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Recognition of Fake Currency Based on Security Thread Feature of Currency

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Abstract: ***In the last few years a great technological advances in color printing, duplicating and scanning, counterfeiting problems have become more serious. In past only authorized printing house has the ability to make currency paper, but now a days it is possible for anyone to print fake bank note with the help of modern technology such as computer, laser printer. Fake notes are burning questions in almost every country. Counterfeit notes are a problem of almost every country but India has been hit really hard and has become a very acute problem. Fake Indian currency of 100, 500 and 1000 rupees seems to have flooded the whole system and there is no proper way to deal with them for a common person. There is a need to design a system that is helpful in recognition of paper currency notes with fast speed and in less time. Our system describes an approach for verification of Indian and other countries currency banknotes. The currency will be verified by using image processing techniques.***

Keywords: Security Features, Currency Recognition & Converter, Image Processing, Counterfeit Currency

1. Introduction

There are many type of currencies in the world, with each of them looking different with their features i.e. differ in the size of the banknotes, color, texture etc. the people who work in the money exchange have to differentiates all the type of currencies. They have to keep all the features of the all the banknotes that may cause some problems, so they need an efficient and exact system to help their work. The aim of system is to help the people who need to recognize different currencies and with convinces and efficiency.

There are machines helps the people to recognize different kinds of currencies. But for most working staff in money exchange have to keep a lot of different characteristics and anti-fakes label for different commonly-used currencies in their mind. However, everyone has a handbook that about the characteristics and anti-fakes labels of come commonly-used currencies. No one can ever be 100 percent confident about the manual recognition.

All currencies around the world look totally different from each other. For instance the size of the paper is different, the same as the colour and pattern. The staffs who work at places like money exchange offices have to distinguish between different types of currencies and that is not an easy job. They have to remember the symbol of each currency. This may result into wrong recognition, so they need an efficient and foolproof system to aid in their work.

The aim of our system is to help people who need to recognize different currencies, and work with convenience and efficiency. With development of modern banking services, automatic methods for paper currency recognition become important in many applications such as vending machines. It is very difficult to count different denomination notes in a bunch. This paper proposes an image processing technique for paper currency recognition and conversion. The extracted region of interest (ROI) can be used with Pattern Recognition and Neural Networks matching technique [1]

2. Potential Applications

Recent years have seen an increased interest in currency recognition system worldwide. And this is because of the various potential applications it has [2].

- **Distinguishing original note from counterfeit currency-** One important application is to distinguish original note from counterfeit currency so that it would be very helpful in encountering the counterfeit note that is flowing throughout economy.
- **Automatic selling-goods-**The system must be very helpful for automatic selling goods. Vendors may sometimes get confuse when there is a huge crowd in a market. There is a possibility of being miscalculation on some of the goods. So the system will help vendors in keeping records of goods sold and the amount received.
- **Banking Applications-** The system should be very helpful in banking application such as counting of notes and its value during monetary transactions, detection of counterfeit notes, etc. Such a system will make the banking process a trustworthy and reliable process. As time is the important factor in today's world so such system will be helpful in saving time too.

3. Problem Formulation

Automatic methods for paper currency recognition become important in many applications such as automated teller machine and automated goods seller machines. This system is

designed to recognize and verify the Indian paper currency. The approach consists of a number of steps including image acquisition, gray scale conversion, edge detection, feature extraction, image segmentation and comparison of images as shown in figure 1 [15].

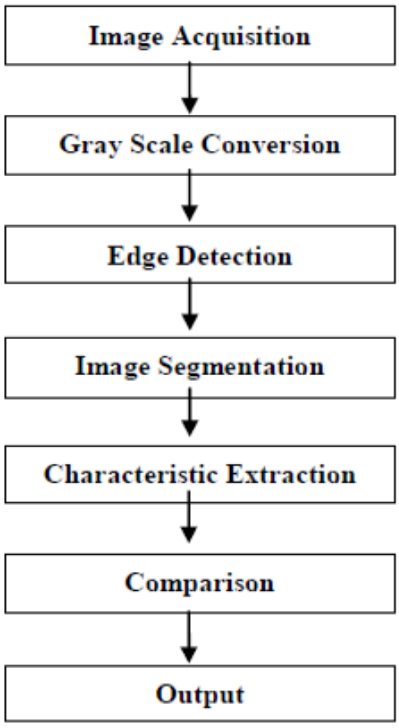

Figure 1: Block diagram of paper currency recognition

3.1 Image Acquisition

Image is acquired by digital camera by applying the white backlighting against the paper currency so that the hidden attributes are able to appear on the image of the currency.

