Indian Institute of Information Technology, Nagpur

FAKE CURRENCY DETECTION USING IMAGE PROCESSING

Project Report

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Contents

Abstract

Fake Currency Detection: The advancement of color printing technology has increased the rate of fake currency note printing and duplicating of the notes on a very large scale.Fake Currency has always been an issue which has created a lot of problems in the market. The increasing technological advancements have made the possibility for creating more counterfeit currency which are circulated in the market which reduces the overall economy of the country. There are machines present at banks and other commercial areas to check the authenticity of the currencies. But it is not feasible for every man and they do not have access to such systems and hence a need for a software to detect fake currency arises, which can be used by common people. This proposed system uses Image Processing to detect whether the currency is genuine or counterfeit.It consists of the steps such as grayscale conversion, edge detection, segmentation, etc. which are performed using suitable methods.The proposed system gives an approach to verify the Indian currency notes.This report describes extraction of various features of Indian currency notes. MATLAB software is used to extract the features of the note. The proposed system has got advantages like simplicity and high performance speed. The result will predict whether the currency note is fake or not.

Keywords:— Counterfeit currency, Image Processing,MATLAB, grayscale conversion, edge detection, segmentation

Introduction

Introduction: Different countries around the world use different types of currencies for the monetary exchange of some kinds of goods. One common problem faced by many countries related to currency, is the inclusion of fake currency in the system. India is one of the countries that face a lot of problems and huge losses due to the fake currencies. Due to this there are losses in the overall economy of the country's currency value.The technological advancements have made a pathway for currencies to be duplicated such that it cannot be normally recognized. Advanced printers and new editing computer softwares are used to create counterfeit currencies. Fake currencies can just be slipped into bundles of genuine currency which is how they are usually circulated in the market.Commercial areas like the banks, malls, jewelry stores, etc have huge amount of transactions on a daily basis. Such places may be able to afford and find it feasible to buy machines that use UV light and other techniques to detect the authenticity of the currency. But for common people it is very difficult to just detect whether the currency is fake or genuine and they may face losses especially during bank deposits or transactions. This system is designed such that any person can use it easily and detect the authenticity of the currency he has by using the visual features of the currency. This system can further be converted into an app so that it is accessible to all the people. Furthermore, this system can be designed to detect currencies of other countries as well.The system is based on Image processing where a number of steps are used to process the image of a currency and give the result to the user that the currency is genuine or not.

As,no one can be 100 percent sure of the manual recognition and so the system has been proposed to compare images of currency with the stored data and detect whether the currency is fake or genuine. This system used MATLAB to run and perform the operations of the system. The feature extraction process mostly focuses on RGB values of the currency where the image is divided into blocks and the operations are performed on the ROI.It proposes a system to improve the currency detection system especially in commercial areas like banks, shopping malls, etc. In a system is proposed to detect fake currency based on different features that can be extracted for comparison. Various methods are used at different stages histogram equalization, using feature vectors to stored extracted features, etc. The features that were used for currency detection were security thread, RBI micro-print and serial number detection.

Methodology

Methods that could help with the problem.: The current systems that are present are only machine based i.e. it is only for commercial use. The systems that use image processing are performed on MATLAB.These machines are based on optical sensing or proximity detection. In optical detection , the currency is kept under the machine and the UV light is scanned over the currency and if the currency shines due to fluoresense then it is a genuine currency. In proxy detection the ink used to make the currency contains ferromagnetic properties, so when the currency is passed through a magnetic belt and if it shows some movement then it is concluded that it is a genuine currency.
Following is the flowchart that shows the general methods used to detect fake currency using image processing

