Indian Currency Identification Using Image Processing

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Abstract— *The paper currency recognition always depends on the currency note characteristics of a particular country and the extraction of different features directly affects the ability of currency recognition. The currency has great significance in today's life and may be because the Indian currency recognition is a great area of interest. It is very complex to count different denomination notes in a bunch. This paper proposes an image processing technique for the identification of Indian currency. First we acquire the image using simple scanner or digital camera with a particular size. We use different methods for Indian currency identification like shape recognition, feature extraction and digit recognition. The characteristics extraction is performed on the given images of the currency and it is compared with the characteristics of the original currency. The image processing approach is discussed with MATLB to detect the features of Indian currency. Image processing involves the changing of nature of an image in order to improve its quality of information for human interpretation. The result will be the identification of Indian currency.*

Keywords— Indian currency recognition, shape recognition, feature extraction, Digit recognition

I. INTRODUCTION

The Indian currency system is very important since a long time. The Indian government introduced its first paper currency issuing 10 rupees notes in 1861[1]. The Indian reserve bank began note production in 1938, and issuing 2, 5, 10, 20,100 and 1000 rupees of notes. Currently the Indian currency system has various currency notes as of rupees 5,10,20,50,100,500 and 1000. All denomination of notes has its value printed on the note. An image processing based approach which identifies Indian paper currencies of different denomination and identification has been proposed in this work.

With the development of different banking services areas, many types of automatic methods for paper currency recognition become more important in many applications such as in automated amount teller machines and automatic goods seller equipments. The requirements for automatic banknote verification systems encouraged many researchers to develop corresponding robust and reliable methods. In which recognition accuracy and processing speed of verification system are generally two important targets in these types of units. In such type of different technology of currency recognition methods focuses to search and extract the visible and hidden marks on Indian paper currency for efficient classification performance.

The Digital Image processing technique is an area characterized by the need for extensive experimental results to establish the validity of proposed solutions to a given method. It encompasses different types of processes whose inputs and outputs are images and encompasses processes that extract different attributes from images including the recognition of individual objects. There are different methods proposed for Indian currency identification. One of the simplest ways is to make use of the visible identification features of the paper currency, such as, the size and text of the paper. This type of methods has great disadvantages as currencies of different values may have the same size and shape in some countries, and the visible marks may be polluting by noise, so it is very difficult to identify.

no.	Currency Denomination	Major color component	Identification Mark
1	Rs. 5	Green	-
2	Rs. 10	Orange-Violet	-
3	Rs. 20	Red-Orange	Vertical Rectangle
4	Rs. 50	Violet	Square
5	Rs. 100	Blue-Green at centre, Brown-Purple at two sides.	Triangle
6	Rs. 500	Olive and Yellow	Circle
7	Rs. 1000	Pink	Diamond

Table1: Features of Indian currency

In the Indian currency there are different types of security features are used like identification mark, serial numbers etc. The Indian currency notes contain different color components and identification marks. The Table 1 contains the currency denominations, major color components and identification mark.

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II. LITERATURE SURVEY

The paper proposed by Jain [2] an image processing method to extract the paper currency quantity. The extracted ROI (Region of Interest) may be wormed with Pattern Recognition and Neural Networks method. In the first step they obtain the image by a flat scanner on glue dpi with an exacting size, then the pixels level is place to attain image. A few filter methods are useful to extract denomination assessment of currency note. They employ dissimilar pixel levels in different quantity of notes.

The paper proposed by Mirza and Nande [3] uses a technique for validating the Indian paper currency. The technique uses four characteristics of paper currency plus identification mark, security thread, latent image and watermark methods. They extract the hidden features that are included with in the paper currency i.e. latent image and watermark of the paper currency. The work is an attempt to propose an approach for the feature extraction of Indian paper currency.

