Paper Currency Verification System Based on Characteristic Extraction Using Image Processing

Rubeena Mirza, Vinti Nanda

Abstract: *Over the past few years, as a result of the great technological advances in color printing, duplicating and scanning, counterfeiting problems have become more and more serious. In the past, only the printing house has the ability to make counterfeit paper currency, but today it is possible for any person to print counterfeit bank notes simply by using a computer and a laser printer at house. Therefore the issue of efficiently distinguishing counterfeit banknotes from genuine ones via automatic machines has become more and more important. Counterfeit notes are a problem of almost every country but India has been hit really hard and has become a very acute problem. There is a need to design a system that is helpful in recognition of paper currency notes with fast speed and in less time. This proposed system describes an approach for verification of Indian currency banknotes. The currency will be verified by using image processing techniques. The approach consists of a number of components including image processing, edge detection, image segmentation, characteristic extraction, comparing images. 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. The image processing software is a collection of functions that extends the capability of the MATLAB numeric computing environment. The result will be whether currency is genuine or counterfeit.*

Index Terms: *Characteristic Extraction, Counterfeit Detection, Image Processing, Paper Currency Verification.*

I. INTRODUCTION

With development of modern banking services, automatic methods for paper currency recognition become important in many applications such as in automated teller machines and automatic goods seller machines. The needs for automatic banknote recognition systems encouraged many researchers to develop corresponding robust and reliable techniques. Processing speed and recognition accuracy are generally two important targets in such systems.

A Digital Image processing is an area characterized by the need for extensive experimental work to establish the validity of proposed solutions to a given problem. It encompasses processes whose inputs and outputs are images and

encompasses processes that extract attributes from images up to and including the recognition of individual objects.

MATLAB is the computational tool of choice for research, development and analysis. The image formats supported by

MATLAB are BMP, HDF, JPEG, PCX, TIFF, XWB, PNG etc.

Characteristic extraction of images is challenging work in digital image processing. It involves extraction of visible and some invisible features of Indian currency notes. A good characteristic extraction scheme should maintain and enhance those characteristics of the input data which make distinct pattern classes separate from each other. The approach consists of a number of steps including image acquisition, gray scale conversion, edge detection, feature extraction, image segmentation and comparison of images.

Image acquisition is the creation of digital images, typically from a physical scene. In the proposed work, the image will be acquired by using simple digital camera by providing some backlighting so that all the features of the currency can appear on the image properly. The image is then stored in the computer for further processing. Edge detection and image segmentation are the most important tasks performed on the images.

A. 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.

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B. 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-

1.) Discontinuity
2.) 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.

II. RELATED WORK

Currently, there are a number of methods for paper currency recognition [1][2][3]. Using the properties of the HSV (Hue, Saturation and Value) color space with emphasis on the visual perception of the variation in Hue, Saturation and Intensity values of an image pixel [1]. In this technique, Fitting tool of Neural Network is used for the purpose of paper currency verification and recognition. Crucial features from Indian banknotes were extracted by image processing and experimented on Neural Network classifier.

In another research work, a simple statistical test is used as the verification step, where univariate Gaussian distribution is employed [2]. The propose using the probability density formed by a multivariable Gaussian function, where the input data space is transferred to a lower dimensional subspace. Due to the structure of this model, the total processing system acts as a hybrid neural network. The method and the numerical experimental results are shown by using the real data and the recognition machine.

Another study describes an approach to digit recognition for the serial numbers on the Chinese currency banknotes [3]. It consists of a number of components including image preprocessing, image binarisation, morphological filtering, segmentation, feature extraction and digit recognition. The newly developed software Labview which is based on the virtual instrument technique is used for image processing and recognition of the currency.

In another technique for paper currency recognition [4], three characteristics of paper currencies including size, color and texture are used in the recognition. By using image histogram, plenitude of different colors in a paper currency is computed and compared with the one in the reference paper currency.

Based on the traditional local binary pattern (LBP) method, an improved LBP algorithm, called block-LBP algorithm, is used for characteristic extraction [5]. LBP is a powerful tool for texture description. This method has advantages of simplicity and high speed.

A Neural Network based recognition scheme is used for Bangladeshi banknotes [6]. The scheme can efficiently be implemented in cheap hardware which may be very useful in many places. The recognition system takes scanned images

of banknotes which are scanned by low cost optoelectronic sensors and then fed into a multilayer perceptron, trained by back propagation algorithm, for recognition.

In another study, three characteristics of paper currency are considered including size, color and texture [7]. The Marcov chain concept is used to model the texture of paper currencies as random process. Ensemble neural network (ENN) is used for the recognition system. The individual neural networks in an ENN are skilled via negative correlation learning. The purpose of using negative correlation learning is to skill the individuals in an ensemble on different parts or portion of input patterns.

