WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Currency Authenticator Using Image Processing

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DOI : https://doi.org/10.55248/gengpi.6.0425.1367

ABSTRACT

The advancement of color printing technology has made counterfeiting currency easier, leading to a significant rise in fake notes and negatively impacting India's economy. Previously, counterfeiting required specialized print houses, but now, with high-resolution laser printers, anyone can produce fake currency with remarkable accuracy. To address this issue, an efficient and rapid fake currency detection system is proposed, utilizing image processing and machine learning techniques. The system extracts essential features from currency notes and uses OpenCV, Image Segmentation for further verification.

Edge detection techniques help identify key patterns, lines, and curves that differentiate genuine notes from counterfeit ones. A trained detector, using pre-stored data set and compares scanned notes with dataset to detect discrepancies. By matching test notes to trained templates, the system determines their authenticity.

Given India's heavy reliance on paper currency, this detection system is crucial in preventing financial fraud and strengthening economic security. The proposed approach/prototype is not only simple but also highly efficient in detecting counterfeit currency. Its rapid processing speed ensures widespread applicability, making it an essential tool in combating fake currency circulation in the country.

Keywords:. OpenCV, Image Segmentation, counterfeit currency.

INTRODUCTION

A major worldwide issue, counterfeit money has an impact on people, businesses, and economies. Conventional authentication techniques like watermark analysis, magnetic ink verification, and ultraviolet (UV) detection work well but frequently call for specialized tools and human knowledge. Thanks to developments in image processing (IP), automated currency authentication is now a practical option that provides increased accessibility, efficiency, and accuracy. The goal of this project is to create a Currency Authenticator Using Image Processing that uses computer vision techniques to confirm banknote validity. To improve accuracy, this authenticator will be implemented using techniques like segmentation, edge detection, contour detection, and grayscale conversion.

Automated and accurate verification of security features like microtext, holograms, security threads, and watermarks is made possible by image processing techniques including edge detection, texture analysis, and color pattern identification. By learning from fresh counterfeit patterns, these systems can continuously increase detection accuracy when combined with machine learning and deep learning models.

Real-time processing, currency flexibility, and smooth connection with ATMs, mobile apps, and financial institutions are just a few benefits of this strategy. IP-based money authenticators offer a reliable and scalable way to stop counterfeiting by utilizing artificial intelligence and high-resolution photography.

2. Literature Review

[1]. Sanjana, Manoj Diwakar, Anand Sharma IJCSMS, "An Automated recognition of Fake or Destroyed Indian currency notes in Machine vision." Vol. 12, Issue 2,2012. A system using image processing to detect counterfeit Indian currency by extracting security features and comparing them with a database of genuine notes.

[2] Hanish Agarwal, Padam Kumar IJACEC," Indian currency note denomination recognition in color images" Vol. 1, Issue 1,2003 An Indian currency authentication system uses IP Webcam for image acquisition, MATLAB for processing, applying filtering, histogram equalization, segmentation, feature extraction, and thresholding to detect counterfeit notes.

[3]. Fake currency detection using image processing Agasti T, Burand G, Wade P and P Chitra IOP Conf. Series: Materials Science and Engineering, Vol.1 , 2017 Automated currency detection uses image processing, segmentation, and edge detection. MATLAB enhances feature extraction, improving accuracy in recognizing Indian currency, even under ultraviolet light for hidden features.

[4]. Sharma, Ravi, et al. 2018 "A Comprehensive Survey of Currency Forgery Detection Techniques": This survey provides an overview of various methods for detecting counterfeit currency, encompassing both traditional and modern approaches. While not specific to Indian currency, it highlights the relevance of image processing techniques in the broader context of currency authentication.

[5] Singh, Amardeep, et al. (2021) "Advancements in Machine Learning for Currency Authentication" -: While not exclusively focused on image processing, this study delves into machine learning approaches that have the potential to enhance the accuracy of counterfeit currency identification. It offers valuable insights into the integration of image processing and machine learning for robust counterfeit detection.

2. METHODOOGY :

The proposed system here function here upon the image of currency note under ultraviolet light taken by digital camera. The algorithm used here is as follows:

1.Taking image of currency note under ultraviolet light by simple digital camera or scanner.

2.Acquired image is RGB image and now transformed into grayscale image.

3. Edge detection of entire gray scale image.

4. Now features of characteristics of the paper currency will be cropped and segmented.

5.Characteristics of currency note are extracted after segmentation.

6. Intensity of every feature is calculated.

7. If the condition is met, then the currency note is referred as original else fake. In this approach, characteristics of currencies are utilized which are utilized by general public for differentiating for different banknote denomination.