3.2 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). Image is acquired in step 1 is large to continue process and colour information is not needed, except the colour index. First, RGB image is converted to pixel values and then to gray scale [16].

3.3 Edge detection

It is the fundamental tool in image processing, which aim at identifying points in digital image at which the image brightness changes sharply or has discontinuities. There are many ways to perform edge detection. . Edges are detected of the gray scale image of paper currency using Sobel operator. It smoothes the image and calculate the gradient of the image. Edge detection is one of the fundamental steps in image processing, image analysis, image pattern recognition, and computer vision techniques.

3.4 Image segmentation

Segmentation is the process of partitioning a digital image into multiple segments. It is typically used to distinguish objects from backgrounds. Here edge based segmentation is performed on the image. Image segmentation sub divides the image into its constituent regions or objects [17].

3.5 Feature extraction

Now the features are extracted using edge based segmentation and objects and background are separated. It is a challenging work in digital image processing. In any currency recognition system, feature extraction is one of the most challenging tasks. Here, the aim is to analyze and identify the unique and distinguishing features of each denomination under various challenging conditions such as old notes, worn out notes, also under different illumination and background.

3.6 Comparison

Lastly the extracted features are compared with the extracted features of original currency by calculating the number of black pixels of segmented image. If the pixels of segmented image of test currency are approximately equal to the pixels of segmented image of original currency then the currency is found to be genuine otherwise counterfeit.

3.7 Output

The output will be currency denomination and either “The note is Genuine” or “The note is fake” at a time anyone will be display.

4. Proposed Algorithm

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The aim of our system is to help people who need to recognize different currencies, and work with convenience and efficiency. With development of modern banking services, automatic methods for paper currency recognition become important in many applications such as vending machines. It is very difficult to count different denomination notes in a bunch. This thesis proposes an image processing technique for paper currency recognition. The extracted region of interest (ROI) can be used with Pattern Recognition and Neural Networks matching technique.

The image processing approach is discussed with MATLAB to detect the features of paper currency. Image Processing involves changing the nature of an image in order to improve its pictorial information for human interpretation. There are various techniques for currency recognition that involve texture, pattern or colour based. We use digital image processing techniques to find region of interest, after that Neural Network and Pattern Recognition Technique is used for matching the pattern.

The proposed system will work on two images, one is original image of the paper currency and other is the test image on which verification is to be performed. A number of methods for banknote classification have been proposed. Template matching is often used as a simple method to classify banknotes. However, new template or matching rules are required for new bill types. An effective way to overcome the

problem is to extract features from bill images representing unique characteristics of bill data.

4.1 Algorithm

1) Obtain the image of the target currency using one of the possible methods (e.g.: Camera, Scanner, etc)

2) Use Image Pre-processing algorithms to change the nature of the image in order to extract required information.

3) Detect the boundaries and extract the ROI (Region of Interest) using cropping.

4) Extract the desired features.

5) Compare the extracted feature values with ideal feature values that are calculated.

6) Display the outputs.

4.2 Description of the Proposed Algorithm:

Aim of the proposed algorithm is to develop an algorithm which can be easily applied to number of different currencies and has good efficiency and high speed.

Step 1: Obtaining the Image:
An Image can be obtained using number of different equipments, such as cameras or Scanner. The only precaution we need to take is, try to maintain a controlled environment so that the external factors won't affect the feature values.

Step 2: Pre-processing Operations:
Pre-processing operations are required to alter the nature of the image, which makes extraction of features easier. In this particular case, pre-processing operations involve, blurring, grayscale conversion, thresholding, noise removal using filters, color blurring RGB to HSV conversion. These operations help us in detecting boundaries, cropping the ROI and Calculating color features.

Step 3: Boundary Detection and cropping:
For boundary detection, we require a binary image, which has only 2 colors, black and white. All we do in this process is simply, separate the background and the foreground, and separate the ROI.

