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Verification of the Authenticity of Indian Currency

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ABSTRACT—

The proliferation of Spurious bills poses a significant threat to both individual livelihoods and national economies. Despite the availability of Spurious bills detectors in banks and corporate settings, ordinary citizens and small businesses remain susceptible. This project aims to address this vulnerability by examining the Anti-counterfeiting measures and developing a software-based solution for detecting and invalidating counterfeit Indian currency using advanced Digital imaging and Machine vision techniques. The proposed currency authentication system is implemented entirely in Python within the Jupyter Notebook environment.

Keywords—Counterfeit currency, counterfeit detection, image processing, feature extraction, Bruteforce matcher, ORB detector.

I. Introduction

Counterfeiting currency, a practice where fake currency notes are illegally produced by imitating the genuine manufacturing process, presents a significant challenge globally. The proliferation of counterfeit currency not only diminishes the range legitimate money but also contributes to inflation by artificially inflating the money supply. Manual authentication methods, while effective, are time-consuming, prone to inaccuracies, and cumbersome. Hence, pressing need for automated currency testing systems capable of efficiently processing large volumes of currency notes while ensuring accuracy. This project proposes a solution to this challenge through the development of a authenticity verifying system leveraging numerous digital imaging techniques and algorithms. The following aims to authenticate Indian currency notes with denominations of 500 rupees. It comprises three primary algorithms designed to validate different security features present in currency notes. The first algorithm encompasses numerous steps, including image collection, preliminary-process, grayscale conversion, value extraction, image shattering, and comparisons, utilizing advanced digital imaging methods such as ORB and SSIM. The second algorithm focuses on authenticating the bleed lines of the currency notes, while the third algorithm verifies the number panel. The processed output is then displayed for each currency note, providing a seamless and accurate method for currency authentication. This automated system has the potential to replace existing manual methods and could be utilized by individuals to detect spurious bills.

Commonly Used Security Features to Detect unauthentic Notes

1) Bleed Lines: Angular bleed lines, which are in left and right corners of 500 rupee notes, are tactile and raised in print. There are five bleed lines on the 500-rupee note and seven on the -rupee note.

2) Security Thread: A color-shifting security thread with the inscription "Bharat" (in Hindi), "RBI," and the denomination (or 500) changes color from green to blue when tilted.

3) Latent Image: A picture of the numeral or 500 becomes visible if it is made visible at a 45-degree angle.

4) Watermark: A watermark of Gandhiji and an electrotype of the numeral or 500 are embedded in the currency note.

5) Denominational Numeral: A see-through register displaying the denominational numeral (or 500) is visible if the note is inclined against the light.

6) Portrait of Mahatma Gandhi: A portrait of Mahatma Gandhi, with "RBI" written on his spectacle, can be examined using a magnifying glass.

7) Number Panel: Numerals, increasing in size from small to large, are printed on the left at the top and right sides at the bottom of the note.

8) Denominational Numeral: The denomination (500 or) is written in Devanagari script on the left side of Gandhiji's portrait.

9) Ashoka Pillar: An Ashoka Pillar is depicted on the right at the bottom side of the currency note.

10) Guarantee and Promise Clause: The guarantee and promise clause of the RBI is presented in Devanagari and English in the top left and top right corners of the currency notes, respectively.

11) RBI Seal: The seal of the RBI is located just below the Governor's signature and is printed using intaglio printing.

12) Denominational Value in Words: The denominational value of the denomination is written in Devanagari script in the top central region.

II. Literature Survey

[1] This paper presents an automatic system designed for identifying counterfeit Indian currency notes. With the rise of technology, including scanning and color printing, counterfeit bill note of denominations like 100, 500, and 1000 rupees have become increasingly prevalent in India. The proposed model involves image acquisition followed by preprocessing steps such as cropping, smoothing, and adjustment. Subsequently, the picture is converted to grayscale and segmented, and features are extracted and reduced for comparison with authentic currency notes

[2] This paper describes the implementation of an automatic recognition system for fake bill notes using MATLAB. The system utilizes value acquiring with Hue Sat V and various digital imaging techniques. The process involves steps such as image gathering, graychannel transformation, edge detection, image segmentation, character acquire, and comparison. The MATLAB program analyzes clicked images of notes to determine their authenticity, displaying the respective message on the screen.

[3] This paper proposes model implemented in MATLAB, specifically designed for detecting counterfeit Bangladeshi notes. The model combines three image processing algorithms: OCR , Hough Transformation, and Face Recognition (MSD), to enhance detection accuracy. The algorithm highlights: gathering of data, preliminary process, detection of edge, feature obtaining, identification, and output generation. Despite slightly longer processing times, the proposed model achieves a significantly higher accuracy of 93.33% compared to individual algorithms.

