

Indian Currency Recognition and Authentication using Image Processing

Prasad Dinkarrao Deshpande¹, Atul Shrivastava²

^{1,2}*E&TC Department, VA College of Engineering, Ahmednagar, (India)*

ABSTRACT

A currency note is a type of a negotiable instrument made by a bank, payable to the bearer on demand. The Indian Rupee is the official currency of the Republic of India. Counterfeit money is imitation currency produced without the legal authorization of the state or government. Counterfeit notes are one of the biggest problem occurring in cash transactions. This has led to the escalation of corruption hindering country's growth. Because of the rapid advancements in imaging, scanning and printing technologies it is very easy for a person to create counterfeit currency notes with use of advanced software and hardware tools. Detecting the counterfeit notes manually become time consuming and untidy process hence there is need of automatic technique with currency recognition process can be efficiently done. This paper made an effort to explore the various security features of the highest denomination of 2000 with multispectral imaging. Counterfeit of currency of denomination 2000 will be a very difficult task because as many security features are embedded in the newly introduced currency notes which makes the currency of highest denomination more secure. This papers is an efforts towards the Security Features Analysis of Indian Currency that can be used for Recognition and Authentication of genuine currency note using Image processing in MATLAB.

Keywords: *Counterfeit Currency, Currency Note, Security features, Multi-spectral imaging, Recognition and Authentication, MATLAB.*

I. INTRODUCTION

The currency is a token that is exchanged for purchasing goods or services. The currency plays an essential role in our daily life. Every day we are dealing with currency for different purposes, so recognition and authentication of currency is an important part of today's world and also is a one of the assistive way for visually impaired persons to judge the originality of the currency.

For country like India Counterfeit note is one of the biggest hurdle in the cash transactions. Because of the fast developments in imaging, scanning and printing technologies it is very easy for a person to print fake currency notes with use of latest software and hardware tools. Currency Recognition and Authentication has various potential applications including electronic banking, currency monitoring systems etc.

The main objective of this paper is to get familiar with the new security features which are added to new currency notes so that they can differentiate between Counterfeit and genuine currency notes with simple examinations.

Automatic machine which can detect currency notes are now commonly used in dispensers of modern products like candies, soft drinks bottle, bus or railway tickets. The technology of currency recognition and authentication basically aims for identifying and extracting visible and invisible features of currency notes.

This paper has made a small effort in revealing the security features of the highest Denomination 2000 currency note which has been newly issued by the Government of India. The currency note shares some similar features with the other denomination currencies around the world such as the Micro-printing, 3D Security thread, Watermarks, Colour shifting Ink Intaglio printing. Forging the note with all the above mentioned features is impossible.

II. LITRATURE REVIEW

Counterfeiting of money is not a new problem and has been present since the coinage of money was started by the Greek in around 600 B.C. During that time, the edges of coins were used to be clipped off to get valuable metal and the metal was used to make counterfeit coinage. [1]

Paper money came in existence in 1200s in China using the wood of mulberry trees. During that time, the guards used to look after mulberry forests and counterfeiting of money were punishable by death. History tells us that counterfeiting of money has been an old evil [2].

Security features of a currency are critical for determining real and fake currencies. Common security features include watermarks, latent images, security thread, intaglio, optically variable ink, micro lettering and fluorescence [3].

Physical testing of currency notes are not efficient and it is difficult for anyone to recognise the difference between Counterfeit Currency and Real Currency. Therefore Automatic methods for bank note recognition are necessary. Extracting sufficient monetary characteristics from the currency image is essential. Involving machines makes notes recognition process simpler and efficient. [4]

III. OBJECTIVES OF THE STUDY

1. To explore the different security features of the Indian currency Note.
2. To extract the security features with Multi-spectral imaging.
3. To acquire the paper currency with the help of scanner or camera.
4. To crop and segment the acquired image for characteristics extraction.
5. To identify the correct denomination of the currency.
6. To recognise the counterfeit and genuine currency note.

IV. SECURITY FEATURES OF CURRENCY NOTE

Here are the security features on new Rs 2,000 note. In the aftermath of government demonetizing Rs 2,000 note, we have received the new currency notes, here is a list of security measures that have been taken to avoid counterfeiting.

4.1 Security Features of Rs 2,000 Note:

The base colour of this note is magenta. And, with the dimensions of 66 mm × 166 mm, having a theme of Motif of Mangalyan - India's first venture in interplanetary space. It is smaller than earlier banknotes of various denominations. Here are some features with respect to the numbers mentioned in the image.