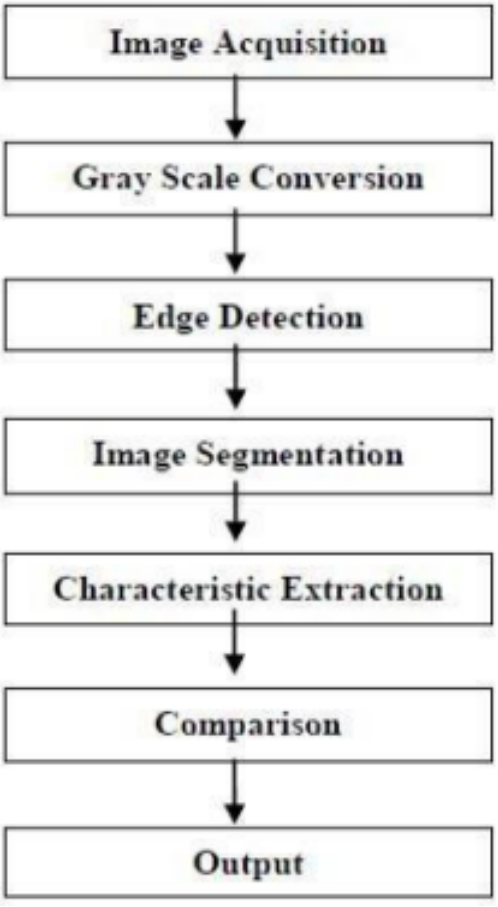


Figure 1: to Detect Fake Currency using Image Processing

The system is based on scanner, PC, and algorithm. The aid of the algorithm is located in the unique figure, RGB to Gray, image binarization, noise elimination, segmentation and the pattern matching.

If the features extracted are carefully chosen it is expected that the feature set will extract the relevant information from the input data.The following features can be taken in account:

- Portrait of Mahatma Gandhi at the center
- Micro letters 'RBI' and ' currency value' on the left side of the bank note
- Windowed security thread with inscription of RBI
- Gurantee Clause, Governor's Signature with Promise Clause and RBI emblem towards right
- Denominational numeral with rupee symbol in the bottom right
- Ashoka Pillar emblem on the right and electrotype watermarks
- Number panel with numerals growing in size on top left side and bottom right side
- Seven angular bleed lines on left and right side of currency
- Year of printing of the currency on the left
- Swacch Bharat logo with slogan

Figure 2: Features in an Indian 2000 Rupees Note for authenticity

Proposed System

Image Pre-processing: The image of the currency that has to be checked or verified as a genuine currency is taken as an input for the system. The input image can be acquired using techniques like scanning the image or clicking a picture with the phone and then uploading it to the system.The aim of pre-processing is to improve the image data that suppresses unwilling distortions or enhances some image features important for further processing.In this system, noise filtration is done.
In order to remove noises on the image, Gaussian blur is performed. Convolving the image with a Gaussian function is performed when a Gaussian blur is applied.The equation of a Gaussian function:

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$$

in two dimensions, it is the product of two such Gaussians, one in each dimension:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$ [1][2]

Figure 3: Gaussian blur for noise removal

Histogram equalization,is another process,it modifies the brightness and contrast of the image, making the image look more clear.

$$h(v) = \text{round}\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-1)\right)$$

where cdf_{min} is the minimum non-zero value of the cumulative distribution function (in this case 1), M × N gives the image's number of pixels (for the example above 64, where M is width and N the height) and L is the number of grey levels used (in most cases, like this one, 256).

Note that to scale values in the original data that are above 0 to the range 1 to L-1, inclusive, the above equation would instead be:

$$h(v) = \text{round}\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-2)\right) + 1$$

where cdf(v) > 0. Scaling from 1 to 255 preserves the non-zero-ness of the minimum value.

Figure 4: Histogram Equalisation

Gray scale conversion: A pixel color in an image is a combination of three colors Red, Green, and Blue(RGB).Similarly, A Grayscale image can be viewed as a single layered image.A gray scale image is the value of each pixel which is a single sample. That means it carries only intensity information. Different techniques can be used to convert a coloured image to grayscale image such averaging method.The conversion of image to a grayscale image reduces the complexity of code.

Edge Detection: The grayscale image is the input to this step.Edge detection is an image processing technique for finding the boundaries of objects within image. It works by detecting discontinuities in brightness. Edge detection is used for image segmentation and data extraction in the area of image processing and computer vision. The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world. Edge detection helps to detect all the edges of the necessary ROI to perform various operations in the latter stages.Not only are edges visually striking, but it is often possible to describe or reconstruct a complete figure from a few key lines.

Segmentation : Image segmentation is the process of dividing an image into multiple parts. This is typically used to identify objects or other relevant information in digital images. It aims to divide an image into parts that have a strong correlation with objects. There are various methods like thresholding, clustering methods, region based segmentation, etc. to perform segmentation in image processing.

