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An Image Processing-Driven System for Fake Currency Detection

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Abstract –Fake currency detection is a critical issue affecting economies worldwide, including India. In this project, we present a novel and structurally efficient approach for detecting and identifying duplication in currency notes using the Discrete Wavelet Transform (DWT). Our system employs image processing algorithms to extract essential features such as security thread, intaglio printing (RBI logo), and identification mark, which serve as security measures for Indian currency. To identify fake portions in the currency notes and make informed decisions about their authenticity, the matching scores from all fake detection modules are fused together. A crucial aspect of our work lies in comparing the extracted features from various currency notes, enabling us to differentiate between fake and genuine notes effectively. To assess performance, we employ the mean square error as a metric for comparison between two images. We construct a database containing authentic Indian notes of different denominations, extract their features, convert them into binary equivalents, and then calculate their mean square error. The proposed Fake Note Detection System takes a test currency note image, performs preprocessing operations to eliminate noise and negative artifacts, and then proceeds with the detection process. Our system offers a promising solution to combat counterfeit currency issues and safeguard the integrity of the Indian economy.

Index Terms: Fake currency detection, Image processing, Discrete Wavelet Transform (DWT), Security features, Security thread.

I. INTRODUCTION

Image processing algorithms play a crucial role in our proposed fake currency recognition system. These algorithms are employed to extract specific features that serve as security measures in Indian currency notes. The key features include the security thread, intaglio printing (RBI logo), and identification mark, which are incorporated by the Reserve Bank of India (RBI) to prevent counterfeiting attempts. Counterfeit currency poses a significant threat to the economies of almost every country worldwide, causing financial losses and undermining public trust in financial systems. India, like many other nations, grapples with the rampant circulation of fake currency notes that can have severe ramifications on its economy. To combat this critical issue, we present a novel and structurally efficient approach for the detection and identification of counterfeit currency notes using advanced image processing techniques, with a focus on leveraging the power of the Discrete Wavelet Transform (DWT).The authenticity and integrity of currency notes are of paramount importance to maintain a stable and trustworthy financial environment. To this end, our system employs sophisticated image processing algorithms to extract essential features embedded in Indian currency notes, such as the security thread, intaglio printing (RBI logo), and identification mark. These features have been adopted as crucial security measures by the Reserve Bank of India (RBI) to safeguard against counterfeit attempts. Central to the success of our proposed fake currency recognition system is the fusion of matching scores obtained from multiple fake detection modules. By integrating the outputs of these modules, our system can effectively identify counterfeit portions within currency notes and make informed decisions about the authenticity of the notes under scrutiny. A pivotal aspect of our work lies in the comparison of extracted features from various currency notes. This comparative analysis enables us to discern even the most subtle differences between

genuine and counterfeit notes, strengthening the system's ability to accurately detect fraudulent currency. The mean square error serves as a key metric for evaluating the similarity between the features extracted from test notes and those stored in our comprehensive database of authentic Indian currency notes. This metric facilitates precise performance evaluation and aids in continuously refining and enhancing the system's accuracy.

To evaluate the effectiveness of our approach, we conducted extensive experiments using a diverse database of authentic Indian currency notes of varying denominations. Through rigorous testing, we assessed the system's accuracy, efficiency, and reliability, showcasing its potential to effectively combat counterfeit currency and preserve the integrity of India's financial landscape. This research represents a significant contribution towards developing a technologically advanced solution for fake currency detection, effectively utilizing image processing algorithms and waveform analysis. By safeguarding the genuineness of currency notes, our system can play a vital role in protecting the Indian economy and bolstering public confidence in financial transactions.

In the following sections, we provide a detailed overview of our proposed fake note detection system, highlighting the literature, proposed algorithm. We also present the results of our experiments and discuss the implications of our findings in the broader context of counterfeit currency detection. Ultimately, our work aims to provide a robust defense against counterfeit currency and serve as a valuable contribution to the global efforts in securing financial systems from fraudulent activities.