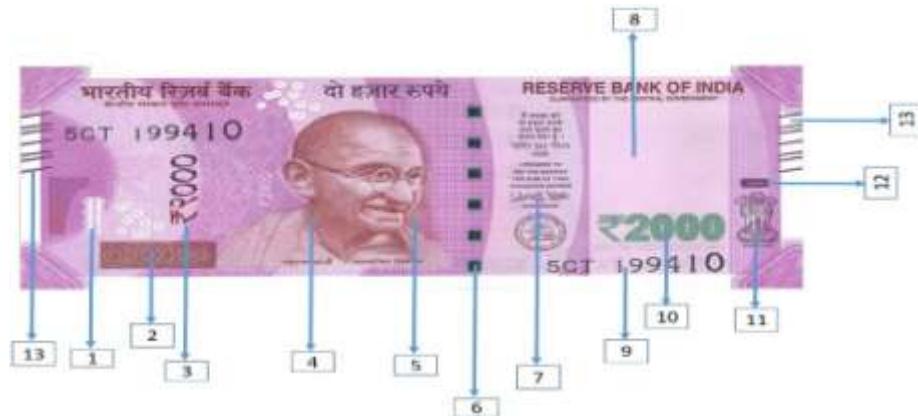


Fig. 1: Salient features on the Front of the Rs.2000 Banknote

1. See-through register with denominational numeral 2000.
2. Latent image with denominational numeral 2000.
3. Denominational numeral in Devnagari.
4. Portrait of Mahatma Gandhi at the centre.
5. Micro letters 'RBI' and '2000' on the left side of the banknote.

6. Windowed security thread with inscriptions and a colour shift from green to blue when the note is tilted.
7. Guarantee Clause, Governor's signature with Promise Clause and RBI emblem towards right.
8. Mahatma Gandhi portrait and electrotype (2000) watermarks.
9. Number panel with numerals growing from small to big on the top left side and bottom right side.
10. Denominational numeral with Rupee Symbol.2000 in colour changing ink (green to blue) on the bottom right.
11. Ashokan Pillar emblem on the right.
12. Horizontal rectangle with 2000 in raised print on the right.
13. Seven angular bleed lines on left and right side in raised print.

For visually impaired Intaglio or raised printing of Mahatma Gandhi portrait, Ashoka Pillar emblem, bleed lines and identity mark.

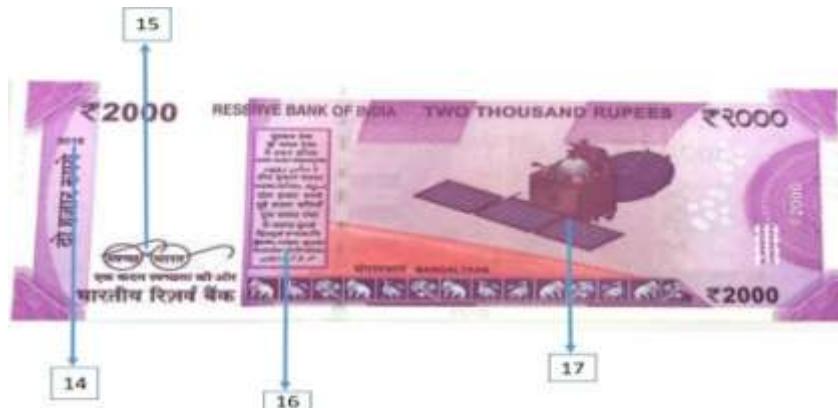


Fig. 2: Salient features on the Back of the Rs.2000 Banknote

14. Year of printing on the note
15. Swachh Bharat logo with the slogan
16. Language panel towards the centre
17. Motif of Mangalyaan - reflecting country's first venture in the interplanetary space

V. DETAILED SECURITY FEATURES OF 2000 CURRENCY NOTE

The newly introduced currency note of 2000 denomination exhibit various authenticating features in order to protect them for counterfeiting. Though it is very hard to copy and forge these security features with precision, various attempts have still been made by the counterfeiters to forge the currency notes to the possible limits. In order to curb these illegal activities of the forgers and to avoid such forgeries and being cheated, it is very important to have an

awareness about the various security features that are present in the Indian currency notes and the various other documents containing these features.

The various security features present in the Indian currency note of denomination value ₹ 2000 and those observed in the photocopied and scanned currency notes are firstly discussed in this paper.

