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Detection of Counterfeit Currency using Discrete Wavelet Transform in MATLAB

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Abstract :--Counterfeit notes are one of the major issue in money transactions. In a growing country like India, it is becoming big problem for the economy. As the advances in printing and scanning technologies are developing, it is very easy for any person to print counterfeit notes with use of latest hardware machines. Identifying counterfeit notes in manual way takes a lot of time and manpower. Hence there is requirement of automation technique using which the counterfeit currency recognition process can be done effectively. Many methods have been proposed and implemented with MATLAB. By using Discrete cosine transform (DCT) algorithm blocks of the image are represented by coefficients of DCT. So, due to the presence of blocking articrafts in DCT, it is a drawback for this method. Hence, We have implemented a counterfeit note detection unit with a different algorithm which uses discrete wavelet transform (DWT) in MATLAB. This paper is another attempt on the same project to give a better solution for counterfeit currency problem.

Keywords* : *Counterfeit notes, Algorithm, MATLAB, Problem, DCT, DWT.

I. INTRODUCTION

The manual process of testing of all notes in exchanges is very tedious and messy procedure and furthermore there is an opportunity of tearing the notes while taking and giving notes. In this manner Automatic techniques for fake note acknowledgment are required in numerous applications [1]. For example, programmed selling-merchandise and candy machines. Extracting adequate money related features from the cash image is essential for precision and vigor of the automated framework. This is a moving issue to framework originators. Consistently RBI (Reserve bank of India) face the fake currency notes or crushed notes. Treatment of huge volume of fake notes forces extra issues. In this manner, including machines (autonomously or as help to the human specialists) makes notes recognition process less complex and proficient. Programmed strategy for recognition of fake currency note is significant in each nation. In this venture we have made a different approach for currency note identification system utilizing MATLAB and extracting the features through discrete wavelet transform of image processing [5]. In this process the note is scanned and uploaded to MATLAB to check whether it is real or not. The task is intended to check Indian cash notes of 100, 500 ,1000 and 2000 rupee notes etc. In the event that the note is certifiable, the particular message is showed up on the screen stating that it is original note or it will show a message stating that the note is fake.

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II. DIFFERENT FEATURES USED TO IDENTIFY FAKE CURRENCY NOTES

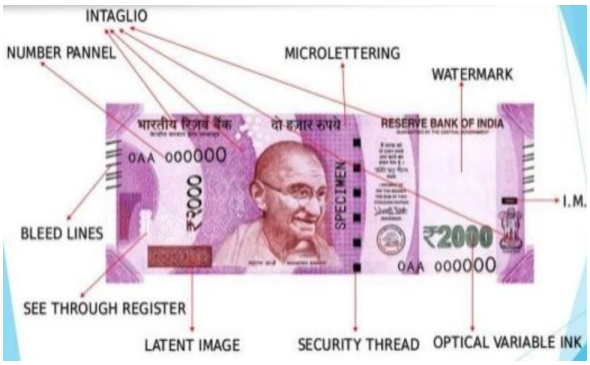


Figure.1 Common features of currency notes

1. Security thread

The security thread appears to one side of the Mahatma's representation. Security thread has a plain, non-clear completely implanted security thread. Yet, since October 2000, the Rs.2000 notes contain a discernible, windowed security thread then again noticeable on the front with the engravings.

2. Watermark

The Mahatma Gandhi Series of bank currency notes contain the Mahatma Gandhi watermark with a light and shade impact and multi-directional lines over it in the watermark window [2].

3. Micro Lettering

This element shows up between the vertical band and Mahatma Gandhi representation. It contains the word 'RBI'.

The notes of Rs.20 or more likewise contain the denominational estimation of the notes in smaller scale letters. This component can be seen well with the assistance of a magnifying glass.

4. Latent Image

On the front side of Rs.2000, Rs.500, Rs.100, Rs.50 and Rs.20 takes note of, a vertical band on the correct side of the Mahatma Gandhi's picture contains an inactive picture indicating the individual denominational incentive in numeral. The inert picture is unmistakable just when the note is held evenly at eye level [3].

5. Identification Mark

To help the blind people an exceptional component in intaglio has been presented on the left of the watermark window on all notes. This component is in various shapes for different groups.

6. Intaglio Printing

This feature is included the certified notes for the accommodation of the visually impaired people groups. The Ashoka Pillar Emblem on the left, picture of Mahatma Gandhi, the Reserve Bank seal, assurance and guarantee statement, RBI Governor's mark are imprinted in intaglio.

7. Optically variable ink or Colour changing ink

The Mahatma Gandhi Series of bank currency notes contain the Mahatma Gandhi watermark with a light and shade impact and multi-directional lines over it in the watermark window.

8. See through register

This element will show up the number when the note is held against the light. The little floral structure printed both on the front and back of the note in the vertical band by the Watermark has a precise consecutive enlistment.