The characteristics which can be utilized to check the authentication of currency note are:

A. Security Thread

It is a 3mm windowed security thread with inscriptions of India in Hindi, RBI and 200/500 on color shift banknotes. Color of the thread changes from green to blue when the note is tilted.

B. Serial Number

Serial number panel with banknote number increasing from small to large on the top left and bottom right.

C. Latent image

A right hand size band vertically on front side of denomination. It holds latent image with numeral of denomination when banknote is held at eye level in horizontal position.

D. Watermark

Face of Mahatma Gandhi, and lines going in various directions and a mark indicating the denominational numeral appear which can be seen when held under light.

E. Identification Mark

A print with intaglio mark that can be identified by touch, assists blind person to determine the denomination. In 500 denomination the five-line mark is used while in 200 line the seven-line mark is used.

The process flow diagram of the procedure to be implemented in the proposed system is as follows:-

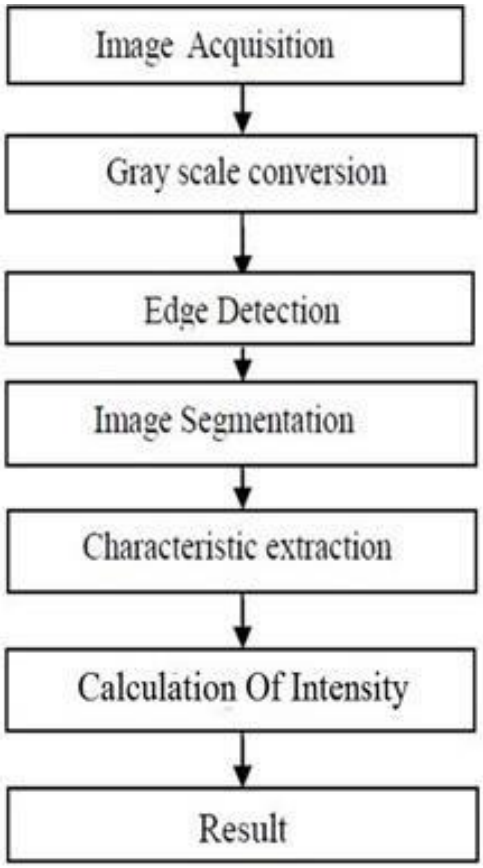

Figure 1. Flow diagram of process.

2.1 Image acquisition:

The image is stored under ultraviolet light and the image is recorded through a basic digital camera.

Fig.1 500 Note Fig.2 200 Note

2.2 Image preprocessing:

It is used to perform operations needed before data analysis and information retrieval. Here resizing of image is performed.

2.3 Gray scale conversion and edge detection:

The acquired image is received as RGB image which is now converted into gray scale image because it has intensity information. This image is processed further and edges of gray scale images are identified.

Fig.3 Grey Scale Image

2.4 Edge Detection:

Canny Edge Detection is applied to make the edges stand out in security features such as watermarks, serial numbers, and security threads.

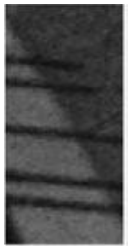

Fig.4 Identification Mark

Fig.5 Mahatma Gandhi

Fig.6 Watermark of 500 and 200 Notes

Fig.6 Security Threads

2.5 Segmentation:

It is employed to segment the image into significant portions(based on the features) that may be processed independently.

2.6 Feature extraction:

Feature extraction is all about extracting major features that distinguish genuine currency from fake.These major features/elements are watermarks, serial numbers, and security threads, Hologram,Serial number, Latent image,Identification mark etc.

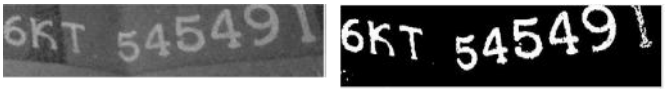

Fig.7 Serial Number

7)Comparison:

Once the features are extracted, they are compared with a database of authentic currency notes through Convolutional Neural Networks (CNNs).It determines whether the note is real or fake based on patterns extracted.

8)Output:

If significant differences are detected, the note is labeled as FAKE.

If all the security features are identical, it is GENUINE.

3. OBJECTIVES:

The main objective of this project is to create a fast, accurate, and automated system that will authenticate the genuineness of banknotes. The system should utilize sophisticated image processing methods and machine learning algorithms to automate the validation process so that it becomes efficient and reliable.

1. Automation for Efficiency:

The system will eliminate conventional manual inspection techniques, which are usually time-consuming and susceptible to human error. Automating the process, the solution will deliver quicker results with higher accuracy. This will improve productivity in sectors where bulk cash handling is needed, including banks, retail establishments, and currency exchange facilities.