The present study focuses on many security features that makes the currency note of highest denomination more safe guard and secure.

5.1 Watermarks:

Watermarks are the designs that are generated in the currency notes incorporated during the manufacturing process by varying the distribution of fibers in the given space. The various watermarks that are present in the 2000 denomination note are

- a. Mahatma Gandhi Portrait
- b. 2K Watermark
- c. RBI Watermark
- d. 2000 WATERMARK
- e. Electrototype Watermark



Fig. 3: Mahatma Gandhi watermark



Fig. 4: 2K watermark



Fig. 5: RBI watermark



Fig. 6: 2000 watermark



Fig. 7: Electrotype watermark

5.2 See Through Register:

The denomination numeral 2000 that is printed on both sides of the note, on one side, it is hollow and on the other side it is filled up. It is written horizontally just along the micro lettering and above the latent image on the left side of the currency note. It looks like one single design when seen against the light.

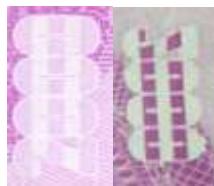


Fig. 8: See through register both obverse & reverse

5.3 Bleed Lines:

Seven angular bleed lines in 5 sets of 1-2-1-2-1 are printed on the obverse in both, the upper left and the right hand edge of the notes to aid the visually impaired.

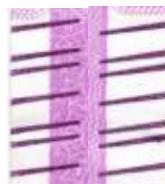


Fig. 9: Bleed Lines of Right and Left Side of Note

5.4 Identification Mark:

Identification marks are made on banknotes to help the visually impaired identify the denomination of notes. On Indian banknote of denomination value 2000 it appears on the right side of the watermark window. The mark in this denomination is a rectangle located above the Ashoka Pillar Emblem on the right side and has 2000 numeral written in the rectangle.



Fig. 10: Identification mark

5.5 Micro Lettering:

Micro lettering refers to the minute inscriptions that can only be read under a microscope or by using a hand lens/magnifier. On the Indian currency note of denomination value 2000 are encrypted “RBI 2000 INDIA”. These words are written alternatively on the left side of the currency note and The words INDIA BHARAT (Hindi) are alternatively inscribed on the left and right side of the clothes of Mahatma Gandhi near the neck and The word RBI is written on the inside of the frame of the spectacles of Mahatma Gandhi.



Fig. 11: Micro lettering

5.6 Optically Variable Ink:

The denomination value 2000 in the Mahatma Gandhi watermark window of the 2000 currency note is printed on the obverse using optically variable ink. The numerals change its colour when viewed at various angles.



Fig. 12: optically variable ink (Green)



Fig. 13: optically variable ink (Blue)

5.7 Intaglio Printing:

Inscriptions or motifs printed using the Intaglio printing or raised printing technique can be felt by touch. On Indian banknote of denomination ₹ 2000, the portrait of Mahatma Gandhi, the Reserve Bank seal, guarantee and promise clause, Ashoka Pillar Emblem on the right, RBI Governor's signature are printed in intaglio.





Fig. 14: Intaglio printing

5.8 Security Thread:

The security thread in the 2000 denomination currency note is a 3mm wide strip, usually 6 windowed and reads three words particularly “RBI”, “BHARAT” and “2000” imprinted on it alternatively with the security thread changing its colour from green to blue on being held at an angle and tilted.



Fig. 15: Security thread when viewed at different light/ angles

5.9 New Numbering Pattern:

The numbers in both the number panels tends to increase from left to right while the first three alpha numeric characters remains constant in size.

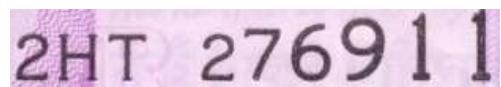
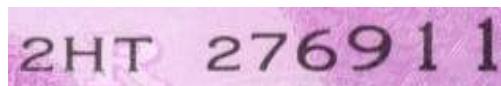


Fig. 16: Number panels at top left and bottom right.

5.10 Latent Image:

The latent image is a safety feature that is covered within the note. It is visible only when it is held horizontally at eye level. The obverse of Rs.2000 currency note come with a horizontal band towards the down left of the currency note and encompasses a latent image featuring the denominational value in numeral.



Fig. 17: Latent Image of 2000 Denomination.