9. Fluorescence

The Number boards of the notes are imprinted in fluorescent ink. The notes additionally have optical filaments. Both can be seen when the notes are before ultra-violet light.

III. METHODOLOGY

Initially, after acquiring the image through the scanner, two steps have to be done to detect the fakeness of that scanned image.

- Pre-processing
- Feature Extraction

Preprocessing: It is one of the most important steps among all. Image pre-processing is done to highlight or intensify some of the features of image which are important for analysis. In this step the image is separated into different channels like red, green and blue [9]. The noise and the interference from the separated image is removed using median filter. The resulting smoothened image is converted from RGB image to GRAY level image for further analysis.

Feature Extraction: Extraction of features from the image is challenging work and can be done in many ways. It involves the extraction of directly visible or indirectly visible features of the currency [10]. The Security features in a currency like security thread are critical for identifying real and counterfeit currencies. In this paper we have extracted the features of an image using Discrete wavelet transform as follows:

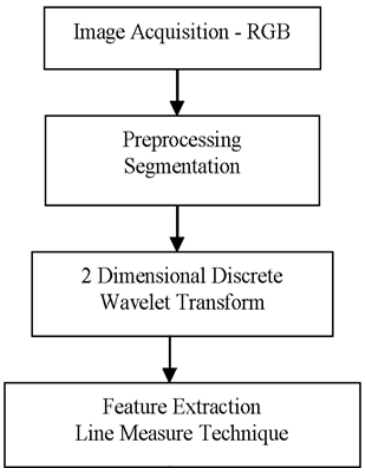


Figure.2 Flow of feature extraction

The basic step is to acquire the image.This acquisition can be done through a digital camera or a scanner [8]. The next step is preprocessing which involves in converting a RGB image to gray scale image. After preprocessing, the feature extraction process is followed. In this paper we consider to employ the structural approach with 2D discrete wavelet transform [6]. Using DWT the acquired images are decomposed into four sub-bands. These sub-bands are LL, LH, HL and HH. LH, HL and HH sub-bands represents the finest scale of the wavelet coefficients. The results which are obtained using this Discrete wavelet transform are used for texture analysis and statistical extraction of features.

IV. WAVELET THEORY

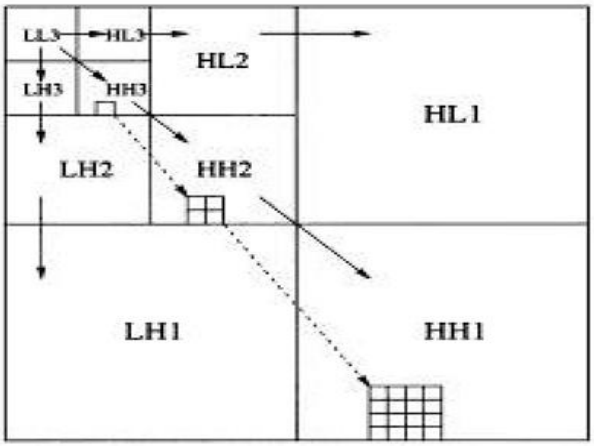


Figure.3 Wavelet transform in image processing

The wavelet transform is mostly similar to the Fourier with a totally different function. The Wavelet Transform has a very wide number of applications in image processing techniques for object identification and detection.

The key difference between them is that the fourier transform will decompose the signal into the sines and the cosines which are the functions localized in Fourier space.

But as an opposite to that the wavelet transform will use the functions which are localized in both the real space and the Fourier space. The main idea of DWT is to represent in both time and frequency domains [7]. Implementing the DWT as an image processing technique will give the transformation values called wavelet coefficients. To extract features using the DWT we have to compute the coefficient distribution for the selected mother wavelet of the image. The 2D discrete wavelet transform represents an image as the functions which are shifted and dilated which are $\psi^{LH},\psi^{HL},\psi^{HH}$ and the scaling function as ϕ^{LL} which forms the orthonormal basis for $L^2(R^2)$ [11].

For example, The DWT of an image x(s, t) is decomposed as

$$x(s,t) = \sum_{k,i=0}^{N_f-1} u_J \, i^{\phi^{LL}} J,k,i(s,t) \; + \; \sum_{B\in B} \sum_{j=1} \sum_{k,i=0}^{N-1} w^B j,k,i^{\psi^B} j,k,i(s,t)$$

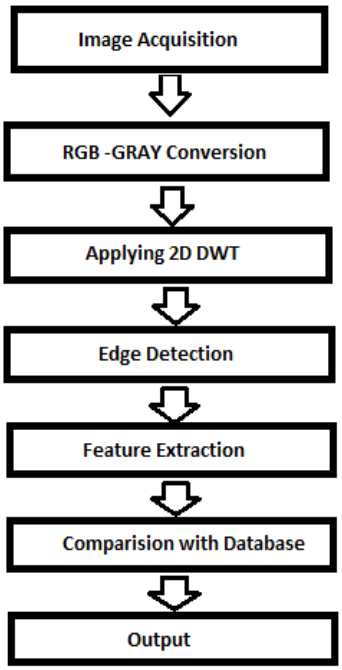
with

$$\phi^{LL} j,k,i(s,t) = 2^{-j/2}\phi(2^{-j}s-k, 2^{-j}t-i)\,,$$
$$\psi^B j,k,i(s,t), \psi^B j,k,i(s,t)$$

$$= 2^{-j/2}\psi^B(2^{-j}s-k, 2^{-j}t-i)\,, B \in B, B$$

V. PROPOSED ALGORITHM FLOW

The diagram below shows the step wise process of Counterfeit currency detection.