The paper was presented by Chakraborty et al. [4] a widespread study on a method of developments in existing years in classification of currency denomination used in different countries. Different types of techniques applied by a diversity of researchers and developers are proposed briefly in organize to evaluate different conditions of art. In this paper the author primarily focusing on currency detection system including different steps involved in it the methods, image attainment, feature extraction and categorization system its uses different algorithm.

The paper was presented by Reel et al. [5] of the heuristic analysis of characters and a different number of serial numbers of Indian currency notes to identification of currency notes. To distinguish a character or letter from a given currency image, there is a requirement to extract feature descriptors of such types of images. As an extraction process technique affects the quality of entire OCR process, it is very significant to extract different features and this will be invariant towards the different processing conditions, employ different font type and deformations of characters and denominations are caused by a misspelled of the different images. A heuristic analysis of characters is complete for this reason to get the different features of extraction in currency recognition.

The paper proposed by Pawade et al. [6] on existing techniques and systems for currency recognition stands on image processing technique. They have discussed both the invent recognition and paper currency recognition or verification techniques separately. Finally they summarize their work in tabular form which is very cooperative for study at a glance. Even though there is lots of works are done on this topic, still there are a number of issues related to the accuracy, speed and efficiency of the method. Thus achieving maximum efficiency and getting 100% correctness for heterogeneous currency, when visible state of currency is not that much good, will always be a main problem for researchers.

The paper was proposed by Ali and Manzoor [7] of the technique for currency recognition using image processing technique. The proposed system employs the various features of the currency for verification. Their experimental results demonstrate that this is the less cost machine to recognize the Pakistani paper currency notes. They had checked different notes on this system and the result shows that the system is working competently.

The paper was presented by Krishan [8] an advance method for the feature extraction of Indian paper currency notes. An Approach that suggested from the beginning of scanning a document of converting it to binary image then thresholding it and morphological filtering methods and word segmentation has been successfully stated in that method. One of the disadvantages in the character segmentation method is that two letters are sometimes joined together.

The paper proposed by Danti and Nayak [9] is an important feature of Indian paper currency note are extracted and recognized. The paper currency features such as denomination, governor declaration, year of print, serial numbers etc. are segmented for recognition using 3×3 grid method. The quantity of currency such as 50,100, 500, 1000 are determined with the help of Neural Network classifier. The year of publish of currency note is extracted using the OCR methods. The method is experimented on a large dataset of images and demonstrated the efficiency of the proposed approach.

The paper proposed by Ravi and Ravi [10] is to extort the surface features of exchange note images. To extort the different features in the image; they are using the PCA Algorithm. The method is exploiting on a currency note and the inexact coefficient matrix of the distorted image is obtained from the image. Different set of coefficient statistical noises are removed from the approximate coefficient matrix. The extracted features from the images are amassed in a feature vector table. The features may be employed for categorization and retrieval of currency notes.

The paper proposed by Pathrabe and Bawane [11] develop a method for recognizing the paper currencies of different countries. The proposed method uses three

characteristics of paper currencies including the size, color, and template. In this proposed technique the system can be trained for a new denomination banknote by just introducing one intact example of the banknote to it. In the calculation method the system may recognize the banknote on each side or any direction based on the image.

III. PROPOSED SYSTEM

The block diagram of the proposed system is shown in fig.1

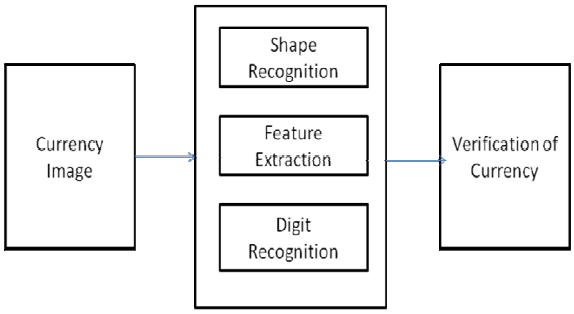

Fig.1: Block Diagram of proposed system

The proposed system is based on three methods; they are shape recognition, feature extraction and digit recognition. The design flow of the proposed system is shown in fig.2