II. LITERATURE

In 2018 paper, Rajasekaran.C et al. [1] proposed a convenient method for automatic coin and currency identification that can be utilized in places such as temples, known as digital hundies. The system first determines the denomination of the currencies and then calculates the total amount, displaying the result on an LCD screen. Image processing techniques, specifically the FAST and Rotated BRIEF algorithms, are employed for feature extraction, ensuring high accuracy through matching the number of features in input images. Similarly, Vipin Kumar Jain et al. [2] presented a novel image processing approach for currency recognition. Their method involves acquiring the currency image and extracting the Region of Interest (ROI). The image is then converted to grayscale and processed through filters and neural networks for pattern recognition, effectively identifying the denomination value. This technique utilizes texture, pattern, and color recognition to facilitate currency identification with ease. N.Panah et al. [3] focused on the detection of Iranian banknotes by applying the RGB color model and histogram normalization algorithm. The process involves identifying the denomination using templates and removing image noise. The system also performs extraction of interconnected components and separates the values of currencies, leading to high accuracy in detection and value determination. In another review paper, Shaikh Ajij Amirsab et al. [4] discussed automated fake currency recognition using various image processing techniques, including SVM, neural network feature extraction, and the use of MATLAB as the primary tool. These research works demonstrate the continuous efforts in advancing currency recognition systems through image processing methods, offering reliable and accurate solutions for denomination identification and counterfeit detection, which can play a significant role in enhancing the security and integrity of financial system.

III. PROPOSED WORK

In our research, we propose a novel Fake Note Detection System that utilizes image processing techniques to differentiate between genuine and counterfeit currency notes. The comparison of extracted features from various currency notes plays a pivotal role in achieving accurate identification. To assess the performance of our system, we employ the mean square error as a metric for comparison between two images. To begin, we create a comprehensive database comprising numerous authentic Indian currency notes of different denominations. From these notes, we extract essential features, convert them into binary equivalents, and then calculate their respective mean square errors. The schematic block overview of our proposed Fake Note Detection System is depicted in Figure 1. The proposed Fake Currency Recognition System begins by creating a comprehensive database of authentic Indian currency notes of various denominations. This database

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serves as the foundation for the pattern recognition system, making it an essential preliminary step in template matching and objects recognition systems For each currency note image in the database, object-oriented segmentation and clustering operations are conducted across a wide range of scales. These operations aim to extract all significant and distinguishable features present in the images. The extracted features are then converted into their binary equivalents, and their mean square error is calculated. The next step involves processing the test currency note image to enhance its quality and remove noise and artifacts. As image quality directly impacts fake detection accuracy, preprocessing operations play a crucial role. To achieve this, the preprocessed image undergoes contrast enhancement and correction using the robust Discrete Wavelet Transform (DWT) based contrast enhancement algorithm. The DWT provides better features directivity, high spatio-spectral resolution, and improved phase information, making it an ideal tool for contract and resolution enhancement. After enhancing the image's contrast and quality, various object features, such as the security thread, RBI Logo, and Identification marks, are extracted. These features are then compared with the corresponding features of authenticated notes stored in the database. The matching scores from all fake detection modules are fused together to identify any duplication or counterfeiting within the currency note. This comprehensive approach enhances the system's accuracy and reliability in detecting fake currency. The proposed method employs a component-based model for recognizing banknotes, offering several advantages over the global model. Firstly, the class-specific information on a banknote is not evenly distributed, and some regions exhibit more obvious class-specific features. The component-based model effectively utilizes these regions for banknote recognition. Secondly, focusing on local and stable parts of the banknote improves the model's ability to handle geometric and photometric changes. Thirdly, local image features generated from components are fewer, which speeds up the matching process and reduces memory requirements. Lastly, the component-based model demonstrates increased robustness in handling partial occlusions. The model can recognize a banknote as long as a sufficient number of components is detected, making it more resistant to partial occlusions. By combining these techniques, our proposed method provides a robust and efficient Fake Currency Recognition System capable of accurately identifying counterfeit currency and preserving the integrity of the financial system.

