iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** III **Month of publication:** March 2025

DOI: https://doi.org/10.22214/ijraset.2025.67938

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

Fake Indian Currency Detection System

Prof. P.S. Purohit[1], Sanika Dattatraya Bhosle[2], Ashish Hemant Ghatule[3], Tejaswini Vijay Kolekar[4], Ritesh Arvind Kataktalware[5], Vishal Ramkrishna Patil[6]
[1]*Professor* [2-6]*Student, Department of Computer Engineering, AGIT's Dr. Daulatrao Aher College of Engineering, Karad*

***Abstract:** This project introduces a new method of counterfeit Indian currency detection based on machine learning. It integrates image processing methods with sound classification algorithms, and the system examines digital images of banknotes to detect inconsistencies that point to counterfeiting. The method includes image pre-processing, feature extraction. The performance of the proposed method is tested using stringent experimentation on a real and spurious Indian banknote dataset and shows promise of being useful for real-world applications in the prevention of currency forgery.*
***Keywords:** Image processing, Feature extraction, counterfeited or real currency.*

I. INTRODUCTION

Currency counterfeiting is a global problem with severe economic and social consequences. It erodes public confidence in the financial system, destabilizes markets, and funds illicit activities. In India, the circulation of fake Indian Rupees (INR) has been a long-standing concern, impacting businesses, financial institutions, and the general public. Regular approaches to detecting counterfeits, based on visual examination and specialized tools, may be labour-intensive and subject to human mistake. This project examines the use of machine learning methods for automating and improving detection of Indian counterfeit banknotes, with a faster, more precise, and scalable solution. The fast pace of machine learning and image processing has created new opportunities to tackle sophisticated challenges such as detecting counterfeit currency. Such technologies have the ability to scan complex patterns and features in images and provide highly accurate identification of forgeries. This project takes advantage of this development to create a system for spotting fake Indian currency. Using advanced algorithms and image analysis, the system is intended to automate the counterfeit detection process with enhanced efficiency and accuracy over conventional methods. The Reserve Bank of India (RBI) incorporates different security features in Indian currency notes to prevent counterfeiting. Yet, advances in printing and reproduction technologies make it increasingly difficult to differentiate real currency from high-tech forgeries. The manual verification process often proves inadequate in handling the large volumes of currency transactions. This project focuses on developing an automated system using machine learning to detect counterfeit Indian currency. By analysing digital images of banknotes and extracting key features, the system aims to provide a reliable and efficient tool for identifying fake currency, thereby protecting the Indian economy from the adverse effects of counterfeiting.

II. BASIC CONCEPT

The overall idea with the application of machine learning in counterfeit Indian currency identification is having the computer learn the fine line distinguishing real money and fake money.

A. Here is the Explanation

1) Data Acquisition: The first step is to acquire a large set of images of both real and fake Indian banknotes. The dataset must be varied, encompassing various denominations, print years, and states. The quality of the dataset determines the performance of the system.
2) Image Pre-processing: The images are pre-processed to improve their quality and prepare them for analysis.
3) Feature Extraction: The essence of the process. The system extracts pertinent features from pre-processed images that differentiate authentic banknotes from fakes.

The features may encompass:

- Texture: Examination of patterns and pixel intensity variations (e.g., through the use of Gabor filters or wavelet transformations).
- Edges: Identifying abrupt transitions in pixel intensities, corresponding to lines and boundaries (e.g., by the use of Canny edge detection).
- Security Features: Determining the presence and integrity of features such as the security thread, watermark, microprinting, and intaglio printing. This is usually done using specialized image processing techniques.
- Colour Analysis: In case colour is employed, examination of the spectral properties of the ink.

4) Machine Learning Model Training: The features are then utilized to train a machine learning model. This is done by providing the model with the feature data and the respective labels (authentic or fake). The model learns to recognize patterns and relationships between the features and the banknote's authenticity.

Popular machine learning algorithms for this purpose are:

- Support Vector Machines (SVM): Suitable for high-dimensional data and complicated classification problems.
- Convolutional Neural Networks (CNN): Strong for image processing, learning relevant features from the images automatically.
- Random Forests: An ensemble technique that uses several decision trees to make more accurate and robust predictions.