VI. EXPERIMENTAL RESULTS

After executing the code, MATLAB will ask to read an image to test.

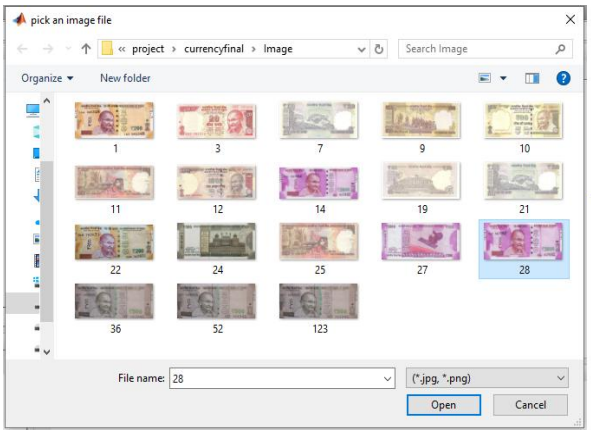


Figure.5(a) Choosing the image file to test

Figure. 5(b) Choosing the note to test

Figure.5(c) DWT applied to decompose into subbands

Figure.4 Flow of proposed algorithm

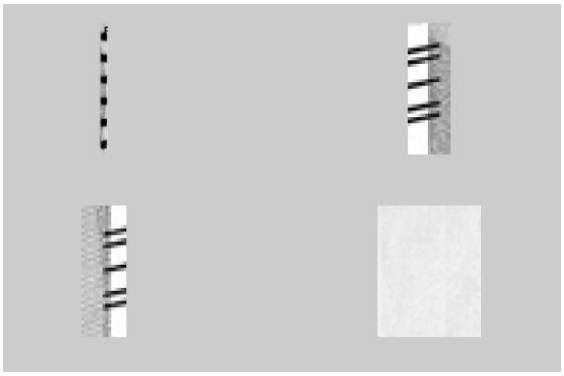


Figure.5(e) Extracted Regions of Interest(ROI)

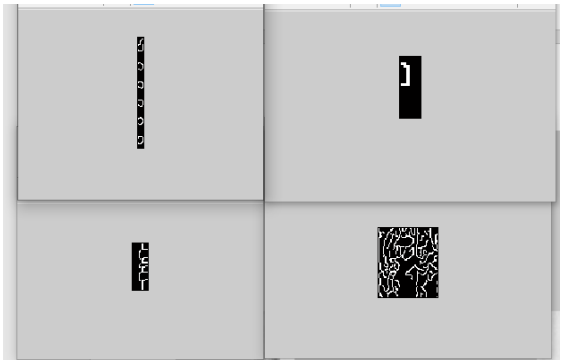


Figure.5(f) Edges detected by Canny's detection

Figure.5(g) Dialog pop up for Fake Currency

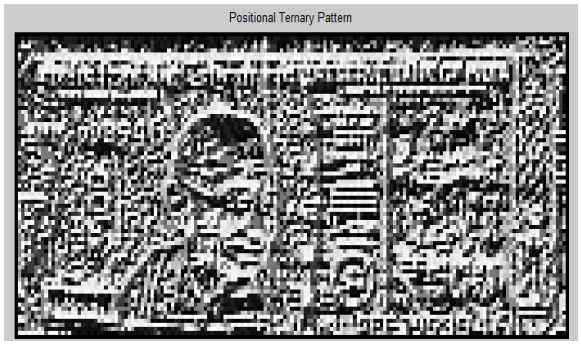


Figure. 5(d) Positional Ternary Pattern to descript edges

Figure.5(h) Dialog pop up for Original Currency

VII. CONCLUSION

The main motive behind the development of this project is to design a system for quick and easy detection of original and counterfeit currency notes. The presented approach gives an efficient method for counterfeit currency detection based on the physical appearance of the notes. This project is a MATLAB based system to automatically recognize the security features of Indian currency. Four important security features are explored in this project for fake currency detection which are the security thread, Gandhi image watermark and identification marks on left side and right side of the note. The Discrete wavelet transform algorithm has been applied to extract the features of the image.

This low cost system which is using effective image processing techniques and algorithms will provide reliable and accurate results as shown by the experimental results.The future perspective of the approach is to use this system to detect other nation's currencies and to compress the presented approach into a mobile application, so that it could be a better utility for the common people.

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