

Research Paper

Automated Currency Detection Using Feature Extraction and Hybrid Classification Models

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Abstract: The circulation of counterfeit currency poses a serious threat to economic stability, making accurate detection essential. This paper presents a hybrid approach combining image processing, machine learning algorithms, and YOLO-based deep learning for effective fake currency detection. The system extracts features such as texture, shape, and color, and applies classification models to distinguish genuine and counterfeit notes with high accuracy. Experimental results demonstrate improved performance, reliability, and real-time detection capability compared to traditional methods.

Index terms - — Fake Currency Detection, Machine Learning, Image Processing, Deep Learning, YOLO, Feature Extraction, Classification Algorithms, Banknote Authentication, Computer Vision, Pattern Recognition.

1. INTRODUCTION

Many people do financial transactions every second, and our currencies are valuable [3]. Fake notes are circulated to disrupt the financial market. Because counterfeit notes seem so authentic, investors are puzzled. They are unlawfully manufactured to do

numerous tasks [12]. Forgery has been increasing since the late 19th century, although as of 1990, it is not a major problem [13]. The 20th century has seen enormous technological advancements, which have made it simpler for fraudsters to counterfeit genuine notes [1]. Thus, the financial market will bottom out. To prevent this and ensure ongoing transactions, secure falsified bank currency [16]. Humans have trouble distinguishing real and fraudulent bank money. Governments have designed banknotes with characteristics that help us verify their validity [9]. However, fraudsters are generating imitation notes with identical characteristics and excellent precision, making them hard to spot [5]. Thus, financial institutions and ATMs must have a system that can distinguish legitimate notes from counterfeit ones [12]. AI and ML may be needed to create a system that can distinguish real banknotes from fakes [6,7,12]. Banknote authenticity may be assessed using this approach. In recent years, supervised machine learning (SML) techniques to categorization have gained prominence. The medical outcomes are extremely promising [2]. Very few writers have authenticated bank cash using SML algorithms [6–9,

12]. An automated approach is needed to verify a letter's authenticity. The input is a note image, and we may extract its attributes using various image processing approaches. These photos are also submitted to SML algorithms to verify message validity. An examination indicates little effort in this area

2. LITERATURE SURVEY

a) Fake currency detection using image processing:

The market has always had a lot of issues due to the problem of fake currency. Growing technical developments have made it possible to produce more counterfeit money, which circulates in the market and weakens the nation's economy as a whole. Banks and other business locations have devices that verify the legitimacy of the currency. However, since the average person lacks access to these systems, a program that can identify counterfeit money becomes necessary. Image processing is used by this suggested method to determine if the money is real or fake. The Python programming language is used throughout the system's architecture. It includes processes like segmentation, edge detection, grayscale conversion, and others that are carried out with appropriate techniques.

b) Recognition of Fake Currency Based on Security Thread Feature of Currency:

Due to significant technology advancements in color printing, duplication, and scanning over the past several years, counterfeiting issues have gotten worse. In the past, only authorized printing houses could produce currency paper, but with the aid of contemporary technologies like computers and laser

printers, anybody can now generate counterfeit banknotes. In practically every nation, fake notes are a major concern. Almost every nation has a problem with counterfeit money, but India has been particularly hard struck and the issue is now rather serious. The system appears to be overrun with counterfeit Indian rupees worth 100, 500, and 1000 rupees, and the average individual has no way to handle them. It is necessary to create a system that can quickly and efficiently recognize paper money. Our technique outlines a method for checking banknotes made in India and other nations. Image processing methods will be used to verify the cash.

c) Android Based Currency Recognition System for Blind:

Many illicit counterfeiting organizations have produced and sold counterfeit coins in recent years, and they have also manufactured counterfeit cash, which has resulted in significant losses and harm to society. Therefore, being able to identify counterfeit money is essential. Using these photos, we suggest a novel method for identifying counterfeit Indian banknotes. The dissimilarity space, a vector space created by comparing the image with a collection of prototypes, is where currency images are represented. Every measurement quantifies how different the image under evaluation is from a prototype. The local key points on each picture are identified and defined in order to determine the dissimilarity between two images. The matching critical features between the two photos may be efficiently determined based on the properties of the currency. To eliminate mismatched important points, a post-processing method is further suggested. Since there aren't many fake currencies in the actual world, SVM is used to

detect them, therefore the classifier just needs real currency to be trained.