5) *Testing and Evaluation:* Following training, the model is tested on a new dataset of images it has not been exposed to before. This tests the model for its generalizability and the ability to correctly classify new banknotes. Accuracy, precision, recall, and F1-score are used as measures of performance to test the model's efficacy.
6) *Deployment:* Once the model performs to a good standard, it can be deployed as part of a real system, e.g., a mobile application or a specific hardware appliance, for the automatic detection of counterfeits.

In other words, the system becomes familiar with the "fingerprint" of authentic banknotes through their visual features. Based on the learned patterns and by comparing the unknown banknote features, the system is able to decide whether the banknote is authentic or not. The point here is to utilize high-quality image processing and machine learning methods to identify and inspect the most significant features.

III. LITERATURE REVIEW

1) This work focuses on the detection of counterfeit currency through various machine learning techniques. Traditional machine learning algorithms are utilized to analyse and identify counterfeit currency based on specific features such as texture, color, and shape. By leveraging classification models, the study demonstrates how machine learning can accurately detect fake notes, with a significant emphasis on automating the detection process. The findings suggest that this approach can enhance efficiency in banking systems and security operations.
2) This research introduces "Sahayaka," a fake currency detection application designed specifically for visually impaired individuals. The application combines image processing and machine learning algorithms to analyse currency notes and provide auditory feedback on whether the note is genuine or counterfeit. By using optical character recognition (OCR) and feature extraction techniques, the system distinguishes real from fake currency. The integration of assistive technology with counterfeit detection offers a valuable solution to make currency validation more accessible to the visually impaired.
3) This study explores the combination of image processing and machine learning classifiers for identifying counterfeit Indian currency. It involves pre-processing currency images to extract features such as colour histograms, edge patterns, and texture information, which are then analysed using classifiers such as Support Vector Machines (SVM) and Random Forests. The results show that these methods can achieve high accuracy in distinguishing between genuine and counterfeit notes, especially when trained on large, diverse datasets. The research highlights the effectiveness of hybrid methods that combine image processing and machine learning.
4) This work explores the application of Deep Convolutional Neural Networks (CNNs) for detecting fake Indian currency notes. Deep learning techniques are used to automatically learn discriminative features from raw images, eliminating the need for manual feature extraction. The CNN model, trained on a large dataset of currency images, is capable of distinguishing real from counterfeit notes with impressive accuracy. The study highlights the advantages of CNNs for feature extraction and classification, offering a robust solution that can handle large-scale datasets and complex real-world scenarios.
5) This research focuses on traditional image processing techniques for fake currency detection. Methods such as edge detection, image segmentation, and texture analysis are used to identify distinguishing features of currency notes. The findings suggest that although these methods can achieve a good level of accuracy, they may struggle in environments with low-quality images. Nonetheless, the research provides a solid foundation for more advanced methods like machine learning and deep learning, showing that even basic techniques can be effective when combined with quality pre-processing.
6) This study proposes a system for the classification and detection of banknotes using machine learning algorithms. It compares various classification models, including decision trees, k-nearest neighbours (KNN), and neural networks, to classify currency notes as genuine or counterfeit. The research emphasizes the importance of feature selection and the use of image features such as symmetry, color patterns, and geometric shapes. The results indicate that ensemble methods can significantly improve classification accuracy compared to traditional approaches, thus advancing the automation of currency validation.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

IV. EXISTING SYSTEM

The current mechanisms to identify counterfeit Indian currency can be generally classified as traditional and advanced technological methods. Here is a division:

A. *Traditional Methods*

1) Manual Inspection: The most used technique, depending on human eye examination of security elements. Cashiers, tellers, and individuals are instructed to search for particular features such as:
   - Watermark: Holding the note up against light to inspect for the Mahatma Gandhi watermark.
   - Security Thread: Checking the visibility and presence of the security thread, which can be embedded or surface-visible.
   - Intaglio Printing: Touching the raised print on some areas of the note.
   - Microprinting: Checking the small text that is hard to replicate.
   - Latent Image: Holding the note at an angle to see the hidden images.