[4] This for counterfeit currency detection: hyper-spectral imaging analysis and obtaining of different features in unverified and verified bill notes. The study employs various color lights, including UV light and LED lights with different wavelengths, implemented in MATLAB. The experimental results demonstrate nearly accurate detection of spurious cash through image processing algorithms.

[5] This paper discusses the recognition and verification of paper currency using digital imaging techniques. The proposed approach involves multiple stages, including picture gathering, obtaining features and comparison, texture analysis, and voice output. identifying the currency denomination through image processing and providing oral output to visually impaired individuals. The desired results include both text and voice output confirming the recognized and verified currency denomination.

III. Problem Statement

The moto of this thing is to develop a system capable of verifying the authenticity of Indian cash bills using digital imaging and machine visioning techniques. The system will take an image of a currency bill as input and utilize number of algorithms to determine its legitimacy.

A. Objectives:

• To identify counterfeit Indian currency notes with an advanced demo employing digital imaging and machine visualization techniques.

• Achieve high accuracy in determining the authenticity of currency notes.

• Provide final results promptly, ensuring efficiency in the verification process.

• Design a user-friendly interface to enhance ease of use and understanding for users.

IV. Methodology

A. Preparation of Dataset

The methodology involves the creation of a dataset comprising images of various currency notes, both genuine and counterfeit, along with images showcasing different features of each currency note. The dataset will be structured as follows:

1. Sub-dataset for Rs. 500 currency notes:

   - Images of genuine Rs. 500 notes
   - Images of counterfeit Rs. 500 notes
   - Multiple images representing each security feature (templates)

2. Sub-dataset for Rs. currency notes (Similar structure to Rs. 500 dataset)

The verified authentic characters considered for Rs. 500 currency notes include:

- Rs. 500 denomination in Devanagari and English script (2 features)
- Ashoka Pillar Emblem (1 feature)
- RBI symbols in Hindi and English (2 features)

- 500 rupees written in Hindi (1 feature)
- RBI logo (1 feature)
- Bleed lines present left and right sides (2 features)
- Number panel (1 feature)

TABLE I: Summary of Literature Survey

Authors	Methodology	Merits	Limitations
Sonali R. Darade	Feature detections and image processing.	Good detection, low cost	External camera dependency
Binod Prasad Yadav, P.H	Feature extraction with HSV image processing	Effective and efficient processing	Entire setup required
Adiba Zarin, Jia Uddin [3]	Optical Character Recognition (OCR)	93.33 % accuracy	Complex implementation

B. Image Acquisition

The system begins by capturing the image of the test currency note, which serves as the input. It is recommended to use a digital camera or preferably a scanner to ensure high-quality images with proper resolution, brightness, and clarity. Images should be free from haziness or blurriness.

C. Pre-processing

Following image acquisition, pre-processing of the input image is conducted. Initially, the image is resized to a fixed size, simplifying subsequent computations. Subsequently, Gaussian Blurring is applied for image smoothing to reduce noise and enhance system efficiency.

D. Gray-scale Conversion

Gray-scale conversion is employed to simplify image processing, as graychannel images have compared to the three channels in RGB images. This simplifies computation and processing tasks.

E. Algorithm-1: Feature Detection and Matching using ORB for Features 1-7

1) Feature detection and matching are performed using the ORB algorithm. The dataset contains images of various security features present in currency notes, with multiple images corresponding to each feature at different brightness and resolutions. ORB is utilized to detect each security feature in the test image. To enhance accuracy, a defined search area is established within the test currency image where the template is likely to be located. ORB then detects the template in the test image, and the output is highlighted using markers. This process is repeated for each image of every security feature in the dataset, ensuring proper detection and highlighting of the identified parts in the test image.

2) Feature Extraction: Now, using ORB location of each template has been detected in the input image within the highlighted area. The highlighted area is then cropped by slicing the 3D pixel matrix of the image. Next, we apply Gray scaling and Gaussian blur to further smoothen the image and now our feature is ready to be compared with the corresponding feature in our trained model.

Fig. 2: Features in 500 | currency bill

3) Feature comparison using SSIM : From the previous step, the test currency image which matches with idividual of the templates will be generated.

F. Algorithm 2: For Feature 8 and 9

Every currency note contains bleed lines near its left and right edges the Rs. 500 currency note, there are five lines on each side, currency note, there are seven lines. This algorithm is designed to count and verify the numerous bleed lines present left and right sides of a currency note.

1) Feature Extraction: The algorithm begins by extracting the regions containing the bleed lines by cropping the input image. This involves isolating a portion near the left and right corners of the currency note image.

2) Image Thresholding: Subsequently, the extracted image undergoes thresholding with a suitable value. This only the black bleed lines remain against a white background, facilitating further processing.

