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Fake Currency Detection using Machine Learning and Computer Vision

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ABSTRACT: The Circulation of counterfeit money is a critical economic and social problem worldwide, calling for efficient detection systems. Conventional manual processes and UV scanning are time-consuming and prone to errors. This paper suggests an automated counterfeit currency detector system based on machine learning and computer vision. The system utilizes high-level image processing algorithms such as ORB (Oriented FAST and Rotated BRIEF) and SSIM (Structural Similarity Index Measure) for feature extraction and matching, and proprietary algorithms for unique security features such as bleed lines and number panels. Dependent on Python, OpenCV, and TensorFlow implementation, the system has high accuracy in detection of up to 83% against counterfeit notes and 80% against authentic notes and processes relatively fast with the processing time taken being around 5 seconds for each note. The framework poses promising applications for banking, retail, and police forces, toward financial security as well as consumer confidence.

KEYWORDS: Fake currency detection, Machine learning, Computer vision, ORB, SSIM, Image processing, Python, OpenCV.

I. INTRODUCTION

Counterfeit currency continues to be a critical concern for economies and financial institutions across the globe. The widespread circulation of fake currency not only undermines the integrity of monetary systems but also results in severe economic repercussions, including inflation, loss of public trust, and financial setbacks for businesses and individuals alike. Traditional counterfeit detection methods—such as manual inspection, UV scanning, and watermark checking—are not only time-consuming and labor-intensive but also susceptible to human error and inconsistency. These limitations highlight the urgent need for a more advanced, automated, and scalable solution.

This project aims to address these challenges by developing a sophisticated Fake Currency Detection System leveraging the power of image processing, computer vision, and machine learning algorithms. The proposed system is designed to efficiently analyze and verify the authenticity of currency notes through detailed examination of security features, pattern recognition, and structural similarity measures. By automating the detection process, the system significantly enhances accuracy, reduces the risk of human error, and increases operational efficiency.

Moreover, the integration of real-time processing capabilities and a user-friendly graphical interface ensures that this solution can be effectively utilized in various domains such as banking, retail, transportation, and law enforcement. Ultimately, this project aspires to strengthen financial security, prevent economic fraud, and pave the way for future innovations in currency authentication technology.

II. PROBLEMS OF COUNTERFEIT CURRENCY

The circulation of counterfeit currency constitutes a significant threat to the financial ecosystem, affecting economic integrity, institutional credibility, and public trust. Illegitimate notes infiltrate the money supply, contributing to inflation and reducing the real value of legitimate currency. This not only destabilizes the macroeconomic environment but also imposes direct monetary losses on businesses and consumers. Small-scale enterprises, in particular, are highly vulnerable due to limited detection capabilities. Furthermore, the presence of counterfeit currency necessitates increased governmental spending on advanced security features, enforcement mechanisms, and public awareness

campaigns. It places an added burden on law enforcement and regulatory bodies, diverting resources from other critical areas such as cybercrime and economic policy enforcement.

On an international scale, counterfeit currency operations can strain diplomatic relations and hinder cross-border financial cooperation. These multifactorial impacts underscore the urgent need for automated, scalable, and technologically advanced solutions to detect and prevent the circulation of counterfeit currency needed.

III. METHODOLOGY

The suggested counterfeit currency detection system utilizes a pipeline-based structured approach involving image processing, feature analysis, and machine learning algorithms to authenticate the genuineness of ₹500 Indian currency notes. The system is developed in Python with OpenCV, scikit-image, and Tkinter libraries.

A labelled dataset was prepared containing images of both real and counterfeit ₹500 notes, captured under varying lighting and orientation conditions. Ten specific security features were extracted as templates, including:

₹500 inscriptions (English & Devanagari), RBI logos (Hindi & English), Ashoka Pillar emblem, RBI seal, Number panel, Left and right bleed lines.

Key security features are detected using the ORB (Oriented FAST and Rotated BRIEF) algorithm, which identifies keypoints and descriptors with rotation invariance and high efficiency. Matched regions are evaluated using the Structural Similarity Index Measure (SSIM), which calculates a similarity score (range: -1 to 1) based on luminance, contrast, and structure.

A feature is validated if:

- The average SSIM score exceeds a pre-set threshold, or
- Any individual template yields a high match (e.g., $SSIM \geq 0.8$).

Regions on the left and right edges of the note are cropped and binarized through thresholding. Each column is scanned to detect black pixel transitions indicating bleed lines. Erroneous columns are discarded, and a valid average line count (~5 for ₹500 notes) confirms the feature.