2) UV Light Detection: Applying ultraviolet (UV) lamps to detect fluorescent inks or fibres infused in authentic banknotes. Counterfeit currency can be devoid of these UV-reactive components or have varied fluorescence patterns.
3) Magnifying Glass: Utilizing magnification to examine fine details such as microprinting and security features.
4) Currency Detectors: Simple machines that employ basic sensors to verify some features such as magnetic ink or precise sizes.

B. *Shortcomings of Conventional Methods*

1) Human Error and Subjectivity: Human inspection is vulnerable to human error and subjectivity, particularly with the growing level of sophistication of counterfeits.
2) Time-Consuming: Manual authentication takes time, particularly in high-value transactions.
3) Ineffective Detection: Conventional approaches might not work against highly advanced forgeries that closely resemble genuine security features.
4) Scalability Challenges: Manual processes are not easy to scale for large-scale currency authentication.

C. *New Technological Solutions*

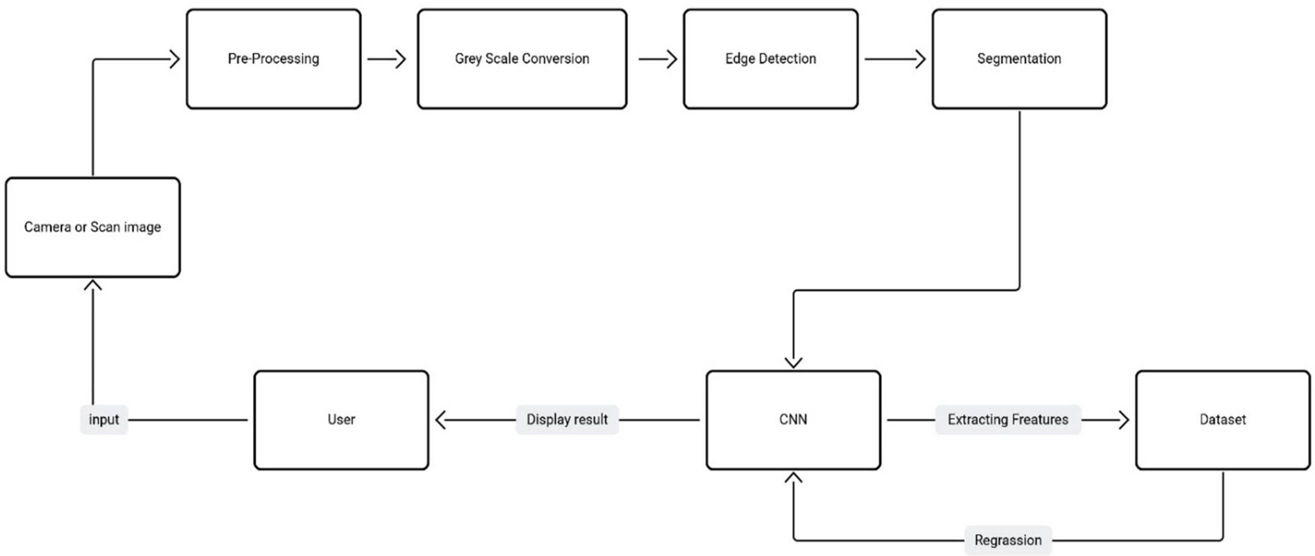
1) Machine Learning and Image Processing: These methods are becoming increasingly important for automated forgery detection. They include:
   - No. Image Acquisition: Digital imaging of banknotes with scanners or cameras.
   - No. Feature Extraction: Examining the images to isolate key features such as texture, edges, and security feature attributes.
   - No. Machine Learning Classification: Classifying machine learning algorithms to distinguish between genuine and forged banknotes based on the extracted features.
2) Spectroscopy: Examination of the spectral characteristics of the ink employed in banknotes. Various inks possess distinct spectral signatures that can be utilized for verification.
3) 3D Imaging: Taking 3D images of banknotes to examine the surface topography and identify differences in printing methods.