Feature Extraction and Comparison : Feature extraction is a type of dimensionality reduction that efficiently represents the parts of image,which holds information as a compact feature vector. 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. The features are extracted and then used for comparison in the further step.

Concluding final Result : Image analysis is a means that the meaningful information from an image is extracted mainly from digital images by means of digital image processing techniques. The features that are extracted from the previous step are used for comparing with the stored features and then the results are displayed as to the currency being genuine or fake.

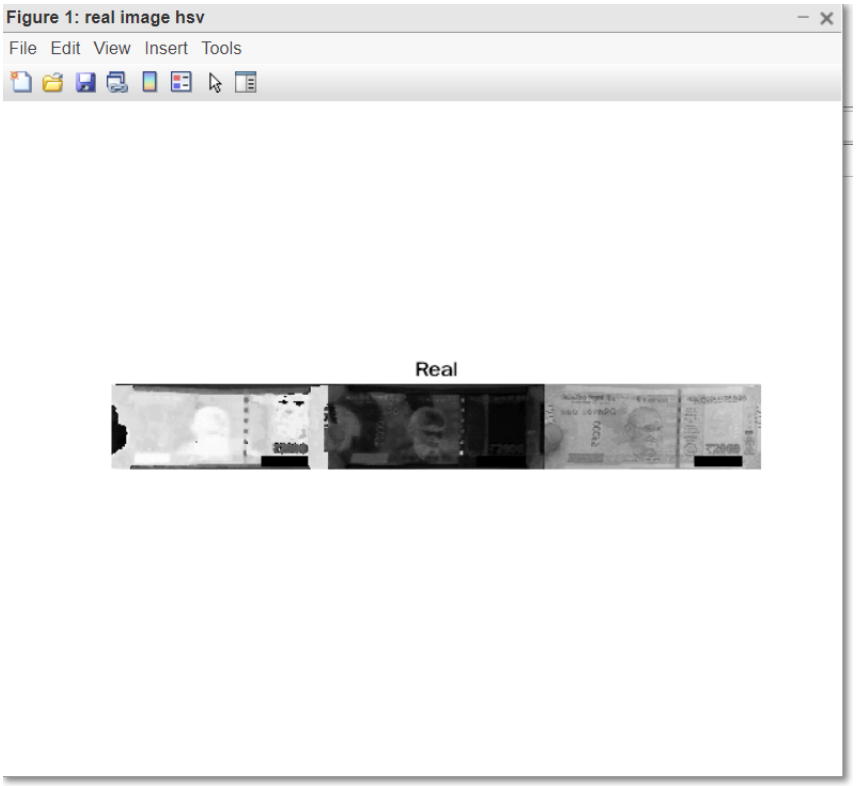
Code and Output

Code:

```
clc;
clear;
close all;

A=imread('Real.jpg');
P=imread('duplicate.jpg');

a = rgb2gray(A);
p = rgb2gray(P);


%[I2, rect] = imcrop(a);
a2_tr = imcrop(a,[2218.5 204.5 535 521]);  %transparent gandhi 1
b2_tr = imcrop(p,[2218.5 204.5 535 521]);  %transparent gandhi 2


a2_str = imcrop(a,[1766.5 4.5 63 1096]);   %thin strip 1
p2_str = imcrop(p,[1666.5 4.5 63 1096]);   %thin strip 2



%decompose into hsv

hsvImageReal = rgb2hsv(A);
hsvImageFake = rgb2hsv(P);


figure('Name','real image hsv');
imshow([hsvImageReal(:,:,1) hsvImageReal(:,:,2) ...
    hsvImageReal(:,:,3)]);
title('Real');
figure('Name','fake image hsv');
imshow([hsvImageFake(:,:,1) hsvImageFake(:,:,2) ...
    hsvImageFake(:,:,3)]);
title('Fake');

%create black and white image

%croppedImageReal = imcrop(hsvImageReal,[1766.5 4.5 63 1096]);
croppedImageReal = imcrop(hsvImageReal,[1778.5 13.5 57 963]);
%croppedImageFake = imcrop(hsvImageFake,[1666.5 4.5 63 1096]);
croppedImageFake = imcrop(hsvImageFake,[1673.5 4.5 96 1096]);

satThresh = 0.3;
```

```
valThresh = 0.9;
BWImageReal = (croppedImageReal(:,:,2) > satThresh & ...
    croppedImageReal(:,:,3) < valThresh);
figure('Name',' strips');
subplot(1,2,1);
imshow(BWImageReal);
title('Real');
BWImageFake = (croppedImageFake(:,:,2) > satThresh & ...
    croppedImageFake(:,:,3) < valThresh);
subplot(1,2,2);
imshow(BWImageFake);
title('Fake');

%closing

se = strel('line', 200, 90);
BWImageCloseReal = imclose(BWImageReal, se);
BWImageCloseFake = imclose(BWImageFake, se);
figure('Name','closed  strips');
subplot(1,2,1);
imshow(BWImageCloseReal);
title('cReal');
subplot(1,2,2);
imshow(BWImageCloseFake);
title('cFake');

%cleanup

figure('Name','cleaned green strips');
areaopenReal = bwareaopen(BWImageCloseReal, 15);
subplot(1,2,1);
imshow(areaopenReal);
title('clReal');
areaopenFake = bwareaopen(BWImageCloseFake, 15);
subplot(1,2,2);
imshow(areaopenFake);
title('clFake');

%count black lines

[¬,countReal] = bwlabel(areaopenReal);
[¬,countFake] = bwlabel(areaopenFake);
%disp(['The total number of black lines for the real note is: ' ...
    num2str(countReal)]);
%disp(['The total number of black lines for the fake note is: ' ...
    num2str(countFake)]);

co=corr2 (a2_str, p2_str);

```

```
%display of conclusion

if (co≥0.5 && countReal == 1 && countFake ≠ 1 )
    disp ('correlevance of transparent gandhi > 0.5');
    if (countReal == 1 && countFake ≠ 1 )
        disp ('currency is legitimate');
    else
        disp ('green strip is fake');
    end;
else
    disp ('correlevance of transparent gandhi < 0.5');
    disp ('currency is fake');

end;
```