VI. METHODOLOGY FOR CURRENCY RECOGNITION USING IMAGE PROCESSING

The currency recognition and authentication based on Image processing technique consists of few basic steps like image acquisition, its pre-processing and finally recognition of the currency. Image processing generally involves three steps:

1. Import a currency image with a scanner or directly through digital camera.
2. Manipulate or investigate the image with the help of Image processing.
3. Output the result.

The flow of the proposed methodology involves following steps:

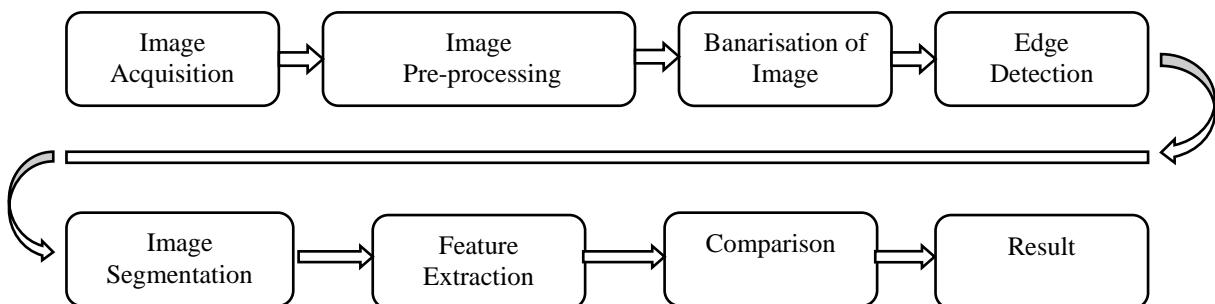


Figure 18: Flowchart of the steps involved in currency recognition technique

6.1 Image Acquisition:

Performing image acquisition in image processing is always the first step. There are various ways to acquire image such as with the help of camera or scanner. The image that is acquired is completely unprocessed and is the result of scanner which was used to generate it, which can be very important in some fields to have a consistent baseline from which to work. Acquired image should retain all the features.

6.2 Image Pre-processing:

The main objective of the pre-processing to improve the appearance of images. Pre-processing removes undesired distortions or improve some image features that are essential for further processing or analysis. Image Pre-processing consist of Image smoothening and Image adjusting.

6.3 *Binarization:*

The image acquired is in RGB color. It is transformed into gray scale because it carries only the intensity information which is easy to process instead of processing three components R (Red), G (Green), B (Blue).

6.4 Edge Detection:

Edge detection is the name for a set of mathematical methods which aim at recognizing points in a digital image at which the image brightness changes sharply or, more formally, has these continuities. The points at which image. Brightness changes sharply are typically organized into a set of curved line segments termed edges. For finding the boundaries of objects within images Edge detection technique is used. It works by detecting discontinuities in brightness. Edge detection is used for image segmentation and data extraction in areas such as image processing, computer vision, and machine vision.

6.5 Image Segmentation:

Image segmentation is the process of partitioning a digital image into multiple Segments. The objective of segmentation is to simplify and change the representation of an image into something that is more meaningful and easier to investigate. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. Segmentation algorithm for images generally are based on one of the two basic properties of image intensity values-

- Discontinuity: Based on sudden changes in intensity such as edges in an image.
- Similarity: Based on partitioning an image into regions that are similar according to a set of predefined criteria.

6.6 Feature Extraction:

Feature extraction is a special form of dimensional reduction. When the input data to an algorithm is suspected to be very redundant and too large to be processed and it is then the input data will be transformed into a compact representation set of features. Transforming the input data into the set of reduced features is called feature extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input. This approach is useful when image sizes are large and a reduced feature representation is required to quickly complete tasks such as image matching and retrieval. Some features of an image are: Size or Area. Every

denomination differs from each other in the size parameter. Therefore size can be used as a feature for currency recognition. But the major limitation of this feature is that the size of the image varies depending on the distance from which photo of the image has been taken. To overcome this problem a new parameter named aspect ratio was used to classify the denominations.

6.7 Comparison:

In comparison the features extracted from the images of the currency notes plays a very important role. Basically, it is the comparison of the features that enables to differentiate counterfeit notes from the genuine ones.

6.8 Result:

The above steps will be followed to identify the counterfeit currency note of Rs. 2000 and Rs. 500. The images were acquired using the camera and then features were extracted from the acquired images using an Image processing. The identification between genuine and counterfeit currency was done on the basis of dissimilarity and discontinuity between them. The extracted features were used for fake currency detection. The decision whether a note is counterfeit or real was made by comparing the values of the two notes.