3) Calculation of the amount of Bleed Lines: The algorithm calculates the amount of bleed lines through the following steps:

a) Iterating over each column of the thresholded image.

b) Iterating over each pixel within each column.

c) Counting the number of black regions in each column by incrementing a counter whenever the current pixel of the column is white and the immediate next pixel is black.

d) If the number of black regions in a column exceeds a certain threshold (e.g., >= 10), the column is considered erroneous and discarded.

e) Finally, the average count of black regions across non-erroneous columns is calculated, and this count represents amount of bleed lines. For Rs. 500 currency notes, this count should be approximately 5, while for Rs. currency notes, it should be around 7.

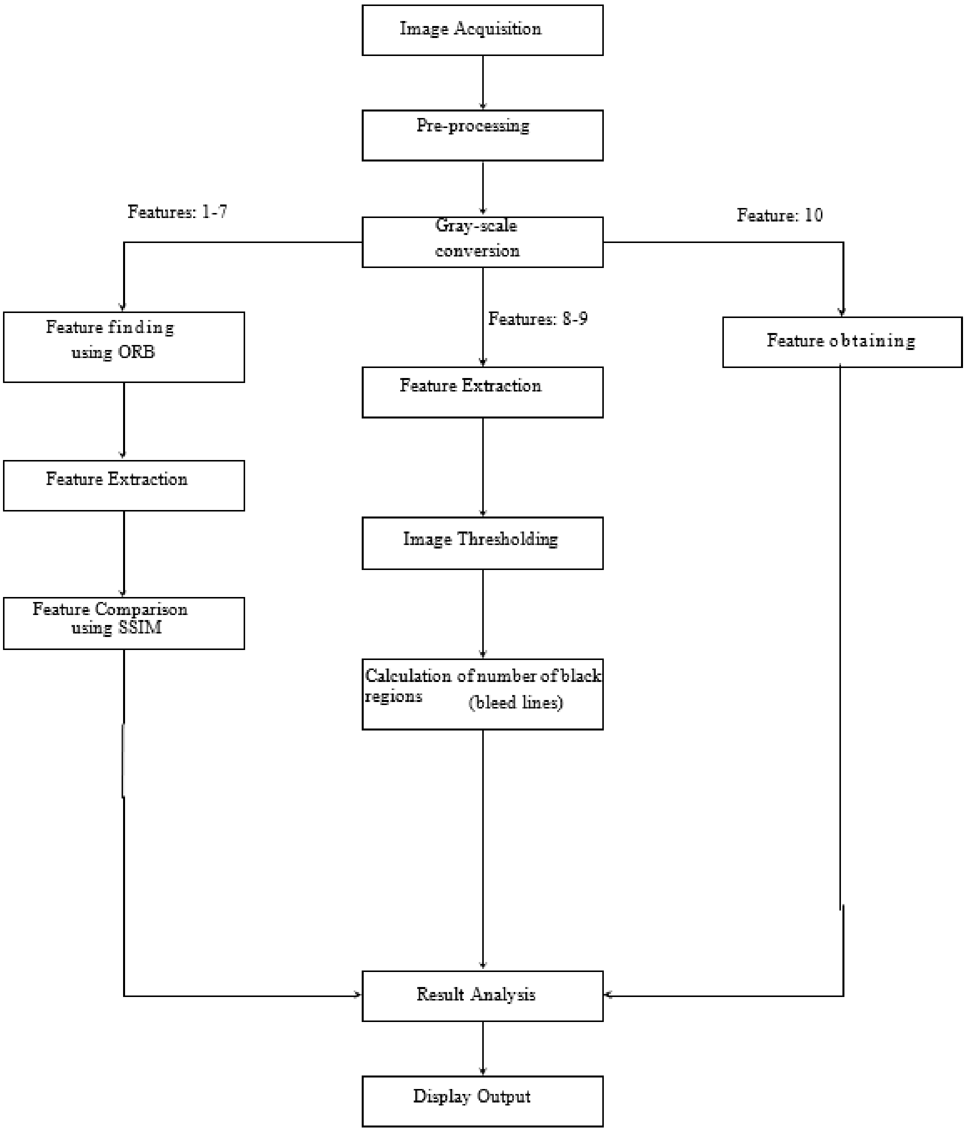

Fig. 4: Flow Diagram

G. Algorithm 3: For Feature 10

Every currency note includes a number panel in the bottom right part, displaying the consecutive number of the note. The amount of characters in the number panel should be nine (excluding spaces). This algorithm performs various operations to count the number of characters present in the panel.

1) Image Thresholding with Multiple Values: Initially, the algorithm applies thresholding with a suitable value to isolate the black characters on a white background in the number panel. This is looped with multiple threshold values, incrementing by 5 each time, until either nine characters are detected in three consecutive iterations or the threshold value reaches the maximum value (e.g., 150).