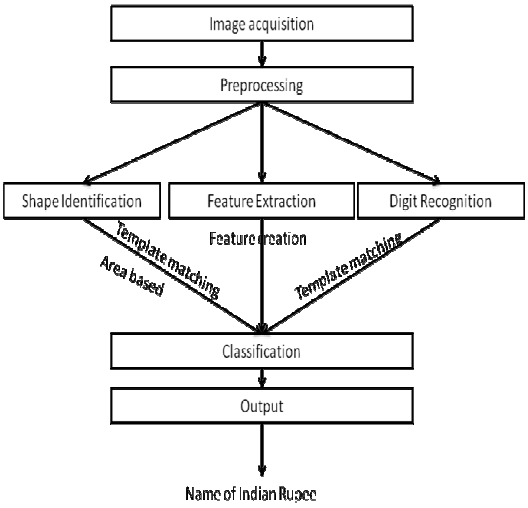

Fig.2: Design flow of proposed system

The different methods used in the proposed system are;

A. Image Acquisition

The image of the Indian currency will be acquired by simple digital camera or scanner.

B. Preprocessing

In preprocessing stage there will be different methods are used. The Gray scale conversion method is used to convert the RGB images into Gray image. A binary image creation is done because to convert the given images into black and white format and stores the binary value. To extract the particular part from the given currency image, ROI (Region of Interest) extraction method is used. To allow all the images into a common size, image resized function is used. Image complement method is used to transfer the color of the extracted region from black to white. To avoid the unwanted noise from the extracted image, the morphological method is used.

C. Shape Identification

Different types of shapes are used in Indian currency. The shapes are known as identification mark. Each type note has a particular identification mark. The notes 5 and 10 have no identification mark. The notes 20 contains vertical rectangle, 50 contains square, 100 contains triangle, 500 contains circle and 1000 contains diamond as identification mark. For currency identification the identification marks from the images are extracted and it will be compared with the trained images. Here template matching method is used to identify the best correlation from the trained images.

D. Feature Extraction

Different types of feature extraction methods are used to extract the features from currency images. The different features are shape features, texture features and color features. The Shape feature extractions used in this paper are solidity, minor axis length, extent and eccentricity. These features are taken from research [12] in order to extract the different shape feature in Indian currency. The eccentricity is used to recognize whether the rust shape is a line segment or circle. Eccentricity is computed as the ratio of the distance between the foci of the ellipse and its major axis length of the image. An ellipse whose eccentricity is 0, then it can be recognized as a circle; while an ellipse whose eccentricity is 1, then it can be recognized as a line segment [13].

The minor axis length is used to measure the length of axis of the extracted region. The minor axis length is the length of the minor axis of the ellipse and region that has the same normalized second central moments as the extracted region (in pixels) [13]. The extent method is used to measure the area of extracted currency region that is divided by the area of the bounding box. Extent is calculated as the area divided by area of the bounding box [13].

The solidity operation is used to measure area of extracted currency region divided by pixels within the convex hull. The solidity is the proportion of the pixels in the convex hull that are also in the extracted region. Solidity is calculated by dividing the area by convex area [13].

Texture Feature

The Gray Level Co-occurrence Matrix (GLCM) extracts the second order statistical texture features [14]. The texture feature extractions used in this paper are correlation, contrast, energy and homogeneity. These

features are taken from the research [12] to extract the texture feature in the currency images region.

The contrast of the pixel and its neighbors is calculated over all of the currency image pixels. Contrast is used to measure the contrast between neighborhood pixels within the image.

$$f1 = \sum_{i=1}^{k}\sum_{j=1}^{k}(i-j)^2 pij \quad (1)$$

The correlation is a measure of correlation of a pixel with its neighbors over the entire image.

$$f2 = \sum_{i=1}^{k}\sum_{j=1}^{k}\frac{(i-mr)(j-mc)pij}{\sigma_r\sigma_c} \quad (2)$$

The energy is the sum of G (grey level co-occurrence matrix) elements within the images.