D. *Benefits of Technological Methods*

1) Automation and Speed: Automated systems are capable of processing large quantities of currency at high speed and efficiency.
2) Accuracy and Objectivity: Machine learning models can attain high accuracy and yield objective results.
3) Subtle Differences Detection: Sophisticated methods can identify subtle differences between authentic and fake banknotes that can be detected using human eye.
4) Scalability and Flexibility: Technology-based solutions can be scaled and modified with ease to new security features and counterfeiting methods.

In summary, though conventional methods remain relevant, increasing use is being made of technology-based solutions, especially image processing and machine learning-based solutions, for more effective, precise, and scalable counterfeit currency detection.

V. PROPOSED SYSTEM ARCHITECTURE



(a) System Architecture

VI. MODULES AND THEIR FUNCTIONALITY

A. Image Acquisition Module

1) Functionality
- Takes digital images of banknotes from different input devices such as flatbed scanners, digital cameras, or mobile phone cameras.
- Maintains uniform image quality by regulating aspects such as lighting, focus, and resolution.
- Can have provisions for automatic cropping or rotation of the input to standardize it.
- Supports various image formats (e.g., JPEG, PNG, TIFF).

2) Function: To get digital images of banknotes safely for subsequent processing.

B. Image Pre-processing Module

1) Operation
- Resizing: Resizes images to a common size to provide uniformity and minimize computational complexity.
- Grayscale Conversion: Transforms color images into grayscale, reducing processing complexity while frequently preserving necessary texture and edge information. Optional but can enhance efficiency.
- Noise Reduction: Adds filters (e.g., Gaussian blur, median filter) to eliminate noise and artifacts that may interfere with feature extraction.
- Image Enhancement: Tunes contrast, brightness, and sharpness to sharpen key features and enhance visibility. Methods such as histogram equalization or contrast stretching can be applied.
- ROI (Region of Interest) Extraction: Extracts the particular region of the banknote that includes important security elements (e.g., watermark zone, security thread position). This minimizes data to be analysed and directs attention to areas of interest.

2) Purpose: To facilitate feature extraction from the images by enhancing their quality, eliminating noise, and bringing them to a uniform format.

C. Feature Extraction Module

1) Functionality

- Texture Analysis: Unwraps texture features employing methods such as
- Gabor Filters: Extract texture details at various orientations and frequencies.
- Wavelet Transforms: Break down the image into various frequency components, showing texture patterns.
- Local Binary Patterns (LBP): Represent the local texture around every pixel by comparing it with its neighbours.
- Edge Detection: Detects edges and lines through algorithms such as Canny Edge Detection: A strong edge detection algorithm that detects sudden changes in pixel intensities.
- Security Feature Detection: Deploys algorithms specifically to detect and examine security features:
- Watermark Detection: Examining the variations in transparency within the image.
- Security Thread Detection: Detecting the existence, location, and appearance of the security thread.
- Microprinting Detection: Using high-resolution image examination and potentially optical character recognition (OCR) to detect and confirm microtext.
- Latent Image Detection: Examining the image at varying angles to show concealed images.
- Colour Analysis: Retrieves colour-based features such as colour histograms or colour moments.

2) *Purpose:* Retrieving measurable features from the pre-processed images that can be utilized for differentiating the authentic banknotes from counterfeits.

D. Machine Learning Classification Module

1) *Functionality*

- RTDBG Accepts the feature vector as input.
- Uses a pre-trained machine learning model to classify the banknote.
- Typical algorithms include:
- Support Vector Machines (SVM): Suitable for high-dimensional data and complicated classification tasks.
- Convolutional Neural Networks (CNN): Very efficient in image-based classification, usually employed when features are learned from images directly.
- Random Forests: A type of ensemble learning that uses many decision trees for better accuracy and reliability.
- Produces a classification result (authentic or fake) along with a confidence measure representing the model's confidence.

2) *Purpose:* To classify the banknote from the extracted features based on a trained machine learning model.

E. Decision and Output Module

1) *Functionality*

- Receives the classification result and confidence level from the ML module.
- Applies a decision threshold to the confidence level. If the confidence level is greater than the threshold, the classification is accepted; otherwise, the result can be flagged as uncertain or needing further analysis.
- Gives user-friendly output:
- Visual display (e.g., "Genuine," "Counterfeit," "Uncertain").
- Audio alerts.
- Logging of results for auditing and analysis.
- Can include provision for reporting suspicious banknotes to the appropriate authorities.

