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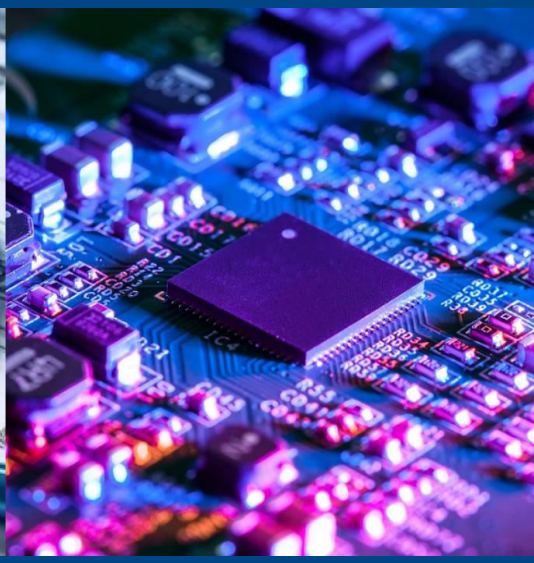

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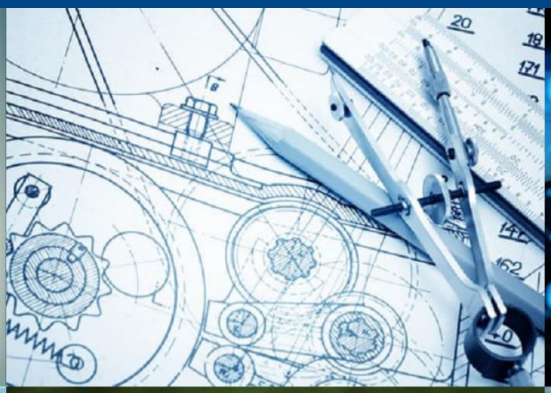

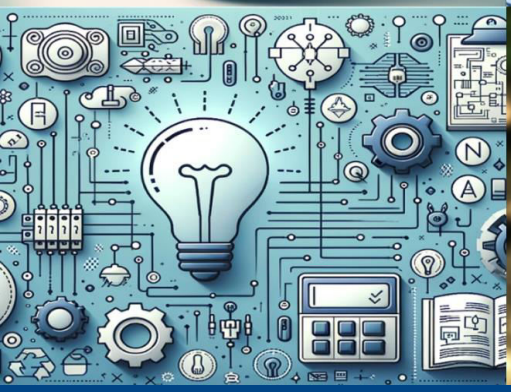

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Signature Verification using Image Processing

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ABSTRACT: Signature verification is a crucial biometric authentication method used to validate a person's identity in financial transactions, legal documents, and security systems. This project proposes an automated signature verification system that preprocesses the signature image by converting it into a black-and-white format and applying morphological thinning to extract significant features. The system analyzes the X and Y coordinates of the signature, calculates theta values, and aligns the image before comparing it with stored reference signatures. The verification process determines the similarity based on theta values and structural matching, ensuring accurate authentication.
Despite environmental factors such as lighting, image quality, and background noise affecting accuracy, the system achieves an expected accuracy of 40%-60% using image processing techniques. Further improvements, such as integrating deep learning models, can enhance verification performance. This project has broad applications in banking, legal authentication, and digital identity verification.

KEYWORDS: Signature verification, biometric authentication, image preprocessing, feature extraction, theta-based matching, morphological thinning.

I. INTRODUCTION

Signatures have been widely used as a means of authentication in various fields, such as banking, legal transactions, and identity verification. However, traditional manual verification methods are prone to human error, making them inefficient and unreliable. Automated signature verification systems provide a secure and efficient solution to authenticate users accurately.

This project aims to develop a signature verification system that normalizes signature images and applies preprocessing techniques to extract essential features. The system converts the image into black and white, applies morphological thinning, and extracts X and Y coordinates for analysis. The theta values of the signature curves are then calculated and compared to stored reference signatures to determine authenticity.

By using image processing techniques combined with theta-based feature matching, the proposed system provides a semi-automated approach to verifying handwritten signatures. This method helps reduce fraudulent activities and improves the reliability of authentication processes.