Each feature is assessed individually, and the system determines authenticity based on the number of features that pass (threshold: ≥ 9 out of 10). Results are presented via a Tkinter GUI, showing:

- Feature status (pass/fail)
- SSIM scores and visual markers
- Final classification (genuine/fake)

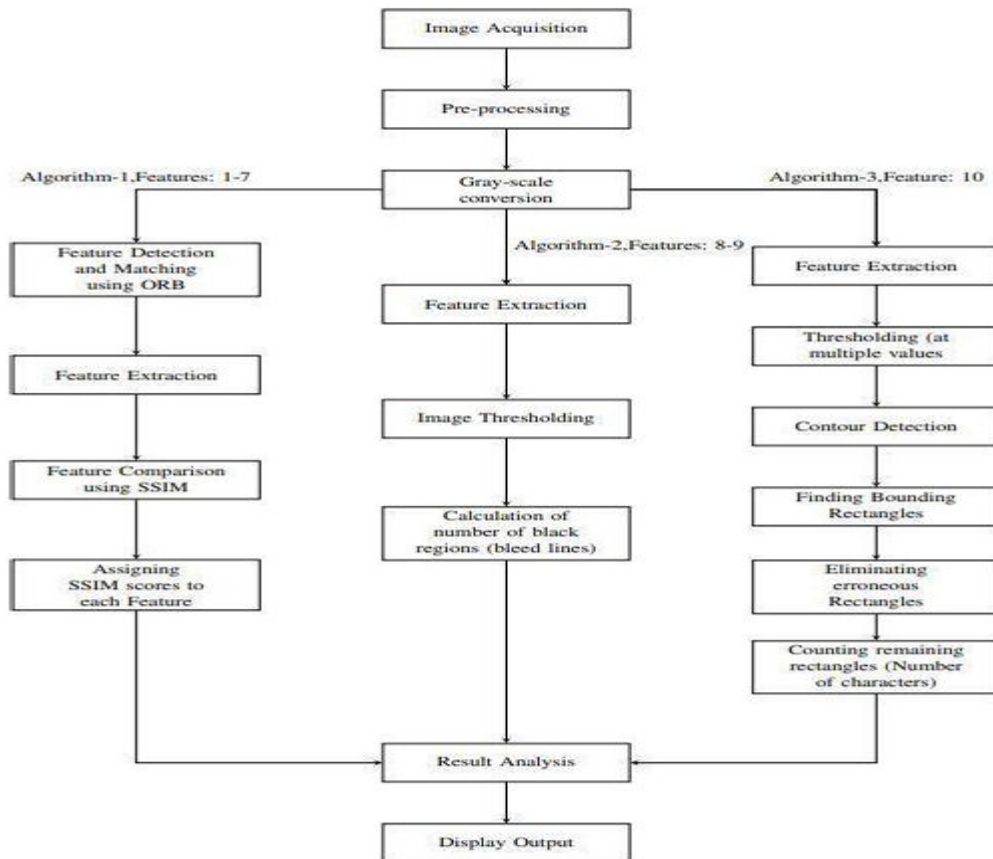


Fig 3.1 Data Flow Diagram

IV. EXPERIMENTAL RESULTS

The system of fake currency detection, as proposed, was tested using a dataset of varying kinds including genuine and forged ₹500 Indian currency notes. The analysis of performance proved promising with the system delivering an accuracy rate of about 80% for genuine and 83% for forged notes. These percentages were established using the criteria that a note can be declared as genuine if not less than 9 out of 10 security features are detected accurately.

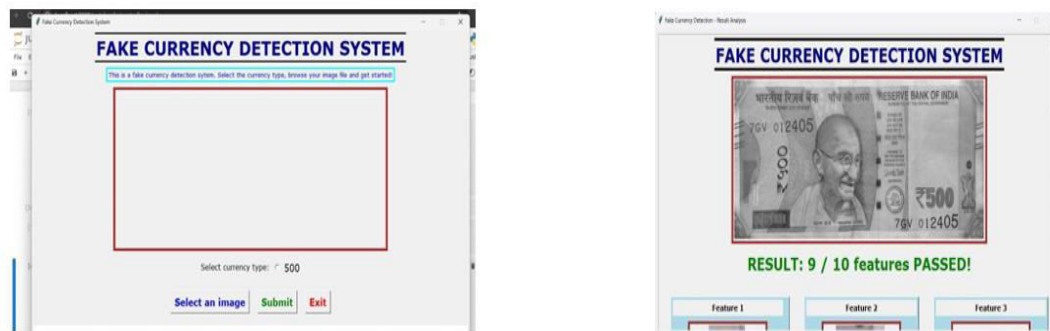


Fig 4.1 Display Output

Every note was subjected to feature-by-feature validation via SSIM-based image similarity rating and algorithmic examination for visual patterns, bleed lines, and serial number form. The mean processing time averaged around 5 seconds per note when showing only final results, and the system is thus ready for near real-time use. Aside from speed and accuracy, the system also prioritized security and reliability in its design.