$$f2 = \sum_{i=1}^{k}\sum_{j=1}^{k}pij^2 \quad (3)$$

The homogeneity method computes the similarity of G to the diagonal matrix.

$$f2 = \sum_{i=1}^{k}\sum_{j=1}^{k}\frac{pij}{1+|i-j|} \quad (4)$$

Color Feature

The color feature is a distinctive feature for image representation that is invariant with respect to the scaling, translation and rotation of an image [13]. The Mean, skewness and kurtosis are used to represent color as features in this paper. The Mean is used to represent the average value of each color channel in the image.

$$\mu = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}Fij \quad (5)$$

The skewness and kurtosis are used to measure the distribution of each color channel in the image [15]. The skewness can be described as:

$$s = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(pij-\mu)^3}{MN\sigma^3} \quad (6)$$

The skewness method is one of the measurements of symmetry. If a distribution is symmetric, then it looks the same to the left and right of the center point of the image. The kurtosis can be representing whether the data are peak or flat relative to a normal distribution. The kurtosis can be described as follows:

$$k = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(pij-\mu)^4}{MN\sigma^4} \quad (7)$$

The combination of mean, skewness and kurtosis are used to represent color feature of orginal and test image of Indian currency.

E. Digit recognition

The Indian currency contains different denominations. In this paper the digit is recognized and identifies the corresponding notes. For this template matching method is used with image correlation matching. One of the fundamental methods for calculating the image correlation is called cross-correlation, which is a simple sum of pair wise multiplications of corresponding pixel values of the currency images.

$$Cross-Correlation(Image1,Image2) = \sum_{x,y} Image1(x,y) * Image(x,y) \quad (8)$$

F. Classification

The SVM (Support Vector Machine) with polynomial kernel function is used as the classifier. The training sample in which there is a support vector machine is separated by a hyper plane method. This is computed according to the decision function f(x) = signum (w . x) + b, where w is a weight vector and b is a threshold cut off. Support vector machine method was chosen as the binary classifier because it can classify accurately even when limit samples were available [16]. The different types of kernel function in SVM classifier. They are linear, quadratic, polynomial, and radial basis kernel functions.

G. Template matching

The Template Matching method is one the high-level machine vision technique that identifies the parts on an image that match a predefined template in the given problem. Template matching techniques shows flexibility and relatively straightforward to use, which makes them one of the most important methods of object localization in image processing. These techniques are expected to addresses the following needs; it provided a reference image of an object (template image) and an image to be tested (input image). We want to identify all input image positions at which the object from the template image is presented. The different template matching methods are:

Cross-Correlation: one of the important methods for calculating the image correlation method is so called cross-correlation, which is essentially one of the simple sums of pair wise multiplications values of corresponding pixel values of the given images.

$$Cross-Correlation(Image1,Image2) = \sum_{x,y} Image1(x,y) * Image(x,y) \quad (9)$$

Normalized Cross Correlation: In normalized cross correlation, it is an improved version of the classic cross correlation method, which introduces two important improvements over the original one:

- The obtained outputs are invariant to the global brightness change, i.e. the consistent brightening or darkening of either of images has no effect on the obtained result.
- The final correlations values is scaled to [-1, 1] ranges, so NCC of two similar images equals 1.0, while NCC of an image and its complement equals -1.0.

$$NCC(Image1,Image2) = \frac{1}{\sigma_1\sigma_2}\sum_{x,y}(Image1(x,y)-\overline{Image1}) * (Image2(x,y)-\overline{Image2}) \quad (10)$$

IV. EXPERIMENTAL RESULTS

The following figures show the results of the proposed methods. The fig. 3 shows the original image for 100 rupee.