Step 4: Feature extraction:
The next step is to extract required information from the cropped ROI image. So from the binary image we find out the dimensions of the currency and find out the aspect ratio, aspect ratio remains same in all light conditions, so it becomes an important feature for recognizing image. Then we compare the aspect ratio of the target image with the ideal aspect ratios of all the denominations of that particular currency. The other features we extract are H, S and V of particular blocks of the currency. We divide the currency in number of blocks. We extract the HSV values of all the pixels and take average of their H, S, V features and again compare them with the values from the database. We use Euclidian distance equation for finding out the average values of the differences between the target and Ideal HSV features

$$d(p, q) = \sqrt{(h2 - h1)^2 + (S2 - S1)^2 + (V2 - V1)^2}$$

Where,
(H1, S1, V1) = Target image feature set
(H2, S2, V2) = Ideal feature set.

HSV is abbreviated to Hue, Saturation and Value. Hue is pure color and is measured by degrees or percentage. Saturation is the radius in the circle. Value (V = 1 or 100%) corresponds to pure white (R = G = B = 1) and to any fully saturated color.

Step 5: Displaying results:
To display the results, we have built a graphical User Interface (GUI); where we are providing a various graph to identify fake currency according to extracted feature.

A block diagram is given below in figure 2 below that represents the processes is done for our currency recognition system.

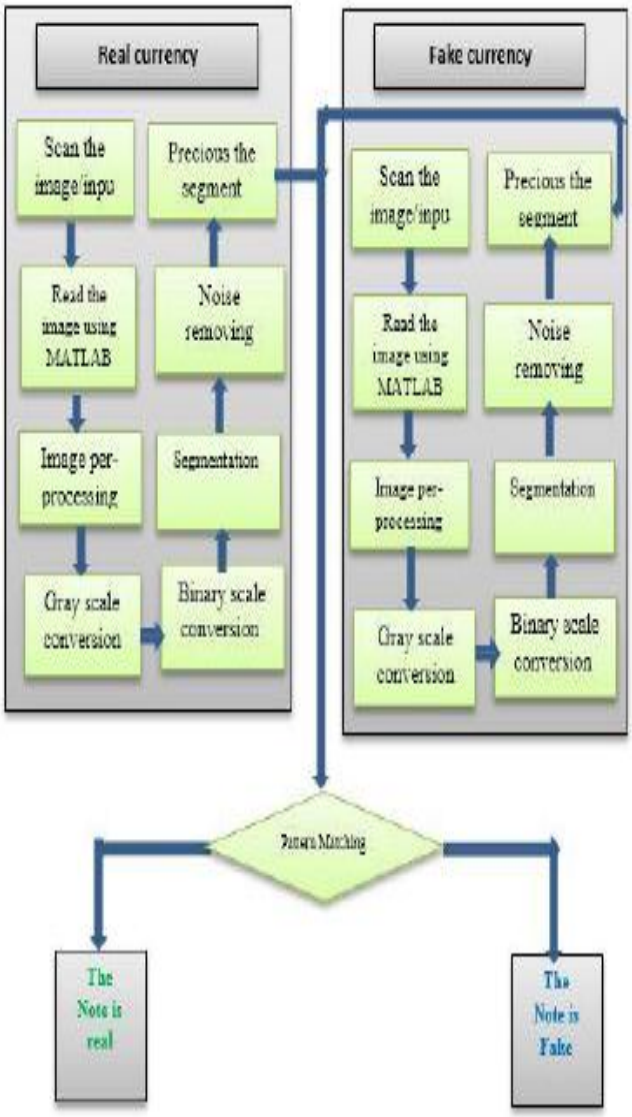

Figure 2: Block diagram of identifying fake and real currency

5. Implementation and Results

The security thread is a security feature of many banknotes to protect against counterfeiting. It consists of a thin ribbon that is threaded through the paper notes. Usually, the ribbon runs vertically, and is woven into the paper. It has characters engraved on it. Threads are embedded within the paper fiber and can be completely invisible or have a star burst effect, where the thread appears to weave in and out of the paper when viewed from one side. However when held up to the light the thread will always appear as a solid line. Features can be built into the thread material e.g. it is a difficult feature to counterfeit but some counterfeiters have been known to print a thin grey line or a thin line of varnish in the area of the thread. Security threads can also be used as an anti-counterfeiting device in passports.

