Survey Of Currency Recognition System Using Image Processing

Amol A. Shirsath[1] S. D. Bharkad[2]
[1]PG Student, Government College of Engineering, Aurangabad (M.S.),
[2]Assistant Professor, Dept. of Electronics & Tele-communication, Government College of Engineering,

ABSTRACT
Image processing based currency recognition technique consists of few basic steps like image acquisition, its pre-processing and finally recognition of the currency. Normally camera or scanner is used for image acquisition. Then these images are processed by using various techniques of image processing and various features are extracted from the images which are the key concept behind currency classification. Application area of currency recognition includes foreign exchange, automatic selling of things and in banks. Recognition ability depends on the currency note characteristics of particular country and extraction of features.

KEYWORDS : *Classifier, Feature extraction, Foreign exchange, Markov chain , LBP, Neural Network, Pre-processing,*

I. INTRODUCTION

In recent years, along with the accelerative developments of world economics incorporation course, the start of euro area, and the increase of asia economics, frontier trade and personal intercourse of various countries are frequent increasingly. Travelling people always take many countries of paper currency. Probabilities that the paper currencies of various countries are probably interweaved together therefore rises increasingly. It is a challenge for conventional paper currency recognition systems.

There are approximately 50 currencies all over the world, with each of them looking totally different. For instance the size of the paper is different, the same as the colour and pattern. The staffs who work for the money exchanging (e.g. Forex Bank) have to distinguish different types of currencies and that is not an easy job. They have to remember the symbol of each currency. This may cause some problems (e.g. wrong recognition), so they need an efficient and exact system to help their work. Also paper currency became older than coins and also possibility of joining broken currency is greater than that of coin currency. So the aim of Currency recognition system is to help people who need to recognize different currencies, and work with convenience and efficiency.Currency recognition is an image processing technology that is used to identify currency of various countries.

Probabilities that the paper currencies of various countries are probably interweaved together therefore rises increasingly. It is a challenge for conventional paper currency recognition systems. However, the focus of most of the conventional currency recognition systems and machines is on recognizing counterfeit currencies. It is not enough for practical businesses. The reason is that in most of banks, especially those internationalized banks, there are large quantities of cash belonging to many different countries need to be process, and it is possible that all of them are real cashes. The situation that cashes belonging to different countries mixes together is possible to occur. It cannot be processed with conventional currency recognition systems. Paper currency recognition systems should be able to recognize banknotes from each side and each direction. Since banknotes may be defaced during circulation, the designed system should have a meaningful accuracy in detecting torn or worn banknotes. The technology of currency recognition is used to research the visible and hidden currency characters, identify features all-around and dispose of the process on time. The original information has a loss because paper currency will get to the worm and blurry, even damaged by human being in circulation.

II. SYSTEM ARCHITECTURE OF PAPER CURRENCY RECOGNITION

System architecure of paper curency recognition includes five stages Image acquisition, pre-processing, feature extraction, classification, and result. Let us explain each of these stages one by one.

A. 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. You can choose between two main types of cameras – analog and digital. Digital cameras can be further classified into parallel digital, Camera Link, and IEEE 1394.Scanner is a device that optically scans images, printed text, handwriting, or an object, and converts it to a digital image. Scanners typically read red-green-blue colour (RGB) data from the array. This data is then processed with some proprietary algorithm to correct for different exposure conditions and sent to the computer via the device's input/output interface.

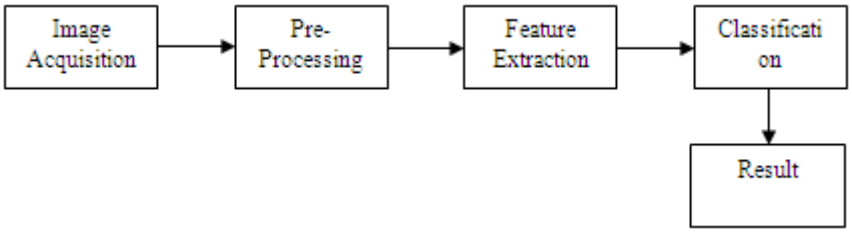

Figure 1 System Architecture of Paper Currency Recognition

B. Pre-Processing

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

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.There are two types of interpolation Bilinear and Bicubic. In the first one concept of four nearest is used to estimate the intensity at a given location. Let (x,y) denotes coordinates of the location where we want to assign an intensity value and *Z*(x,y) denote that intensity value so to evaluate assigned value we use equation

$$Z(x,y) = ax + by + cxy + d \qquad (1)$$

Where four coefficients can be obtained from the four equations from the four unknown can be written using four nearest neighbors of point.