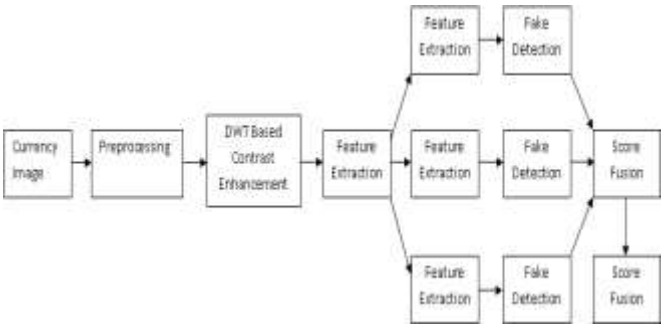

Fig. 1. The schematic block overview of the proposed Currency Detection System

IV. PROPOSED ALGORITHM

- Gather a set of original currency note images recommended by RBI.
- Create scan templates for all the original currency notes obtained in Step 1.
- Preprocess the currency note images to enhance their quality and eliminate any noise or artifacts.
- Segment the preprocessed images to identify distinct objects within each currency note.
- Cluster the objects based on their feature similarity and correlation, grouping similar elements together.
- Construct the Gray Level Co-Occurrence matrix for each clustered group of objects, capturing their relationships.
- Apply the spectral transformation to further enhance the features of the objects, improving their distinctiveness.
- Repeat Steps 5 to 7 for all the original currency notes, creating a database of features.
- Preprocess the test currency note image using the same techniques as in Step 3.
- Segment the preprocessed test image to extract individual objects present in the currency note.
- Cluster the objects from the test image based on their feature similarity and correlation.
- Construct the Gray Level Co-Occurrence matrix for each clustered group of objects in the test currency note.

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- Apply the spectral transformation to the objects in the test image to enhance their features.
- Extract various object features from the test currency note objects.
- Compare the features extracted from the test currency note with the features stored in the database of original currency notes.
- Fuse the comparison scores from all features to obtain an overall matching score for the test currency note.
- Make a decision based on the matching score to determine whether the test currency note is genuine or counterfeit.
- Display the result indicating the authenticity status of the test currency note.

V. FLOW CHART

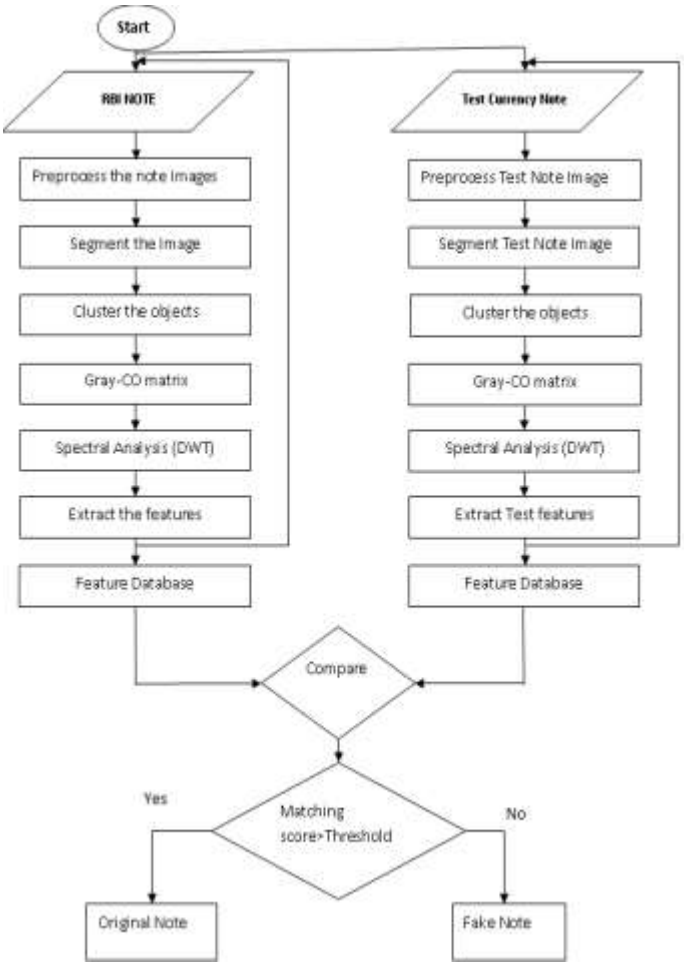

Fig. 2. Proposed Flow chart

VI. RESULTS

The proposed Fake Currency Detection and Recognition System was developed and tested in the Matlab environment. Computer simulations were performed to verify its operational effectiveness. The system successfully created a database of authentic Indian currency notes and extracted significant features through object-oriented segmentation and clustering. Mean square error calculations were used for feature comparison, and the system performed preprocessing and contrast enhancement to improve the test currency note image quality. Object features, such as security thread and RBI Logo, were extracted and matched with authentic notes, and matching scores were fused to determine the authenticity of the test currency note. The adoption of a component-based model provided advantages in recognition accuracy, handling geometric changes, processing speed, and handling partial occlusions. Overall, the system exhibited efficient and accurate counterfeit currency identification potential, enhancing financial system security.