d) A Review Paper on Currency Recognition System:

This study discusses an algorithm for cash identification that is based on the frequency domain feature extraction approach. This technique effectively recognizes a banknote picture by utilizing its local spatial properties. In order to create a currency identification system, the complete system is pre-processed for the best and most effective use of the two-dimensional discrete wavelet transform (2D DWT). The estimated efficient matrix is then used to derive a collection of coefficient statistical moments. Currency notes may be recognized, categorized, and retrieved using the extracted characteristics. The categorization outcome will make it easier to identify counterfeit money, primarily through the use of OCR to extract serial numbers. It is discovered that the suggested approach produces better outcomes.

e) Using Hidden Markov Models for Feature Extraction in Paper Currency Recognition:

In order to recognize paper money, this research suggests a novel feature extraction method. This method uses the textural characteristic for recognition. The texture of paper money has been modeled as a random process using the Markov chain idea. Paper money from many nations may be recognized using the technique described in this paper. The system is trained using only complete instances of paper money from each denomination. We tried this approach on over 100 denominations from various nations, and the machine successfully identified 95% of the data.

3. METHODOLOGY

i) Proposed Work:

The suggested method uses image processing and machine learning to detect fraudulent currencies. The technology first preprocesses a dollar note picture to increase quality and reduce noise. Advanced image processing extracts texture patterns, edges, security markings, and structural elements. Features are extracted and sent to machine learning or deep learning algorithms for categorization. A more accurate and reliable model predicts whether a dollar note is real or counterfeit. The suggested method develops a more efficient and intelligent detecting strategy for contemporary counterfeit note designs.

ii) System Architecture:

The proposed system follows a structured pipeline that begins with image acquisition and preprocessing. The user uploads a currency image, which is then validated and processed using techniques such as grayscale conversion, noise removal, and segmentation to enhance important features. After preprocessing, the system extracts key features including shape (Hu Moments), texture (Haralick), color (histogram), and local descriptors (SIFT with BOVW), which provide meaningful information required for accurate classification.

These extracted features are then passed to machine learning classifiers such as SVM, Random Forest, and KNN to determine whether the currency is genuine or counterfeit. Additionally, a YOLO-based deep learning model is integrated to perform real-time object detection and localization of the currency note, improving system accuracy and speed. Finally, the system outputs the classification result along with

confidence levels and, if applicable, displays the detected regions using bounding boxes.

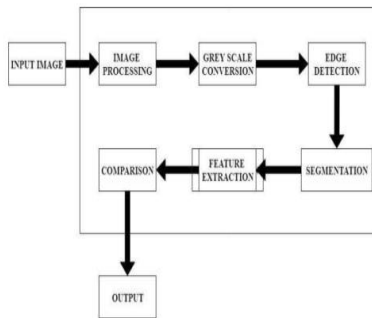


Fig. 2 Architecture diagram of proposed System

Fig1 proposed architecture

iii) Modules:

1. Image Acquisition Module

- Captures or uploads currency images from the user
- Ensures proper format and quality of input images

2. Preprocessing Module

- Converts image to grayscale and removes noise
- Enhances image quality and performs segmentation

3. Feature Extraction Module

- Extracts features like Hu Moments (shape), Haralick (texture), Histogram (color), and SIFT (local features)
- Converts image data into numerical feature vectors

4. YOLO Detection Module

- Performs real-time object detection on currency images
- Identifies and localizes important regions using bounding boxes

5. Output Module

- Displays prediction result (Fake/Genuine)
- Shows confidence score and processed image output

iv) Algorithms:

images and known genuine or fake samples.

4. YOLO (You Only Look Once)

YOLO is a real-time object detection algorithm based on deep learning. It divides the image into grids and predicts bounding boxes along with class probabilities in a single pass. In this system, YOLO is used to detect and localize currency notes within the image, improving detection speed and enabling real-time analysis.

4. EXPERIMENTAL RESULTS

The proposed system was evaluated using a dataset of currency images, including multiple denominations and different lighting conditions. The implementation was carried out using Python with libraries such as OpenCV, Scikit-learn, and TensorFlow. The system processes input images through preprocessing, feature extraction, and classification stages to predict whether the currency is genuine or counterfeit.

The results demonstrate that the hybrid approach combining feature extraction and machine learning algorithms achieves high classification accuracy. The integration of YOLO further improves real-time detection by accurately localizing currency regions,

as observed in the output interface where the system detects a rupee note with high confidence. Additionally, visualization tools such as confusion matrices indicate strong model performance with minimal misclassification.