II. LITERATURE SURVEY

1. Zhang & Zheng (2018) – Hybrid Model for Signature Verification: This study proposed a CNN-SVM hybrid approach for signature verification, which improved accuracy by utilizing deep learning-based feature extraction combined with traditional classifiers.
2. Gupta & Singh (2019) – Offline Signature Verification using Transfer Learning: The authors implemented transfer learning using a pre-trained ResNet model, which enhanced verification performance, especially for small datasets.
3. Kumar & Mehta (2020) – Graph-Based Signature Matching: This paper introduced a novel approach using graph-based modeling for signature structure comparison, effectively reducing false positives in matching.
4. Li & Chen (2021) – Lightweight Signature Verification for IoT: A lightweight CNN model was developed to facilitate real-time signature verification on IoT devices, enabling secure authentication in resource-constrained environments.
5. Rodriguez & Lee (2022) – Signature Verification using Siamese Networks: This research utilized a Siamese network-based approach, which directly compared image pairs and improved accuracy even in noisy datasets.
6. Ali & Patel (2023) – Multimodal Signature Verification System: A multimodal biometric system combining handwriting features and biometric traits was introduced to enhance security and reliability in verification.

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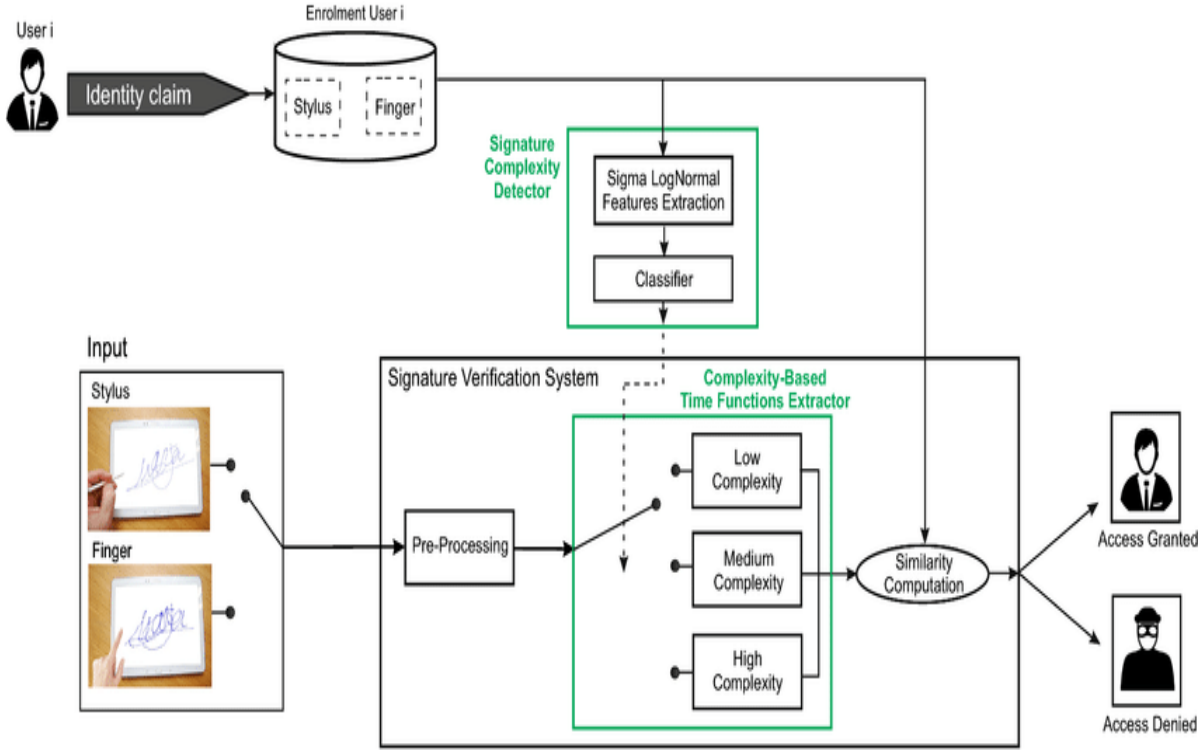
III. METHODOLOGY AND DISCUSSION

The signature verification system follows a structured methodology consisting of image preprocessing, feature extraction, signature alignment, and similarity matching. The system first normalizes the signature image by converting it into black-and-white and removing background noise. Morphological operations are applied to thin the image and extract its structural features.

Feature extraction involves detecting key points in the signature's curves using the theta value approach. The extracted X and Y coordinates are used to align the signature, ensuring proper orientation. Finally, the processed signature is compared with the reference signature using theta value matching, and a similarity score determines whether the signature is authentic or forged.