2) *Purpose:* To make a final decision based on the ML classification and provide clear and informative output to the user.

F. Database

1) *Functionality:*

- Stores the training dataset (images of genuine and counterfeit banknotes).
- May store extracted features for analysis and model retraining.
- Can be used to store logs of transactions and classification results.
- Allows for database updates with new counterfeit samples to improve model performance over time.

2) *Purpose:* To serve as a repository for data utilized in training, testing, and operation of the system, facilitating model enhancement and data analysis.

By establishing the purpose of each module clearly, you develop a well-organized and maintainable system for detecting fake Indian currency.

VII. ADVANTAGES OF PROPOSED SYSTEM

The proposed machine learning-based system for detecting fake Indian currency has several benefits over conventional methods and some less complex technological solutions:

1) More Accuracy and Objectivity: Deep learning models, such as CNNs, machine learning models tend to be more accurate in their ability to recognize counterfeits than manual analysis or simple sensor-based detectors. The system derives objective results depending on learned patterns, minimizing human error and subjectivity.
2) Automated and Speedier Processing: The system's automated aspect enables speedy processing of large amounts of banknotes, making it much more efficient than manual checking, which is time-consuming and labour-intensive.
3) Subtle Counterfeit Detection: High image processing and machine learning algorithms can identify subtle variations between authentic and forged banknotes that would go undetected by human eye or lesser detection techniques. These vary in texture, microprints, and other security features.
4) New Counterfeiting Methods Adaptability: Through the retraining of the machine learning model using fresh samples of counterfeits, the system is able to adjust to changing counterfeiting methods and remain effective in the long run. This ability to adapt is a huge benefit over fixed detection systems.
5) Reduced Reliance on Human Expertise: The system reduces the reliance on specialized human expertise for counterfeit detection. This makes it easier to deploy the system in various settings, even where trained personnel are not readily available.
6) Scalability and Cost-Effectiveness: The system can be scaled at will to support heavy loads of currency transactions, thus being applicable for banks, financial institutions, and other large-scale organizations dealing with huge cash amounts. Though an initial development and training cost is incurred, long-term cost-effectiveness is increased with lesser labour costs and better efficiency.
7) Enhanced Security: The system enhances overall security by providing a more reliable and efficient method for detecting counterfeit currency, helping to protect the economy and financial system from the negative impacts of counterfeiting.
8) Consistent Performance: Unlike human inspectors whose performance can vary based on fatigue or other factors, the automated system provides consistent performance around the clock.
9) Data Logging and Analysis: The system has the capability of logging transaction information and classification outputs, generating important data for auditing and analysis purposes. Such data can be employed to monitor counterfeiting trends and continually refine the system's performance.
10) Integration with Current Systems: The system can also be integrated into existing currency handling systems, such as automated teller machines (ATMs) or cash counting devices, and in the process expand their capability.

In conclusion, the suggested machine learning-based system presents a more efficient, accurate, adaptable, and scalable solution for detecting counterfeit Indian currency than conventional approaches and less advanced technological methods, leading to a safer and more stable financial environment.

VIII. RESULT

A. *Types of Results*

- Accuracy: Most frequent measure, the total percentage of accurately identified banknotes (genuine and counterfeit). High accuracy is desired (i.e., over 95%, but it will vary based on how complicated your counterfeits are in your sample).
- Precision: Of all banknotes labelled as counterfeit, how many were they actually? High precision keeps false positives (genuine notes erroneously identified as fake) to a minimum.
- Recall: Among all the genuine counterfeit banknotes in the sample, what fraction were accurately labelled? High recall reduces false negatives (false notes misclassified as real).
- Confusion Matrix: A table to display the results of classification, with the amount of true positives, true negatives, false positives, and false negatives. It is used to see where the model is failing.
- ROC Curve and AUC: The Receiver Operating Characteristic (ROC) curve is a plot of the true positive rate against the false positive rate at different1 threshold settings. The Area Under the Curve (AUC)2 is a measure of the classifier's overall performance at all thresholds.
- Processing Time: How many seconds does the system take to process one banknote? This is relevant to real-world use.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