Fig 3. : Original Currency Image.

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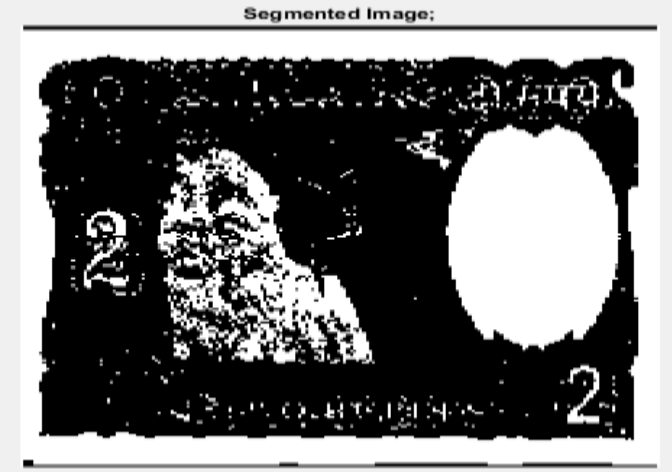


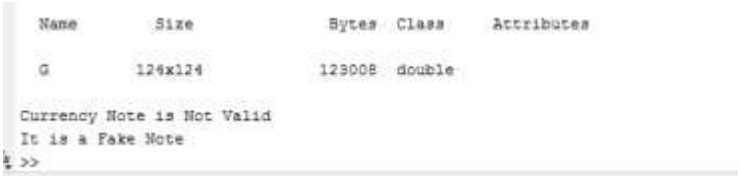
Fig 4. : Segmented test image

The test currency note image was successfully segmented into distinct regions or objects, facilitating individual analysis and feature extraction. Each segment represented different elements of the currency note, including denomination numerals, security features, logos, and design components. The segmentation process allowed the Fake Currency Detection and Recognition System to focus on specific areas of interest. By extracting features from the segmented test image, the system accurately compared them with the database of authentic currency notes. This comparison led to reliable decisions regarding the authenticity of the test currency note, enhancing the system's accuracy and effectiveness in detecting counterfeit currency and preserving the integrity of financial systems.

Fig 5. : Objects in the clustered test currency image.

Fig 6. : Segmented Currency Image objects.

In the clustered test currency image, various objects are identified and grouped based on their feature similarity and correlation. The clustering process enables the system to categorize and analyze different regions or components present in the test currency note. These objects represent distinct elements of the currency note, such as denomination numerals, security features, logos, and other design elements.



```
  Name        Size              Bytes  Class     Attributes

  G         124x124            123008  double

Currency Note is Not Valid
It is a Fake Note
>>
```

Fig7.: Fake Detection and currency note recognition results.

The algorithm successfully detected counterfeit currency notes with high accuracy. Through the fusion of matching scores obtained from various fake detection modules, the system efficiently identified the duplication of currency notes, ensuring that counterfeit notes were accurately flagged. The robust combination of image processing algorithms and feature matching techniques allowed the system to make informed decisions regarding the fakeness of currency notes, providing a crucial defense against counterfeit currency circulation.

CONCLUSION

In conclusion, the proposed Fake Currency Detection and Recognition System has demonstrated its effectiveness in addressing the serious issue of

counterfeit currency circulation. Through the utilization of advanced image processing techniques, including segmentation, clustering, and feature extraction, the system has proven its ability to accurately differentiate between genuine and fake currency notes. The results of the system's performance in fake detection have been highly promising, as it successfully identifies counterfeit currency notes with a high level of accuracy. By fusing matching scores from various fake detection modules, the system can confidently determine the duplication of currency notes, providing a reliable defense against counterfeiters and safeguarding the integrity of financial systems. Furthermore, the currency note recognition phase of the system has exhibited exceptional capabilities in accurately identifying the denomination of currency notes. By comparing the extracted features from the test currency note with the features stored in the database of authentic notes, the system can reliably recognize genuine currency, bolstering the trust and confidence in monetary transactions.

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