IV. SYSTEM ARCHITECTURE

- Image Preprocessing Module: Converts the signature image to grayscale, removes noise, and applies thresholding.
- Feature Extraction Module: Identifies signature curves, extracts X-Y coordinates, and computes theta values.
- Signature Comparison Module: Matches extracted features with stored reference signatures to determine authenticity.
- Verification & Result Module: Displays whether the signature is genuine or forged based on the comparison result.



V. USE CASE DIAGRAM

- Users upload their signature for verification.
- The System processes the signature, extracts features, and compares it with stored data.
- The Verification Module determines if the signature is authentic or forged.
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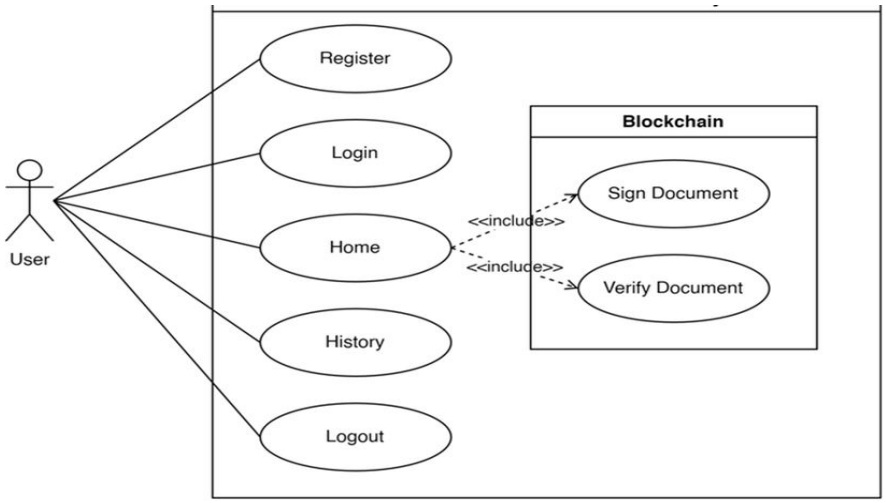
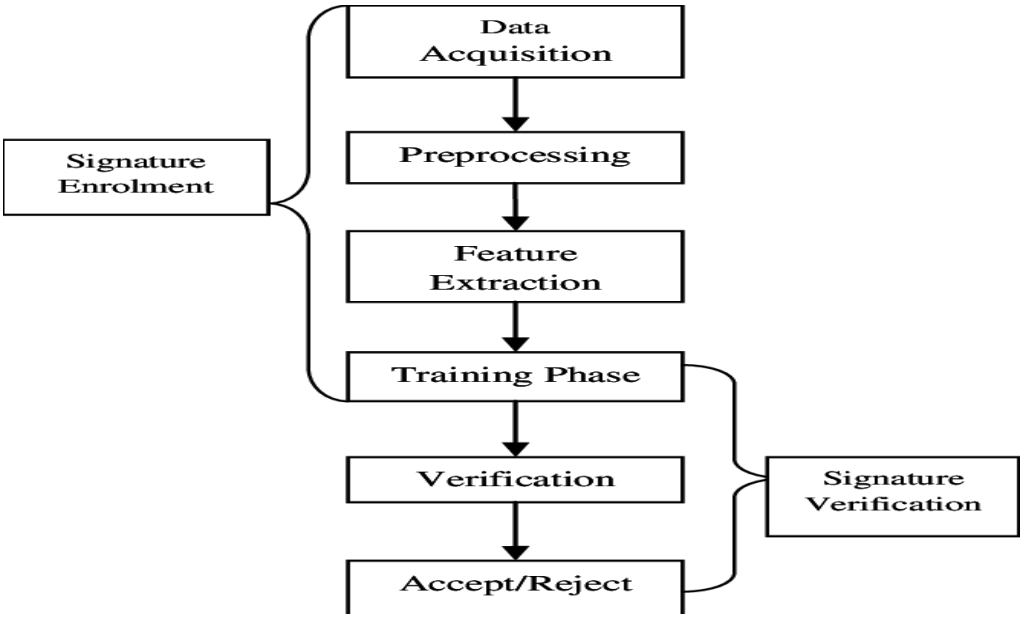


VI. FLOWCHART

1. User uploads a signature.
2. Preprocessing (grayscale conversion, noise removal, thresholding).
3. Feature extraction (black pixel detection, X-Y coordinates, theta calculation).
4. Signature alignment using extracted features.
5. Comparison with reference signature.
6. Result generation (genuine or forged).



