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VARIOUS FAKE CURRENCY DETECTION TECHNIQUES

Megha Thakur[1], Amrit Kaur[2]
Department Of Electronics and Communication
Punjabi University
Patiala, Punjab, India

Abstract: ***This paper presents the various fake currency detection techniques. Fake currency is imitation currency produced without the legal sanction of the state or government. Producing or using fake currency is a form of fraud or forgery. Over the past few years, as a result of the great technological advances in colour printing, duplicating and scanning, counterfeiting problems have become more and more serious. Therefore the issue of efficiently distinguishing counterfeit banknotes from genuine ones via automatic Fake currency detection system has become more and more important. Fake currency detection system can be used in places such as shops, banks counter and automated teller machine, auto seller machines etc. We have reviewed different fake currency detection systems. The systems are developed using different methods and algorithms. The benefits of this study for the reader are that this study will provide information about the different methods and algorithms used for fake currency detection system. They can compare the detection systems. Detection ability depends on the currency note characteristics of particular country and extraction of features.***

Keywords: Fake currency, Digital image processing, counterfeit detection.

I. INTRODUCTION

Fake currency is imitation currency produced without the legal sanction of the state or government. Producing or using Fake currency is a form of fraud or forgery. Counterfeiting is almost as old as money itself. Before the introduction of paper money, the most prevalent method of counterfeiting involved mixing base metals with pure gold or silver. A form of counterfeiting is the production of documents by legitimate printers in response to fraudulent instructions.

Some of the ill-effects that counterfeit money has on society include a reduction in the value of real money; and increase in prices due to more money getting circulated in the economy- an unauthorized artificial increase in the money supply; a decrease in the acceptability of paper money; and losses, when traders are not reimbursed for counterfeit money detected by banks, even if it is confiscated. According to figures disclosed in Parliament, during the 2006-09, 7.34 lakh of Rs 100 notes, 5.76 lakh of Rs 500 notes and 1.09 lakh of Rs 1000 notes, all fakes, have been seized. The number of fake notes per million have increased from 4.4 in 2007-08 to 7.51 in 2011-12. For higher denominated notes (Rs 500 and Rs 1000) the increase was almost double: from 9.7 in 2007-08 to 18.2 in 2011-12. This is considered only as the "tip of the iceberg" when compared to the total unseizured notes in the Indian market. The Nayak Committee, appointed to assess the menace of fake currency, puts the total amount of fake currency in circulation in India at about Rs 1,69,000 crore as of 2000 (in other words, eight per million were fake). The magnitude of the problem, therefore, is immense [15]. To distinguish between fake and real currency notes has become increasingly difficult mainly due to the fact that counterfeits are now printed with state of the art technology using security paper [15]. Due to great technological advancement counterfeiting problems have become more and more serious. Therefore the issue of efficiently distinguishing counterfeit banknotes from genuine ones via automatic machines has become more and more important [9]. The fake currency detection system is developed to detect the fake currency by applying different techniques and methods on currency note. The fake currency detection system should be able to recognize the note quickly and correctly. The fake currency detection system should be able to recognize currency note from any side. Currency recognition system can be used in places such as shops, banks counter and automated teller machine, auto seller machines etc [12]. We have reviewed different fake currency detection systems. The systems are developed using different methods and algorithms. The benefits of this study for the reader are that this study will provide information about the different methods and algorithms used for fake currency detection system. They can compare the detection systems. Detection ability depends on the currency note characteristics of particular country and extraction of features [11].

II. DIFFERENT FAKE CURRENCY DETECTION TECHNIQUES

A. Commonly Used Methods to Detect Fake Currency

1. See through Register

The small floral design printed both on the front (hollow) and back (filled up) of the note in the middle of the vertical band next to the Watermark has an accurate back to back registration. The design will appear as floral design when seen against the light.

2. Water marking

The Mahatma Gandhi Series of banknotes contain the Mahatma Gandhi watermark with a light and shade effect and multi-directional lines in the watermark window.

3. Fluorescence

Number panels of the notes are printed in fluorescent ink. The notes also have optical fibres. Both can be seen when the notes are exposed to ultra-violet lamp.

4. Security Thread
The Rs.500 and Rs.100 notes have a security thread with similar visible features and inscription 'Bharat' (in Hindi), and 'RBI'. When held against the light, the security thread on Rs.1000, Rs.500 and Rs.100 can be seen as one continuous line. The Rs.5, Rs.10, Rs.20 and Rs.50 notes contain a readable, fully embedded windowed security thread with the inscription 'Bharat' (in Hindi), and 'RBI'. The security thread appears to the left of the Mahatma's portrait.

Fig.1 Original Indian 100 denomination

5. Intaglio Printing
The portrait of Mahatma Gandhi, the Reserve Bank seal, guarantee and promise clause, Ashoka Pillar Emblem on the left, RBI Governor's signature are printed in intaglio i.e. in raised prints, which can be felt by touch, in Rs.20, Rs.50, Rs.100, Rs.500 and Rs.1000 notes.