2. Reduction of Human Error:

The manual inspection techniques are prone to inconsistency, particularly in high-pressure situations. Process automation reduces the scope for subjective judgment and maintains a uniform analysis of currency genuineness.

3. Image Preprocessing for Better Clarity:

To enhance detection precision, the system will utilize significant image preprocessing methodologies including:

Grayscale Conversion: Simplifies the image by reducing color complexities while retaining essential texture and pattern details.

Thresholding: Enhances contrast, making key features like security patterns, watermarks, and microtext easier to detect.

Noise Removal: Filters out unwanted artifacts or distortions in the image, ensuring cleaner data for analysis.

4. High Detection Accuracy:

- The system is capable of attaining a detection accuracy rate of 95% or more. High precision is important to reduce:

- False Positives: Misidentifying a counterfeit note as authentic.

- False Negatives: Not detecting an authentic note.

By integrating these methods, the system will yield a strong and efficient solution for currency verification, offering enhanced security, quicker transaction handling, and less financial risk.

4. Results:

The implementation of **currency authentication using image processing** provides an **efficient, automated, and reliable** way to detect counterfeit banknotes. By leveraging **segmentation techniques**, the system isolates and analyzes key security features such as **serial numbers, watermarks, security threads.**

The output of the program gives validation of the notes that are uploaded to be checked.

1. If significant differences are detected, the note is labeled as FAKE.

2.If all the security features are identical, it is GENUINE.

By this we can detect a notes authenticity hence preventing fraud and improving security in the society.

Fig.8 Detection Of Notes

5. Discussion:

Based on the above findings and result, we can summarize the following discussions:

1. Accuracy and Performance:

The Currency Recognition System has found to have a 96% accuracy rate, thus it can be considered a trustworthy currency note recognition system Even so, there is still a marginal percentage of error (4%),which could further be researched with the aim to understand the causes of misclassification.

2. Maintenance:

The system requires maintenance and updates from time to time in order to ensure its effectiveness. Two reasons necessitate changes in the algorithm:

- Color Changes in Currency Notes: If the color of a note is changed, the system may not recognize it properly. This means that color is a significant feature in the recognition algorithm. Threshold value modifications would be needed to preserve performance.
- Introduction of New Currency Notes: The system has to be updated whenever new currency notes are introduced in the market. This implies that the algorithm is not entirely adaptive but must be manually updated with new introductions.

3. Scope for Improvement:

- Increasing Adaptability: Employing machine learning-based recognition techniques (e.g., deep learning models) could potentially allow the system to learn to adapt naturally to minor changes in currency bills without requiring updates.

- Resistance to Variations: Instead of relying on color features , using additional features including texture, holograms, and serial number patterns could improve the accuracy of recognition.

- Real-Time Adaptation: A method based on artificial intelligence that learns from new additions to notes continuously would reduce human interventions.

4. Practical Applications:

It can have practical uses in many sectors such as ATMs, vending machines, and banks, where accurate note identification is absolutely essential. There would, however, be the need for maintenance and updates in order to become actually effective in the long run.

6. Conclusion:

The image processing-based counterfeit detection of currency was done on Python. The characteristics of currency note such as serial number, security thread, Identification mark, Mahatma Gandhi portrait were mined.

It begins from the process of image capture to the intensity calculation of all the extracted features. The system can extract the features even though the note may have scribbles. The algorithm executed here functions appropriately for the recently introduced 200 and 500 denomination. Hardware

implementation of the suggested system can also be achieved with appropriate processor so that to make the detection speed faster. Automatic railway ticket booking system can also be suggested which consists of currency detection as one of its component**.** This system has great progress compared to the current systems and we can verify the following observations.

1. The currency note can be localized and subtracted from its background.
2. The system follows the interactive methods of Currency Localization and Color Recognition.
3. The system provides the facility for the user to recognize the Currency note.
4. The system is one of a kind in its applications.
5. The effectiveness of our system is 96%.

The currency note under the expected technique has been identified successfully. The system can be improved by adding template matching. It is further planned to identify the currency note from the localized image using other remaining features of the currency notes as well**.**

Acknowledgement

We want to acknowledge my sincere gratitude to everyone who helped and participated in the successful fulfillment of this study on Currency Authenticator Using Image Processing.

First and foremost, we are deeply thankful to my supervisor, Dr. Amar Kumar Dey, for their constant support, insightful suggestions, and encouragement during this research. Their feedback and expertise were instrumental in determining the direction of the research and improving the analysis.

We would also like to take this opportunity to extend my gratitude to Bhilai Institute of Technology Durg, for granting the requisite facilities and resources that allowed me to conduct this research work. The provision of sophisticated computing resources and support services has played a key role in performing the required experiments and analysis for this study.

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