A new technique is proposed to improve the recognition ability and the transaction speed to classify the Japanese and U.S. paper currency [8]. This paper compare two types of data sets, time series data and Fourier power spectra, are used in this study. In both cases, they are directly used as inputs to the neural network. Still more we also refer a new evaluation method of recognition ability. Meanwhile; a technique is proposed to reduce the input scale of the neural network without preventing the growth of recognition. This paper applied the neural network to paper currency recognition and showed the effectiveness compared with a conventional manual method. Furthermore, it has proposed a structure reduction method of the neural network using random masks and showed its effectiveness for time series data and its Fourier power spectra.

III. PROPOSED WORK

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.

The proposed algorithm for the discussed paper currency verification system is presented as follows-

A. Image of paper currency will be acquired by simple scanner or digital camera.

B. The image acquired is RGB image and then it will be converted into gray scale.

C. Edge detection of the whole gray scale image will be performed.

D. After detecting edges, the four characteristics of the paper currency will be cropped and segmented.

E. After segmentation, the characteristics of the paper currency will be extracted.

F. The characteristics of test image are compared with the original pre-stored image in the system.

G. If it matches then the currency is genuine otherwise counterfeit.

In the proposed method characteristics of paper currencies are employed that are used by people for

differentiating different banknote denominations. Basically, at first instance, people may not pay attention to the details and exact characteristics of banknotes for their recognition, rather they consider the common characteristics of banknotes such as the size, the background color (the basic color), and texture present on the banknotes. In this method, these characteristics will be used to differentiate between different banknote denominations-

A. Identification mark

A symbol with intaglio prints which can be felt by touch, helps the visually impaired to identify the denomination. In 500 denominations the identification mark is a *circle*. In 1000 denominations the identification mark is a *diamond*.

B. Security thread

It is a 3.00 mm wide strip with inscriptions ".art" and "RBI" and color shift from green to blue when viewed from different angles. The thread is visible as a continuous line from behind when held up against light.

C. Latent image

It is a vertical band on front side of denomination at right hand side. It contains latent image showing the numeral of the denomination when the banknote is held horizontally at eye level.

D. Watermark

The portrait of Mahatma Gandhi, the multidirectional lines and on electrolyte mark showing the denominational numeral appear in this section and these can be viewed better when the banknote is held against light.

The below diagram shows the step-by step process of this paper currency verification system-
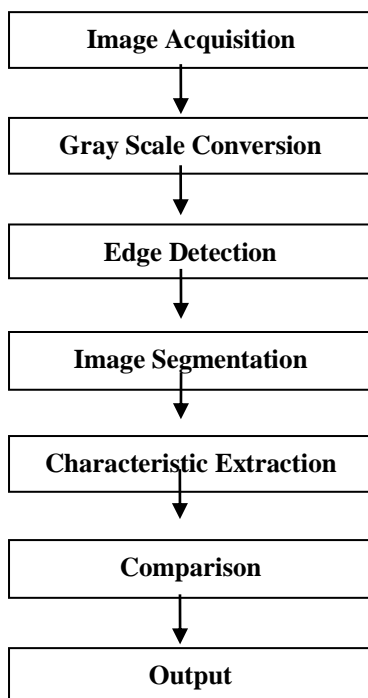
Image Acquisition
↓
Gray Scale Conversion
↓
Edge Detection
↓
Image Segmentation
↓
Characteristic Extraction
↓
Comparison
↓
Output

Fig. 1 Design Flow of Indian Paper Currency Recognition system

IV. OTHER EXTRACTION PARAMETERS

A. Intaglio Printing

This gives a more complex and reliable method, since it is the printing process itself that serves to vouch for the authenticity of the document. The note is subjected to a high-pressure printing process that strengthens and slightly raises the paper's surface structure. This method can also be used with optically-variable ink to produce interference which shows different spectral colors when viewed from different angles.

B. Micro lettering

The letters "RBI" and the numeral "500" can be viewed with the help of a magnifying glass in the zone between the Mahatma Gandhi portrait and the Security thread.

C. See Through Register

The floral design printed on both the front and reverse in the middle of the security thread and next to the watermark window has the denominational numeral "500". Half the numeral is printed on the obverse and half on the reverse. Both the printed portions have an accurate back to back registration so the numeral appears as one when viewed against light.

D. Ultraviolet Fluorescence

Embedded fluorescent fibers into the paper, or printed ultra-violet ink onto the paper, creates a form of optical verification easy. By exposing the note to ultra-violet light, the ink or fibers fluoresce, reveals a colored pattern not visible under natural light.

E. Optically Variable Ink

The color of the numeral 500 appears green when the note is held flat but would change to blue when the note is held at an angle. The font size is reduced.

