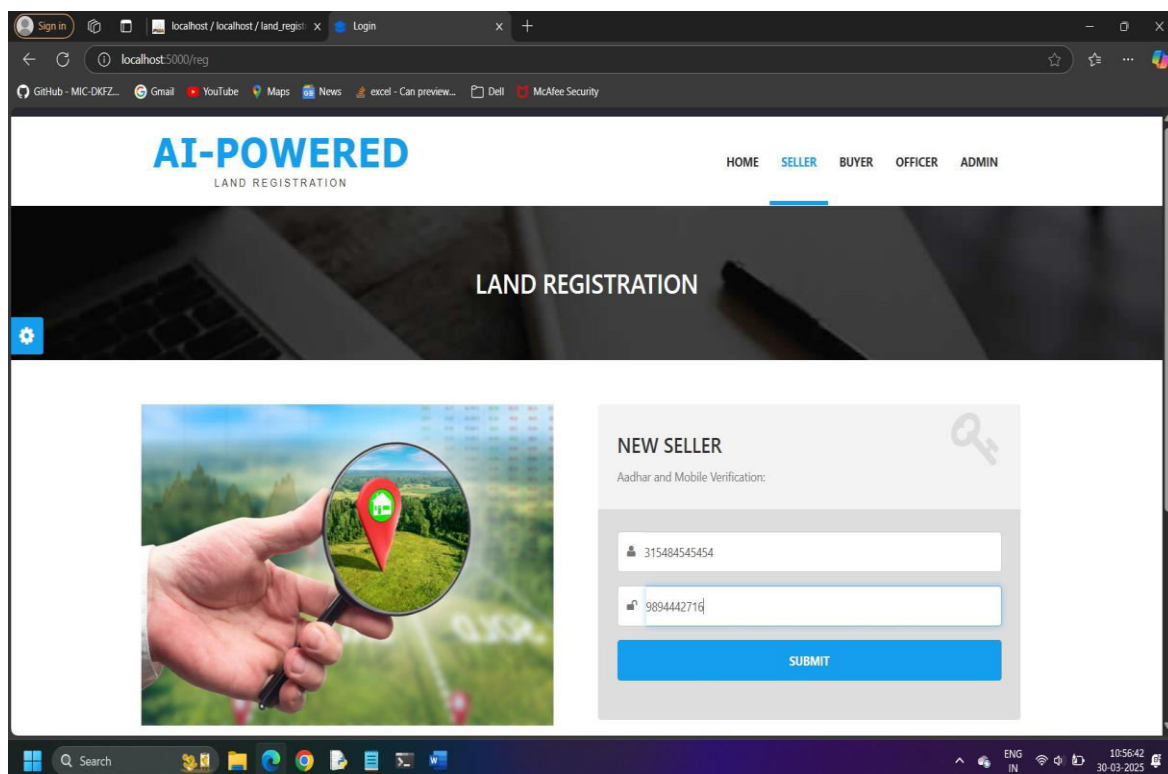


FIGURE.6. Seller registration interface with property listing and document upload module.