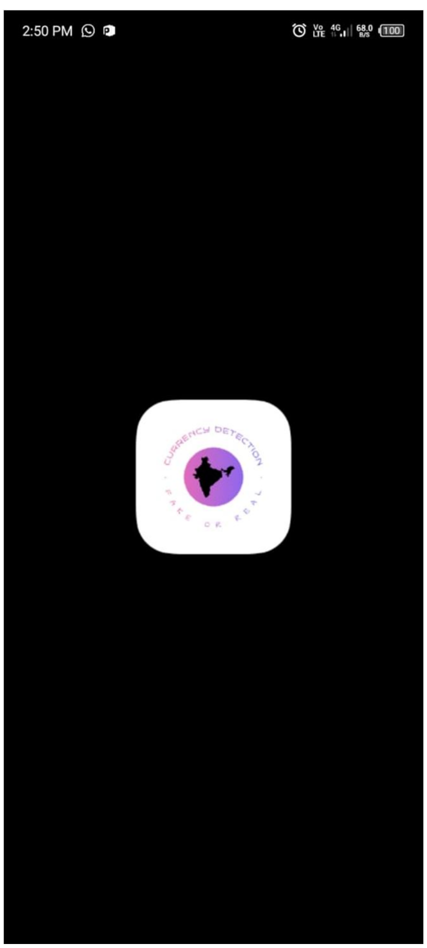
B. Presenting Results

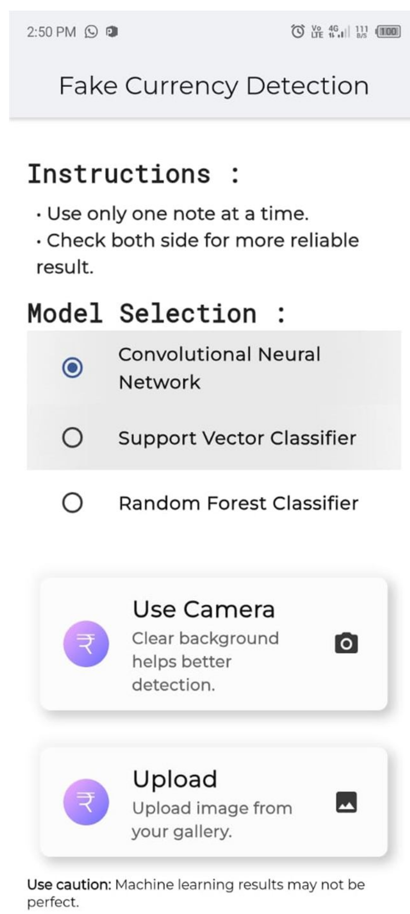
- Tables: Present the performance measurements (accuracy, precision, recall, F1-score) clearly using tables in different models or experimental configurations.
- Graphics: Use plots (e.g., bar plot, line graph) to compare the performance of various models using graphics. You may, for instance, display the accuracy of various models using a bar graph.
- Confusion Matrix: Present the confusion matrix in order to reflect the detailed results of classification.
- ROC Curve: Plot the ROC curve and provide the AUC value to indicate the overall performance of the classifier.
- Comparison with Existing Methods: If feasible, compare your results with existing methods' performance (e.g., manual inspection, less complex detectors) to illustrate the merits of your proposed system.
- Discussion: Explain your results and discuss their meaning. Describe the reasons why particular models outperformed others. Discuss the restrictions of your system and propose enhancements in the future.