Image smoothning

When using a digital 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 neighbour of the pixel is used to do some transforming. After that a new value of the pixel is created. The neighbour 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 smoothning can be done with the help of median filter which more effective than convolution when goal is to simultaneously reduce the noise preserving edgees. Median filter replaces a pixel via the median pixel of all the neighborhoods:

$$Y[m,n] = median\{x(i,j) \ ,(i,j) \in W\} \qquad (2)$$

Where W represents a neighbouhood centered around the location

III. FEATURE EXTRACTION

It is the most challenging work in digital image processing. During the feature extraction process the dimensionality of data is reduced. Extracting too many features will not only increase the cost but also sometimes lower the system performance in terms of execution time.Feature extraction is a important procedure considerably for currency recognition, which effects on design and performance of the classifier intensively [1]. If the selected features are so large, it can easily construct a classifier with good recognition performance. The main task here is how to find effective feature among many features.

There are mainly two types of features [1] as, Structural feature: It describes geometrical and topological characteristics of pattern by representing its global and local properties. Statistical Features: It describes characteristic measurements of the pattern.In [2] component-based framework for banknote recognition by using Speeded Up Robust Features (SURF) is used. The component-based framework is effective in collecting more class-specific information and robust in dealing with partial occlusion and viewpoint changes. Furthermore, the evaluation of SURF demonstrates its effectiveness in handling background noise, image rotation, scale, and illumination changes.Size, Colour, text these are the three characteristics of a currency used to distinguish between different banknote denominations.

A. Texture Feature

For texture feature LBP (Local Binary Pattern) operator [3] is used. Texture is the visible feature of the paper currency.

LBP operator: It is originally introduced by Ojala et al [3]. In LBP, the neighbourhood pixels are converted to binary code 0 or 1 by using the gray value of the centre pixel as threshold and further arranged to form as a ordered pattern. The feature extracted with LBP gives the relationship of the texture within local area. LBP code for pixel p is defined as

$$LBP(p) = \sum_{i=0}^{7} 2^i s(g_i - g_p) \quad (3)$$

Where
g_p – Gray value of the centre pixel p.
g_i – Gray value of the i^{th} pixel, 8-neighbourhood of p
i – 0, 1 ...7.
$s(t) = g_i - g_p$, is the threshold function and given by

$$s(t) = \begin{cases} 1, t \geq 0 \\ 0, else \end{cases} \quad (4)$$

From equation (1) we can say that LBP can produce 256 kinds of different outputs, corresponding to 256 kinds of different binary patterns.
Junfang Guo, Yanyun Zhao[4] has proposed the improved method for texture analysis using LBP. They have segment the whole image into M * N blocks. In each block calculate the LBP value for every pixel, and make the histogram of the block, which is known as a block histogram. The block histogram is normalized by the number of pixels in the block.

Markov Chain Concept: As in many countries colour spectrum and size of some banknotes are very close to each other. For such a type of difficulties we are considering template of the banknotes. And to recognize these templates we are using Markov Chain Concept [5] to represent the random phenomenon.
A random process $\{x_k, k = 0, 1, 2....\}$ is called Markov chain if the possibility value in state x_{n+1} depends on the possible value in state x_n, given as below

$$P(x_{n+1} = \beta | x_n = \alpha, x_{n-1} = \alpha_{n-1}, \dots x_0 = \alpha_0) = P(x_{n+1} = \beta | x_n = \alpha) \quad (4)$$

This possibility can be shown by P_{ij}. The state space of a Markov chain can be shown in matrix as below

$$P = \begin{bmatrix} P_{11} & P_{12} & \cdots & P_{1n} \\ P_{21} & P_{22} & \cdots & P_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ P_{n1} & P_{n2} & \cdots & P_{nn} \end{bmatrix} \quad (5)$$

Where n, is the number of states in the chain. In discrete time Markov chain, the possibility value of different states in the matrix is computed as

$$P_{ij} = \frac{n_{ij}}{\sum_{k=1}^{n} n_{ik}} \quad (6)$$

Where n_{ij}, is the number of transitions from state i to state j. considering (5), matrix P can be multiplied by the denominator of (5). To obtain

$$P = \begin{bmatrix} N_{11} & N_{12} & \cdots & N_{1n} \\ N_{21} & N_{22} & \cdots & N_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ N_{n1} & N_{n2} & \cdots & N_{nn} \end{bmatrix} \quad (7)$$

This is matrix is used to differentiate between textures in different denominations [3].

B. Colour Feature

If the primary image is in RGB format, then after resizing it is converted to HSV colour space[6]. Advantage of HSV colour space is that it is closer to human conceptual understanding of colours and has ability to separate chromatic and achromatic Components. Feature extraction of a colour image can be done by analysing its colour histogram, hue, saturation, intensity (or value). In HSV (Hue, Saturation, Value) space hue distinguishes colour, Saturation is the percentage of white light added to a pure colour and value represents perceived light intensity.