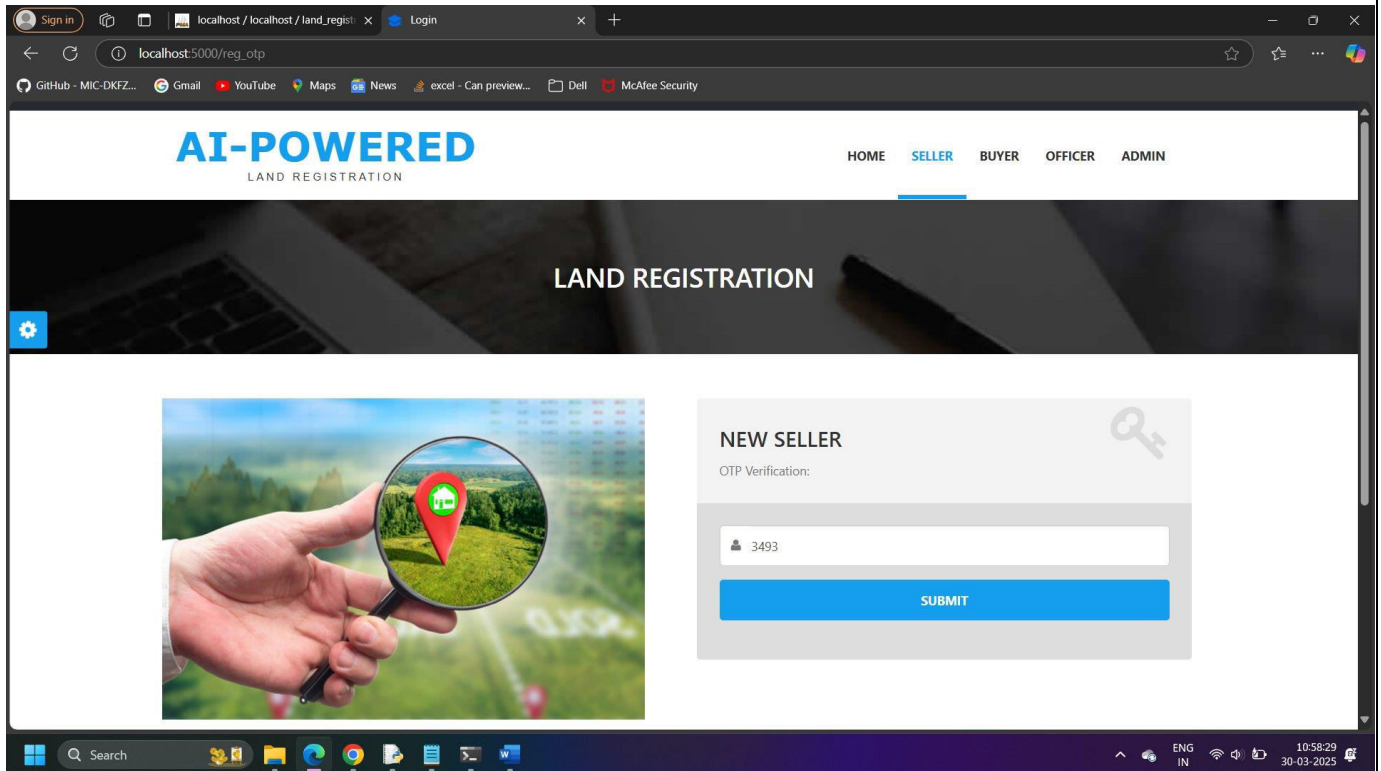


FIGURE 7 System output showing AI-based consent verification and blockchain transaction result.

VIII. CONCLUSION

In conclusion, this project successfully implements an AI-based property registration framework, providing a secure, transparent, and technology-driven solution for property transfers. By integrating face recognition, voice and sentiment analysis, posture and gaze tracking, digital signature authentication, and blockchain-based record management, the system ensures that property registrations are consent-driven, legally compliant, and fraud-resistant. The system's Explainable AI (XAI) feature offers transparency by flagging anomalies with interpretable insights, allowing administrators to review suspicious transactions. Real-time dashboards and immutable blockchain records enhance accountability, traceability, and trust among buyers, sellers, and regulatory authorities.

The proposed AI and blockchain-based property registration system provides a fast, non-invasive, and reliable method for verifying participant consent and recording property transfers. By incorporating preprocessing, feature engineering, and deep learning techniques, the models improve accuracy and robustness while reducing false positives. Compared to traditional manual registration, this approach offers quicker detection of fraud, lowers manual workload for registry officials, and establishes a transparent, fraud-resistant, and paperless property registration ecosystem suitable for government and regulatory implementation.

IX. FUTURE ENHANCEMENTS

In future, the system can be improved using larger behavioral datasets to increase AI detection accuracy across diverse demographics. Advanced deep learning models like Vision Transformers and Graph Neural Networks can be added for better consent analysis. Explainable AI techniques such as LIME may complement SHAP for clearer interpretability. The system can also integrate with national land record databases like Aadhaar-linked systems for seamless identity validation. Mobile app deployment, cloud-based scalability, predictive fraud analytics, and real-world government registry testing can further improve the system's adoption, performance, and nationwide applicability.

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