F. Fibre-Based Certificates of Authenticity

Based on the characteristics of fibre-optic light transmission, this method makes use of unique configurations of fibres embedded in the paper. Using a scanner to illuminate one end of an embedded fibre, the other corresponding end of that fibre will become illuminated. By using the position of both illuminated ends, the certifier has a "fibre signature". This string can then be converted into a bit string and combined with any extra data that is required (e.g. value, serial number, source, etc.). This is in turn combined with a cryptographic hash of itself and is signed using a private key, with the corresponding public key made available. The final result of these steps can then be encoded onto the banknote (this method is suitable for certifying a wide range of other documents too) in the form of a barcode or verification number of some kind.
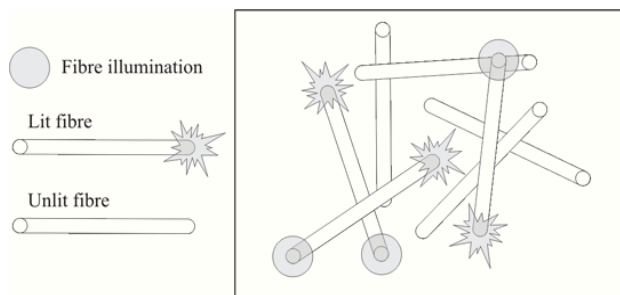
Fig. 2 Conceptual Scanning of Embedded Fibres

V. CONCLUSION

This paper discussed a technique for verifying paper currency of India. The technique uses four characteristics of paper currency including identification mark, security thread, latent image and watermark. The system may extract the hidden features i.e. latent image and watermark of the paper currency. The proposed work is an effort to suggest an approach for the characteristic extraction of Indian paper currency. Approach suggested from the beginning of image acquisition to converting it to gray scale image and up to the word segmentation has been stated. The work will surely very useful for minimizing the counterfeit currency.

REFERENCES

[1] G. Trupti Pathrabe, Mrs.Swapnili Karmore, "A Novel Approach of Embedded System forIndian Paper Currency Recognition", International Journal of Computer Trends and Technology- May to June Issue 2011, ISSN: 2231-2803.

[2] M. Tanaka, F. Takeda, K. Ohkouchi, Y. Michiyuk "Recognition of Paper Currencies by Hybrid Neural Network", IEEE Transactions on Neural Networks", 0-7803-4859-1/98, 1998.

[3] Ji Qian, Dongping Qian, Mengjie Zhang "A Digit Recognition System for Paper Currency Identification Based on Virtual Instruments" IEEE Transactions, 1-4244-0555-6/06,2006.

[4] H. Hassanpour ,A. Yaseri, G. Ardeshiri "Feature Extraction for Paper Currency Recognition", IEEE Transactions, 1-4244-0779-6/07,2007.

[5] Junfang Guo, Yanyun Zhao, Anni Cai, "A Reliable Method for Paper Currency Recognition Based on LBP",IEEE Transactions, Proceedings of IC-NIDC2010, 978-1-4244-6853-9/10.

[6] Nadim Jahangir, Ahsan Raja Chowdhury, "Bangladeshi Banknote Recognition by Neural Network with Axis Symmetrical Masks", IEEE Transactions, 1-4244-1551-9/07.

[7] Ms. Trupti Pathrabe, Dr. N.G Bawane "Feature Extraction Parameters for Genuine Paper Currency Recognition & Verification" International Journal of Advanced Engineering Sciences and Technologies", Vol No. 2, Issue No. 1, 085 – 089, 2011.

[8] Fumiaki Takeda, Sigeru Omatu "High Speed Paper Currency Recognition by Neural Network" IEEE Transactions on Neural Networks, Vol. 6, No. 1, January 1995.

[9] Chin-Chen Chang, Tai-Xing Yu, Hsuan-Yen Yen "Paper Currency Verification with Support Vector Machines", IEEE Computer Society, 978-0-7695-3122-9/08, 2008.

[10] Sigeru Omatu,Michifumi Yoshioka,Yoshihisa Kosaka "Bank Note Classification Using Neural Networks", IEEE Transactions, 1-4244-0826-1/07,2007.

[11] Rajesh Kannan Megalingam, Prasanth Krishna, Pratheesh somarajan, Vishnu A Pillai, Reswan Hakkim "Extraction of License Plate Region in Automatic License Plate Recognition", International Conference on Mechanical and Electrical Technology, IEEE Transactions, 978-1-4244-8102-6/10

[12] Woods, Gonzalez and Eddins(2005), Digital Image Processing Using MATLAB (Low Price Edition).

[13] Woods and Gonzalez (2008), Digital Image Processing (Third Edition), Pearson Education, New Delhi, 110092.

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