2) Contour Detection: The thresholded picture of the number panel undergoes contour detection.

3) Finding Bounding Rectangles: Bounding rectangles are determined for each contour, and the details of each rectangle are stored in a list.

4) Eliminating Erroneous Rectangles: Erroneous rectangles, such as too large or too small, are eliminated. Rectangles enclosed by larger rectangles and those positioned too high in the number panel are also discarded.

5) Calculation of Number of Characters: The remaining rectangles correspond to individual characters in the number panel. The algorithm counts the amount of rectangles to determine the amount of characters detected in the thresholded image.

This process is repeated for multiple threshold values until the termination condition is met, and the final count of characters is displayed as the output.

V. Results and Analysis

The investigation into fake currency detection involves a systematic approach encompassing data collection, preliminaryprocess, obtaining of feature, teaching the model, evaluation, and analysis. Initially, a diverse dataset containing genuine and counterfeit currency images is amassed, followed by standardizing image attributes like size and grayscale conversion for consistency. Unique characters such as texture, watermark, and security items are then obtained from the images. These features serve as the base for teaching system learning models, which discern between authentic and counterfeit banknotes. Evaluation metrics like accuracy and precision gauge model performance, informing subsequent analysis. By dissecting the results and discerning prevalent terms, researchers pinpoint pivotal factors in detection accuracy, guiding future enhancements. These insights drive the implementation of countermeasures, refining both currency design and detection algorithms to thwart evolving counterfeit schemes. Subsequent deployment in relevant sectors, alongside continuous monitoring and updates, ensures the sustained efficacy of genuinity detection systems.The proposed system authenticates currency notes through image processing, employing various algorithms to examine extracted features. Results are calculated as follows:

- Algorithm 1 (Feature 1-7): Calculates average and maximum SSIM scores for each feature. A feature passes if the average SSIM score exceeds a threshold or if the maximum SSIM score is sufficiently high (e.g., > 0.8).

- Algorithm 2 (Feature 8-9): Returns the average number of bleed lines on the left and right sides of the currency note. Passes if the average number is close to 5 for Rs 500 notes.

- Algorithm 3 (Feature 10): Determines the amount of characters within number panel. Passes if the count is 9 for at least one threshold value.

Performance Analysis:

- Tested with real and fake notes of denominations Rs. 500 .

- For real notes, 79% accuracy was achieved for Rs. notes and 83% for Rs. 500 notes.

- For fake notes, accuracy was 83% for both denominations.

- A bar graph (Fig 13) illustrates the precision of the system for real and fake currency notes.

Time Analysis:

- Implemented in Python using Jupyter Notebook.

- Printing all data takes about 35 seconds, while displaying only final results takes 5 seconds per input image.

- The model practically takes about 5 seconds to process and provide results for each input image.

- The processing time related to speed of the processor.

- If a higher power pc is used then the results are displayed in least time.

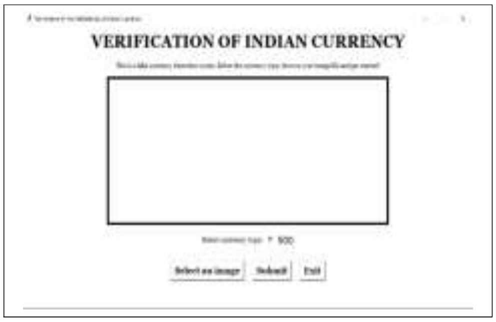

Fig. 6: Intially no image is dislayed and user is asked to insert image

Fig. 7: Browsing image

Fig. 8: Input image of currency note

Fig. 9: Image sent for processing…

Fig. 10: GUI showing final result(Real note)

Fig. 11: GUI showing final result(Fake note)

VI. Conclusion

This paper presents a fake currency detection model for authenticating Indian currency notes of denominations 500. Implemented using the OpenCV image processing library in Python3, the model considers 10 features of the input currency note and analyzes them using three different algorithms.

The model employs a graphical user interface (GUI) created with the Tkinter GUI library, allowing users to browse and process currency note images from their systems. Process for provided image is approximately 5 seconds when only final results are displayed, making it efficient for real-time use.

Results show promising accuracy, with approximately 79% accuracy in detecting genuine currency and 83% accuracy in detecting counterfeit currency.

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The initial idea for our model was inspired by the paper titled "Fake Indian Currency Note Recognition" authored by Mangayarkarasi, P., Akhilendu, A. S., Anakha, K., Meghashree, K., and Faris, A. B., published in 2020. However, while our system shares the same goal of recognizing counterfeit Indian currency notes, the methodology employed in the thing varies drastically from that described in the referenced paper.

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