6. Latent image
On the obverse side of Rs.1000, Rs.500, Rs.100, Rs.50 and Rs.20 notes, a vertical band on the right side of the
Mahatma Gandhi's portrait contains a latent image showing the respective denominational value in numeral. The latent image is visible only when the note is held horizontally at eye level.

7. Micro lettering
This feature appears between the vertical band and Mahatma Gandhi portrait. It always contains the word 'RBI' in Rs.5 and Rs.10. The notes of Rs.20 and above also contain the denominational value of the notes in micro letters. This feature can be seen well under a magnifying glass.

8. Identification Mark
Each note has a unique mark of it. A special feature in intaglio has been introduced on the left of the watermark window on all notes except Rs.10/- note. This feature is in different shapes for various denominations (Rs. 20-Vertical Rectangle, Rs.50- Square, Rs.100-Triangle, Rs.500-Circle, and Rs.1000- Diamond) and helps the visually impaired to identify the denomination.

9. Optically Variable Ink
This is a new feature included in the Rs.1000 and Rs.500 notes with revised color scheme introduced in November 2000. The numeral 1000 and 500 on the obverse of Rs.1000 and Rs.500 notes respectively is printed in optically variable ink viz., a color-shifting ink. The colour of the numeral 1000/500 appears green when the note is held flat but would change to blue when the note is held at an angle.

B. Digital Image Processing Method To Detect Fake Currency
The design flow of fake currency detection system includes eight stages: Image acquisition, pre-processing, gray scale conversion, edge detection, image segmentation, feature extraction, comparison and output [11]. This system is works on two images, one is test currency image on which authentication is to performed and other is the original currency image.

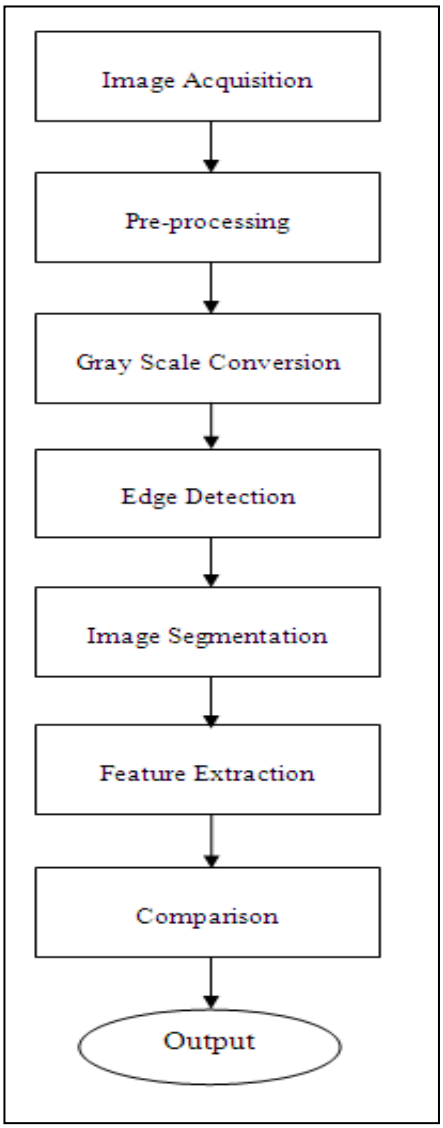

Fig.2 Flow Chart of Digital Image Processing Method To Detect Fake Notes

1. Image Acquisition
There are various ways to acquire image such as with the help of camera or scanner. Acquired image should retain all the features [11].

2. Pre-Processing
Pre-processing of image are those operations that are normally required prior to the main data analysis and extraction of information. The aim of image pre-processing is to suppress undesired distortions or enhance some image features that are important for further processing or analysis. It includes

2.1 Image Adjusting
When we get the image from a scanner, the size of the image is so big. In order to reduce the calculation, we decrease the size of image. Image Adjusting is done with the help of image interpolation. Interpolation is the technique mostly used for tasks such as zooming, rotating, shrinking, and for geometric corrections.

2.2 Image smoothening
When using a camera or a scanner and perform image transfers, some noise will appear on the image. Image noise is the random variation of brightness in images. Removing the noise is an important step when image processing is being performed. However noise may affect segmentation and pattern matching. When performing smoothing process on a pixel, the neighbor of the pixel is used to do some transforming. After that a new value of the pixel is created. The neighbor of the pixel is consisting with some other pixels and they build up a matrix, the size of the matrix is odd number, the target pixel is located on the middle of the matrix. Convolution is used to perform image smoothing. Also image smoothening can be done with the help of median filter which more effective than convolution when goal is to simultaneously reduce the noise preserving edges. Median filter replaces a pixel via the median pixel of all the neighborhoods [11].

3. Gray-scale conversion:
The image acquired is in RGB color. It is converted 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) [7].

4. Edge detection
Edge detection is a fundamental tool in image processing and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. Edge detection is one of the fundamental steps in image processing, image analysis, image pattern recognition, and computer vision techniques [9].