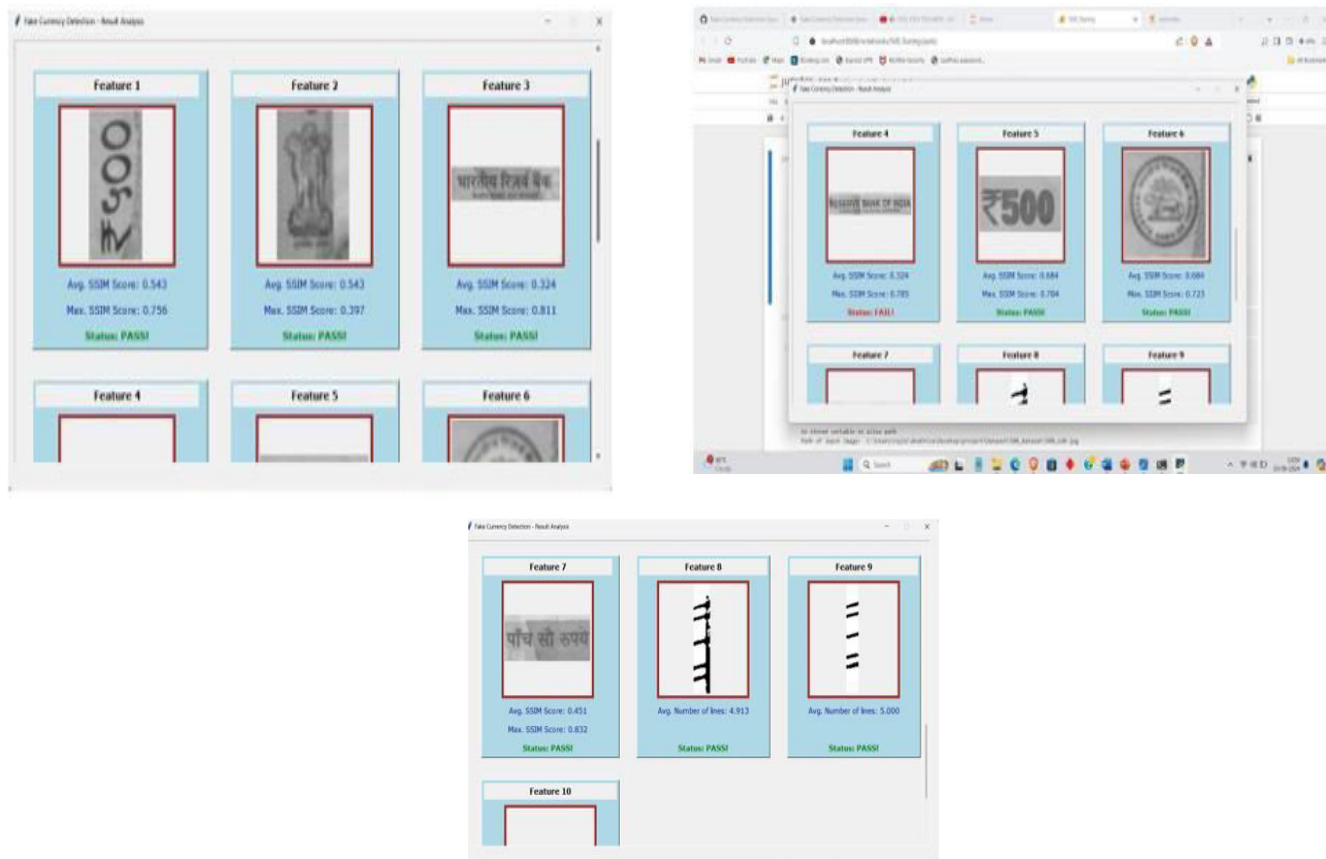


Fig 4.2 Analysis using SSIM score, anomaly detection and bleed lines

Major considerations were secure handling of data via encryption, tamper-resistant design to ensure system integrity, and access control features like role-based access and user authentication to avoid misuse. Software-level protections involved periodic patching, secure coding techniques, and sandboxed execution environments to reduce vulnerabilities. In addition, data integrity was maintained through checksums and hashing mechanisms, while system resilience was facilitated through backup processes and incident response procedures. These features collectively assure that the system not only operates efficiently in detecting counterfeits but also satisfies essential criteria for operational security, reliability, and scalability—making it a solutions-ready candidate for deployment in financial institutions, retail establishments, and law enforcement settings.

V. CONCLUSION

In this paper, an artificial currency detection model for Indian currency note authentication of denomination 500 and 2000 is proposed and implemented using OpenCV image processing library in Python3. In this model, 10 features of the input currency note are used and then processed using 3 different algorithms. The input image is passed through a GUI which facilitates the user to view the image in his/ her machine. Subsequently, the results of the model deployed are calculated, and the analysis of every feature is exhibited in detail through a graphical user interface(GUI) developed by Tkinter GUI library. The model is less time-consuming (approximately 5 sec- when only results are displayed

without unnecessary details) in processing an input image. The results are also very good, providing nearly 79% accuracy in identifying real money and 83% accuracy in identifying counterfeit money

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