Example of Result Presentation:

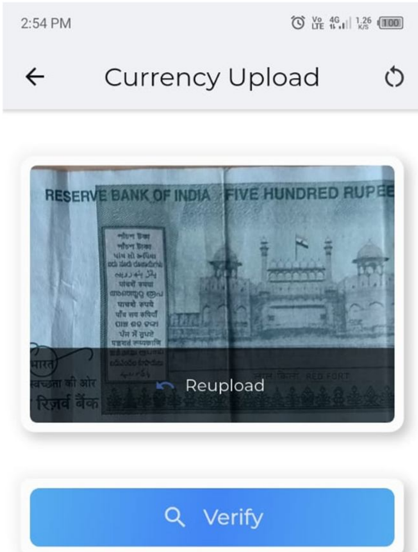
Model	Accuracy	Precision	Recall	F1-Score
Support Vector Machine (SVM)	92.5%	90.1%	95.2%	92.6%
Convolutional Neural Network (CNN)	98.2%	97.8%	98.5%	98.1%
Random Forest	95.7%	94.5%	96.8%	95.6%

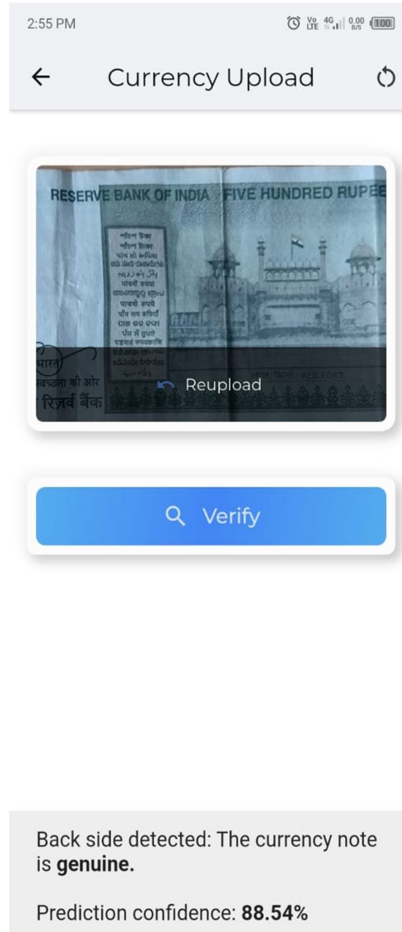
"As shown in Table 1, the CNN model achieved the highest accuracy (98.2%), precision (97.8%), recall (98.5%), and F1-score (98.1%), demonstrating its superior performance compared to the SVM and Random Forest models. This suggests that the CNN's ability to automatically learn relevant features from the images is particularly effective for this task."





ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com





IX. CONCLUSION

The project created a machine learning-based system for the detection of counterfeit Indian currency with promising results in the identification of counterfeit banknotes. The performance of the system, however, relies on the quality and diversity of the training dataset. Future research will include increasing the dataset to cover more types of counterfeits, investigating more sophisticated feature extraction methods, and optimizing the machine learning algorithms for higher accuracy and resistance. In addition, investigating real-time deployment and integration with current currency processing equipment is an essential next step.

REFERENCES

[1] Sanyal, S., Kaushik, A., & Gandhi, R. "Spurious Currency Detection using Machine Learning Techniques." 2024 International Conference on Automation and Computation (AUTOCOM)

[2] P. S, S. C, V. Padmapriya, and S. Uma. "Sahayaka: A Fake Currency Detector Application for Visually Impaired Individuals." 2024 IEEE International Conference for Women in Innovation, Technology & Entrepreneurship (ICWITE)

[3] Vivek Sharan, Amandeep Kaur, Parvinder Singh. "Identification of Counterfeit Indian Currency Note using Image Processing and Machine Learning Classifiers." Proceedings of the Third International Conference on Artificial Intelligence and Smart Energy (ICAIS 2023)

[4] Kara, S. T., Loya, S., Raju, S. S., Vanteru, N., & Rajulapati, B. "Detection of Fake Indian Currency Using Deep Convolutional Neural Network." 2023 IEEE 3rd Mysore Sub Section International Conference (MysuruCon)

[5] Shinde, S., Wadhwa, L., Naik, S., Kudale, R., Sherje, N., & Mohnani, K. "Fake Currency Detection using Image Processing." 2023 7th International Conference on Computing, Communication, Control and Automation (ICCUBEA)

[6] Kumar, C. P., Yadav, M. G., Praneetha, K., Rushikesh, M., & Shreya, R. R. "Classification and Detection of Banknotes using Machine Learning." 2023 5th International Conference on Inventive Research in Computing Applications (ICIRCA)