5. Image segmentation
Image segmentation sub divides the image into its constituent regions or objects. The level to which sub division is carried depends on the problem being solved. Segmentation algorithm for monochrome images generally are based on one of the two basic properties of image intensity values-

- Discontinuity
- Similarity.

In the first category, the approach is to partition an image based on abrupt changes in intensity such as edges in an image. The approach in the second category is based on partitioning an image into regions that are similar according to a set of predefined criteria [9].

6. Feature Extraction
In pattern recognition and in image processing, feature extraction is the special form of dimensionality reduction. It is the method of capturing the visual content of images for indexing and retrieval. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (much data but not much information) then the input data will be transformed into a reduced representation set of features (also named feature vector). If the attributes extracted are carefully chosen, it is expected that the attributes 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. Feature extraction involves simplifying the amount of resources required to describe the large set of data.

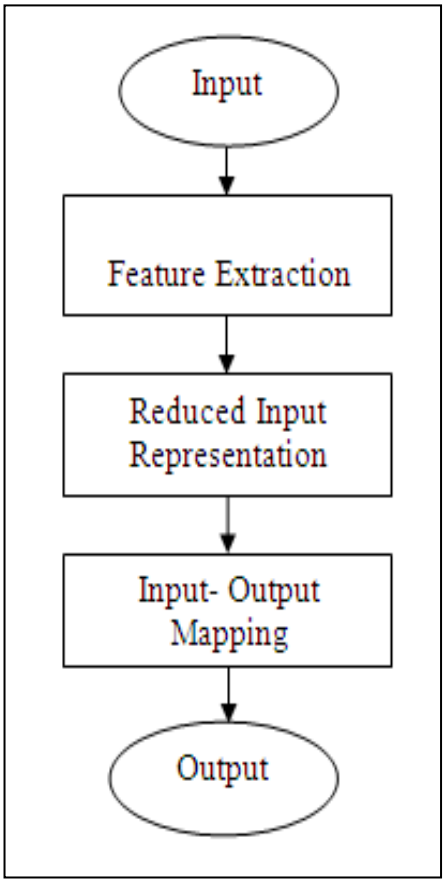

Fig.3 Feature Extraction Approach

Visual attributes of images are of two types-

- Domain specific attributes which include fingerprints, human faces.
- General attributes which include color, texture, and shape.

There are two types of attributes categorized under the shape attribute extraction-

- Global attributes include moment invariant, aspect ratio and circularity.
- Local attributes include boundary segments [7].

7. Comparison

Lastly the extracted features of test currency image are compared with the extracted features of original currency image, if it matches then the currency is original otherwise fake [7].

C. MATLAB technique:

In this technique one can split the red, blue, green components of a picture and name them as r1, g1, b1 which correspond to image i.e. original currency note. Consider second image that is note to be tested. Split this image to components r2, b2, g2. Construct a new image with components as r1, g2, b1 or r2, g1, b1 or b2, g1, b1. But r1,g2,b1 combination is most preferred because human eye is sensitive to green component and most of our images contains maximum green component so that our output image will be much easier to identify the fake note more efficiently. After that compare newly constructed image with image1.Calculate the threshold value of equivalence by calculating the standard deviation. If equivalence is above 40% then one can consider it as original note. Here consider 40% value because note may be damaged. Parameters for measure of comparing images are Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR in dB), and structural Content (SC).When combine two various components of two images then if note to be tested is original then only at the place of number we get variation. But in case of fake note after applying the same code, one can observe that the image overlapping is not done correctly. One can also see that the resultant image is blurred indicating fake note. So one can confirm that it is a fake note [6].

D. Counterfeit Detection Pen:

A counterfeit pen is simply an inexpensive device that is designed to determine if a currency note is original or fake. The pen contains a tincture of iodine as ink which, when drawn over a note, will remain amber or brown. According to one manufacturer the ink will turn black if the note is fake.

1. Working of counterfeit pen:

The iodine in the pen reacts with starch, which is the primary component that makes white paper look brighter. Most commercial paper, made from wood pulp, is brown unless bleached and starched. If there is no starch present in the paper then the pen will indicate - by remaining amber- that the note is original.

2. How counterfeiters defeat this pen:

The iodine in the pen reacts with starch that makes white paper look brighter. Most unless bleached and starched. If there is no starch present in the paper then the pen will indicate – by remaining amber - that the note is original [6].

E. Other techniques:

The other anti-counterfeit device for the money is an Ultraviolet counterfeit detection scanner. Best used in highly lit point of sale locations, the UV detector identifies the ultraviolet security features present in most currencies. By simply placing the note in the detector, counterfeit currency is immediately identified, without the need for an employee to closely examine the note [6].

III. CONCLUSION

In this study, we discussed various fake currency detection techniques, each one has its own significance. By using mentioned methods we have observe that good results can be obtained quickly and correctly. The benefits of this study for the reader are that this study will provide information about the different methods and algorithms used for fake currency detection system. They can compare the detection systems.

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