VII. APPLICATIONS

1. Banking & Financial Services – Prevents fraud in cheque verification and financial transactions.
2. Legal Document Verification – Ensures authenticity in government-issued documents and contracts.
3. Forensic Investigation – Helps law enforcement detect signature forgeries.
4. Digital Identity Verification – Used in online identity verification for secure login systems.
5. Education Sector – Prevents document forgery in certificates and transcripts.

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VIII. OBJECTIVES

- Develop an automated system for verifying handwritten signatures.
- Implement image preprocessing and feature extraction for accurate verification.
- Improve authentication reliability using a theta-based matching approach.
- Ensure efficient signature alignment and comparison with stored reference signatures.
- Enhance security and fraud detection in document verification.

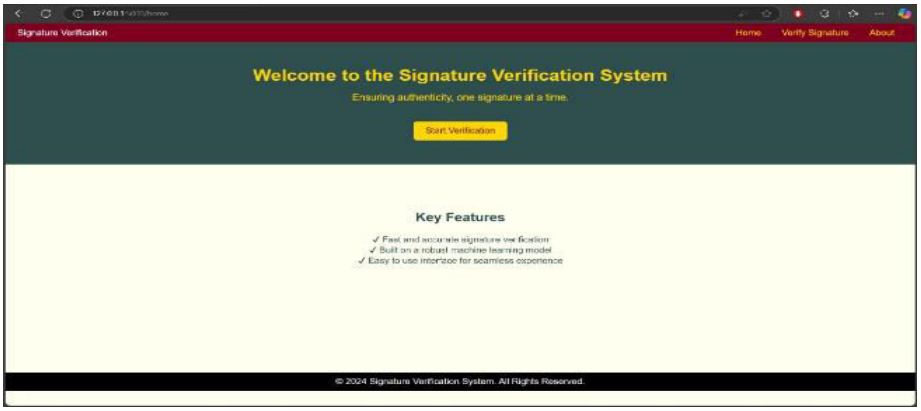
IX. ADVANTAGES

- Automated Verification – Reduces human errors in signature authentication.
- Security Enhancement – Detects forged signatures in sensitive transactions.
- Time Efficiency – Processes signatures quickly compared to manual verification.
- Scalability – Can be integrated with banking, legal, and digital security systems.
- Cost-Effective – Reduces dependency on human resources for authentication.

X. LIMITATIONS

- Accuracy Dependence on Image Quality – Poor lighting and resolution affect results.
- Limited Accuracy (40%-60%) – Can be improved using deep learning models.
- Computational Complexity – Requires processing time for feature extraction.
- Not Ideal for Complex Forgery – Advanced fraudsters may bypass theta-based matching.

XI. RESULTS



Dashboard Overview

Upload Image for Testing

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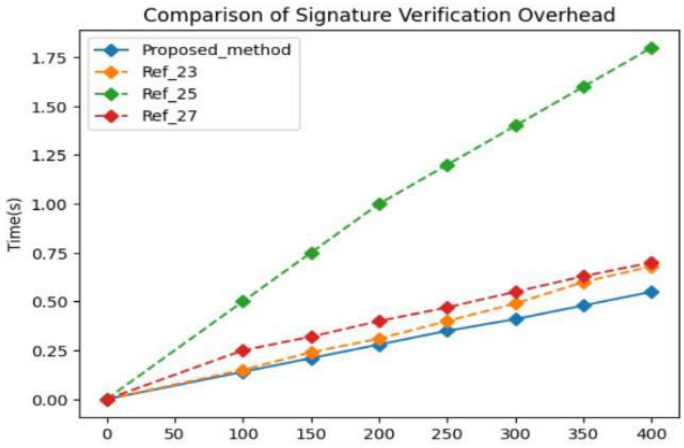
Results of Verifications



Comparison graph

XII. CONCLUSION

The proposed signature verification system efficiently authenticates signatures using image preprocessing and theta-based matching. The system normalizes, extracts, and aligns the signature before comparing it with stored references. While achieving an accuracy of 40%-60%, future enhancements using deep learning models like CNNs and Siamese networks can further improve verification performance. The project has significant applications in banking, legal document verification, and forensic investigations.

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