RESULTS

7.1 Denomination Recognition:

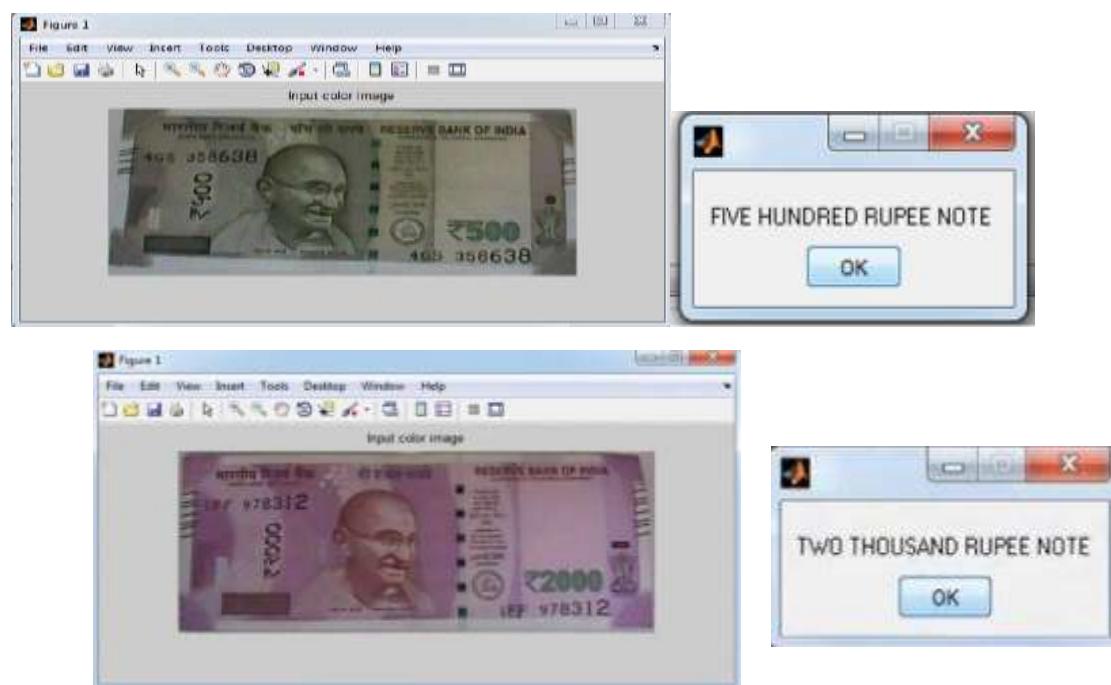


Fig. 19: Denomination Recognitionn of currency note of 500 and 2000.

7.2 Denomination Authentication:

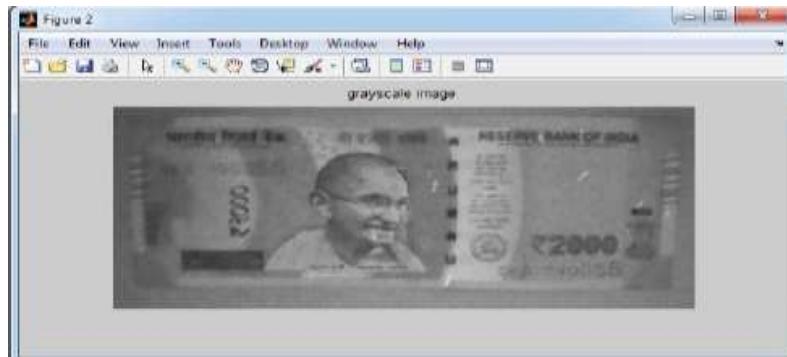


Fig 20: Grey scale converted image of 2000.



Fig 21: Final Output of the Currency AuthenticationSystem.

VIII. CONCLUSION

This paper proposes a novel method for recognition and authentication of Indian paper currency note using Image processing with MATLAB. The paper also include the study of detailed information about the various distinct security features that are embedded in the original Indian currency note of the denominational value 2000 using multispectral imaging. This study also exposes the features that do not appear in the photocopy and scanned currency notes so as to offer a better knowledge and idea about variance in the genuine and fake currency. The work will surely be very useful for minimizing the counterfeit currency. Every individual must have knowledge about these security features in order to prevent the counterfeiting of currency notes. In future this work also extended for different newly introduced denominations.

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