In a paper currency I want to check the strip is broken or solid line. For that I took a picture with the background a strong light. And I got the following two pictures, one a genuine currency and the other a fake one. I cropped the image at the position where the strip exist and did opening-closing reconstruction, and finally to count the black pixels.
Implementation steps are explained below:

Step 1: Read in the Image

```
Ireal = imread('real500.jpg'); % Real
Ifake = imread('fake500.jpg'); % Fake
```

Step 2: Decompose image into HSV and analyse

```
hsvImageReal = rgb2hsv(Ireal);
hsvImageFake = rgb2hsv(Ifake);
```

Step 3: Threshold the saturation and value planes to create a binary image

```
croppedImageReal = hsvImageReal(:,90:95,:);
croppedImageFake = hsvImageFake(:,93:98,:);
satThresh = 0.4;
valThresh = 0.3;
BWImageReal = (croppedImageReal(:,:,2) >
satThresh & croppedImageReal(:,:,3) < valThresh);
figure;
subplot(1,2,1);
imshow(BWImageReal);
title('Real');
BWImageFake = (croppedImageFake(:,:,2) >
satThresh & croppedImageFake(:,:,3) < valThresh);
subplot(1,2,2);
imshow(BWImageFake);
title('Fake');
```

Step 4: Do some minor closings

```
se = strel('line', 6, 90);
BWImageCloseReal = imclose(BWImageReal, se);
BWImageCloseFake = imclose(BWImageFake, se);
figure;
```

Step 5: Final cleanup

```
figure;
areaopenReal = bwareaopen(BWImageCloseReal, 15);
imshow(areaopenReal);
title('Real');
figure;
areaopenFake = bwareaopen(BWImageCloseFake, 15);
imshow(areaopenFake);
title('Fake');
```

Step 6: Count the number of black lines

```
[~,countReal] = bwlabel(areaopenReal);
[~,countFake] = bwlabel(areaopenFake);
```

Figure 3 below shows the real and fake Indian currency of 500 rupees

Figure 3: Images of Real & Fake Indian Currency

Figure 4 below shows the decomposition of images Real & Fake into HSV.

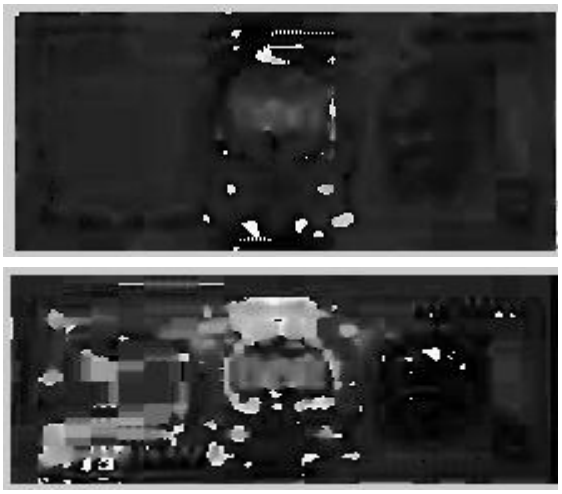

Figure 4: Decomposition of images Real & Fake into HSV

Figure 5 below shows the result after threshold the saturation and value planes of Real & Fake Images.

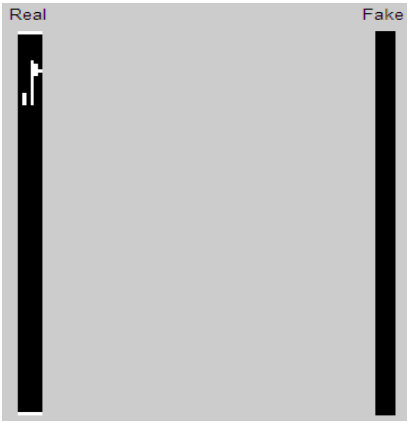

Figure 5: Threshold the saturation & value planes

6. Conclusion

In the world, currency is the main role as medium of exchange where government of many countries introduces as banknotes and coins that is Indian rupees, dollar, Yuan, dinar etc. in different appearance such as picture of our leaders, different color, size, serial numbers, watermarks. There are machines helps the people to recognize different kinds of currencies. But for most working staff in money exchange have to keep a lot of different characteristics and anti-fakes label for different commonly-used currencies in their mind. The aim of our system is to help people who need to recognize different currencies, and work with convenience and efficiency. This paper proposes an image processing technique for paper currency recognition. The extracted region of interest (ROI) can be used with Pattern Recognition and Neural Networks matching technique.

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