Accuracy: A test's accuracy is its capacity to distinguish healthy from ill cases. Find the percentage of instances with genuine positives and negatives to assess test accuracy.

$$\text{Accuracy} = \frac{TP + TN}{(TP + TN + FP + FN)}$$

$$\text{Accuracy} = \frac{(TN + TP)}{T}$$

Precision: Classification accuracy or positive cases constitute precision. The formula for accuracy is:

$$\text{Precision} = \frac{\text{True positives}}{(\text{True positives} + \text{False positives})} = \frac{TP}{(TP + FP)}$$

$$\text{Precision} = \frac{TP}{(TP + FP)}$$

Recall: A model's recall measures its ability to recognize all appropriate machine learning class instances. The ratio of accurately predicted positive observations to total positives indicates a model's class instance detection skill.

$$\text{Recall} = \frac{TP}{(FN + TP)}$$

mAP: Mean Average Precision ranks quality. It considers the number and order of relevant ideas. Calculating MAP at K uses the arithmetic mean of each user or query's Average Precision (AP).

$$mAP = \frac{1}{n} \sum_{k=1}^{k=n} AP_k$$

$AP_k = \text{the AP of class } k$
 $n = \text{the number of classes}$

F1-Score: A high F1 score suggests an accurate machine learning model. Integrating recall and precision improves model correctness. Accuracy measures how often a model predicts a dataset correctly.

$$F1 = 2 \cdot \frac{(\text{Recall} \cdot \text{Precision})}{(\text{Recall} + \text{Precision})}$$

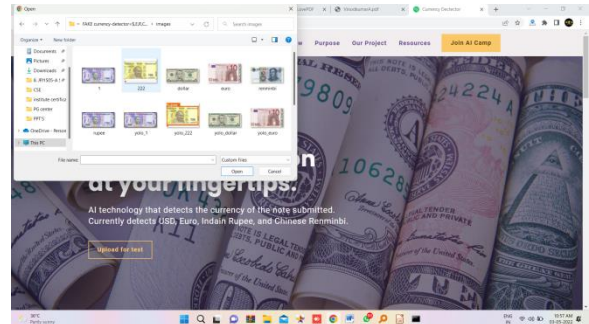


Fig2 Uploaded image

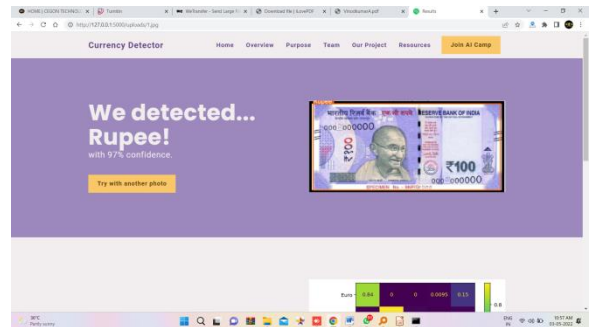


Fig3 Results

5. CONCLUSION

This paper presented a hybrid approach for fake currency detection by integrating image processing, feature extraction techniques, machine learning algorithms, and YOLO-based deep learning. The system effectively extracts meaningful features such

as shape, texture, and color, and uses them for accurate classification of genuine and counterfeit notes. The inclusion of YOLO further enhances the system by enabling real-time detection and localization of currency images.

Experimental results demonstrate that the proposed system achieves high accuracy, reliability, and efficiency compared to traditional methods. The automated approach reduces human effort and provides a scalable solution for banking and financial applications. Overall, the system proves to be effective in detecting fake currency under various conditions and can be extended for practical real-world deployment.

6. FUTURE SCOPE

The proposed system can be further enhanced by incorporating advanced deep learning models such as CNNs and Transformer-based architectures to improve detection accuracy and robustness. Expanding the dataset to include more currency types, worn-out notes, and different environmental conditions will help in building a more generalized and reliable model. Integration with mobile applications can enable real-time fake currency detection for common users.

Additionally, the system can be deployed in banking systems, ATMs, and vending machines for automated verification. Future work may also include multi-currency support, counterfeit detection using security features like watermark analysis, and integration with blockchain technology for secure currency validation. These improvements will make the system more scalable, efficient, and suitable for real-world applications.

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