C. Size

The first step of recognition of algorithm proposed by H. Hassanpour [8], considers size of the banknote. It is considered because during circulation of banknote worn and torn reduces its size, also it may increased slightly by rejoining torn banknote. Therefore they proposed decision tree as follows

$$|x - x_0| < d_x \;\&\; |y - y_0| < d_y \quad (8)$$

Where x_0 and y_0 are size of the testing paper currency, x and y are size of reference paper currency.
d_x, d_y shows changes in the vertical and horizontal directions.

Classifier

After getting features of currencies, it is essential to recognize the pattern of the currencies on the base of these features, which should be practised by an effective recognition system called classifier.

The input of the classifier will be the test currency images and the output of the classifier will be three parts:

[1] The country name that using this currency;
[2] The denomination of the input currency image;
[3] The front or back side of the currency.

A Neural network based recognition scheme is used for Bangladeshi banknotes [9]. 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 perception, trained by back propagation algorithm, for recognition.Baiqing Sun [10] proposes a kind of currency recognition system, in which a three-layer feed forward neural network is used as a classifier, They proposed it in order to improve the performance of currency recognition system. In the feed- forward neural network a kind of Gaussian function is proposed as the activation function, which is employed in all units on the hidden layer and the output layer. The characteristics of this activation function are analyzed. It is a kind of localized function, its activation approaches zero as the distance to its centre approaches infinity. Its active region is governed by its width parameter. Just relying on this property of the proposed Gaussian, the rejection capabilities of the system can be improved.Fumiaki Takeda [11] proposed a new mask having symmetrical masked area against a axis dividing long side of paper currency in equal part, they called it as a symmetrical mask. Using this mask they have obtained same value from inverse and upright image of paper currency. Firstly geometrical meaning of symmetrical mask is shown and then procedure of the mask optimization by GA (Genetic algorithm) is given. Then neural network is constructed using optimized symmetric mask to recognize currency.As explained in [12] there are numerous models are developed to recognize paper currency. Such as auto associative network, nonlinear auto associative network, radial basis function (RBF) network. Most of them uses single neural network with one hidden layer but there are certain limitation of this networks. Firstly, single NN is not sufficient to train all aspects of currency note. Secondly, decision was made completely from a NN and not from a group of NN.

IV. CONCLUSION

This survey article presents overview of recent work on currency recognition system. Multi Country currency recognition is a challenging work as some currency notes has common features such as colour, size. To sort out this problem several authors suggest techniques such as Markov chain concepts, Local binary pattern technique. Also this paper introduces brief overview on system architecture of currency recognition system, it includes various steps starting from image acquisition through scaner or camera then processing on digital

image with the help of image processing tools and at the end result will be shown. Classifier discussed in this paper is neural network employing guassian function.

REFERENCES

[1] Parminder Singh Reel, Gopal Krishan, Smarti Kotwal, Image Processing based Heuristic Analysis for Enhanced Currency Recognition, International Journal of Advancements in Technology, Vol 2, No 1, January 2011.

[2] Faiz M. Hasanuzzaman, Xiaodong Yang and Yingli Tian, Robust & Effective Component based Banknote Recognition by SURF Features, NSF grant IIS-0957016.

[3] T Ojala,M Pietikainen, and D Harwood, A comparitive study of texture measures with classification based on feature distributions, Pattern recognition, Vol.29, No. 1, 1996, pp.51-59.

[4] 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.

[5] M. Iosifescu, Finite Markov Processees and Their Applications, Wiley, New York, NY, 1980.

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

[7] Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, Digital Image Processing Using MATLAB,2012.

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

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

[10] Baiqing Sun, Research on Rejection Capabilities of Paper Currency Recognition System with the Neural Network Employing Guassian Function, Kochi University of Technology, Japan,2006.

[11] Fumiaki Takeda, Toshihiro Nishikage, and Yoshiyuki Matsumoto, Characteristics Extraction of Paper Currency using Symmetrical Masks Optimized by GA and Neuro-Recognition of Multi-National Paper Currency, IEEE Transactions, 0-7803-4859-1/98, 1998.

[12] Masato Aoba, T. Kikuchi, Y. Takefuji, Euro Banknote Recognition System using a three layer perceptron and RBF networks, IPSJ transaction on Matematical Modeling and its Applications, vol 44, 7(8), pp. 99-109, 2003.

[13] Kalyan Kumar Debnath, Sultan Uddin Ahmed, Md. Shahjahan, A Paper Currency Recognition System Using Negatively Correlated Neural Network Ensemble, Journal of Multimedia, vol. 5, No. 6, December 2010.

[14] F. Takeda and T. Nishikage, Multiple kinds of paper currency recognition using Neural Network and application for Euro currency, In Proc. IEEE International Joint Conference on Neural Networks, pp 143-147, 2000.

[15] D. A. K. S. Gunaratna, N.D. Kodikara and H. L. Premaratne, ANN Based Currency Recognition System using Compressed Gray Scale and Application for Sri Lankan Currency Notes-SLCRec, Proceedings of world academy of science, engineering and technology, vol. 35, ISSN 2070-3740, Nov 2008.