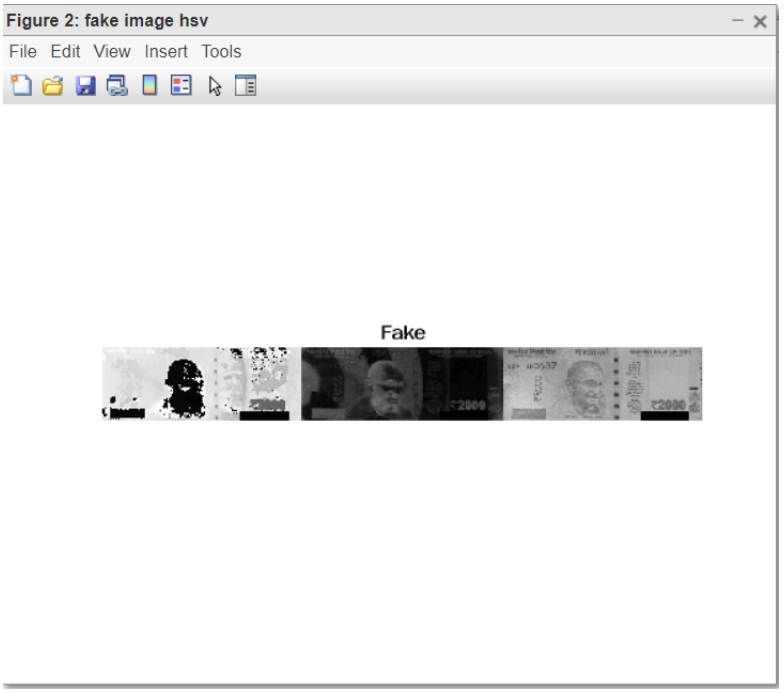


Figure 2: fake image hsv
File Edit View Insert Tools
Fake

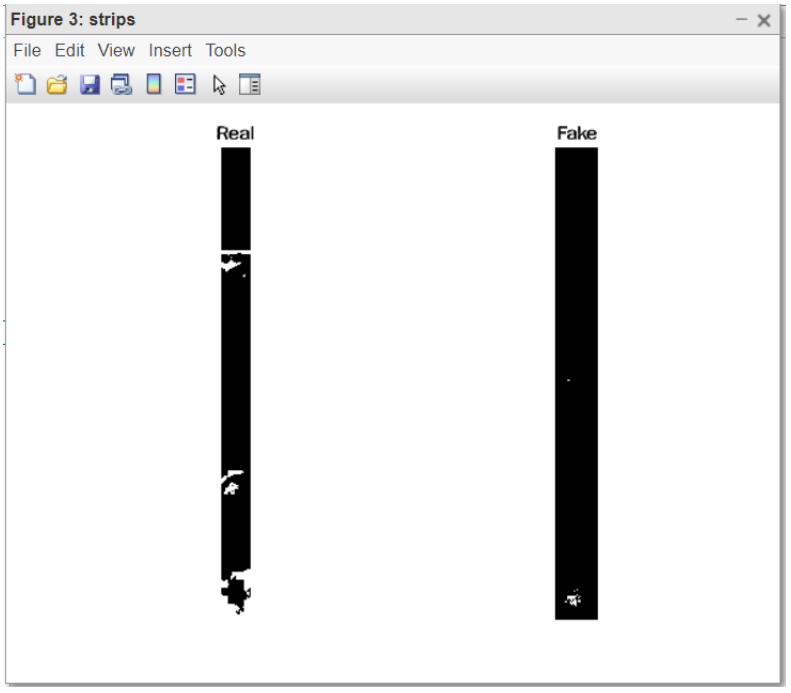


Figure 3: strips
File Edit View Insert Tools
Real
Fake

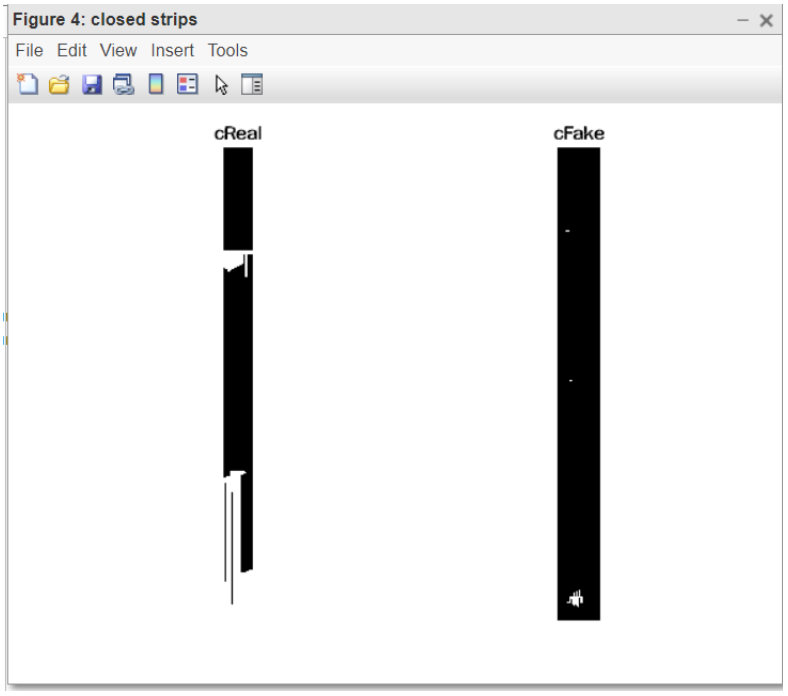


Figure 4: closed strips
File Edit View Insert Tools
cReal
cFake


Figure 5: cleaned green strips
File Edit View Insert Tools
clReal
clFake

Result and Conclusion

Result: The system is programmed and the main steps in the system includes reading the image we get from scanner,pre-processing, removing noise, smoothening image,further, Image process, edge detection, segmentation, and pattern matching and after all this is done, results printing.

Conclusion: If the image exhibit information loses such as surface damage, noise level, sharpness issues and so on, the recognition may fail and the user may get the wrong results.This can happen if the note is dirty or torn. If a note is dirty, its color characteristic are changed widely. So it is important that how we extract the features of the image of the currency note and apply proper algorithm to improve accuracy to recognize the note.When some error occurs, the system will emerge some exception, which may cause the exceptions like “the image not complete”, “failed recognition”, etc.

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