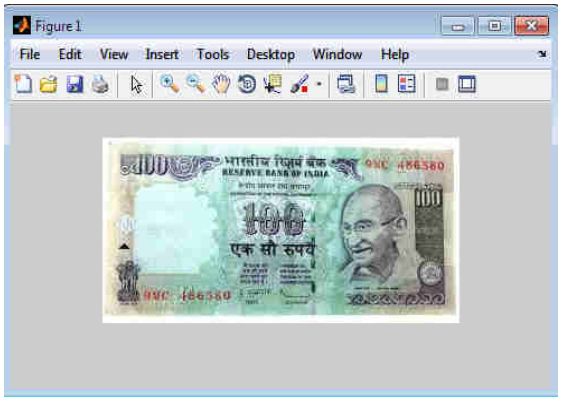

Fig.3: Original image

The fig. 4 shows the extracted identification mark from the hundred rupees. In hundred rupees the identification mark is triangle.

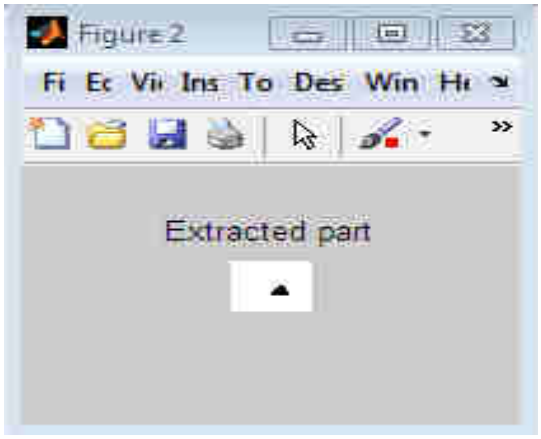

Fig.4: Extracted identification part

The fig. 5 shows the extracted digit from the hundred rupees.

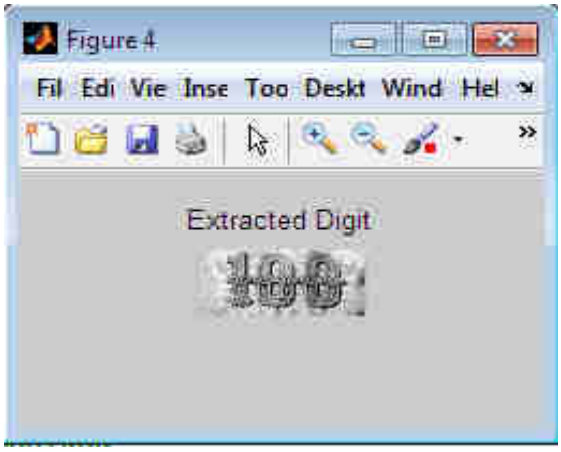

Fig.5. Extracted digit part

The fig. 6 shows the identification of hundred rupees.

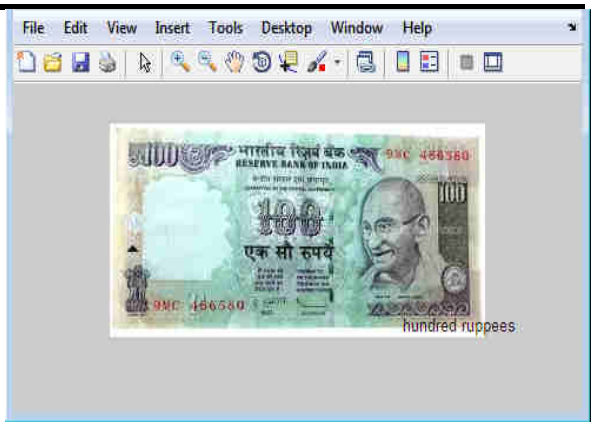

Fig.6. Identification of hundred rupee.

V. CONCLUSION

In this paper the identification of Indian paper currency is described by applying the image processing technique. In this paper basically three methods are used, they are shape identification, feature extraction and digit recognition. The three methods are combined together so this method becomes stronger. The implemented technique begins from image acquisition and end at comparison of features. The proposed work is an effort to suggest an approach for the different characteristic extraction of Indian paper currency.

The complete proposed methodology works for different Indian denomination such as 5, 10, 20, 50, 100, 500, 1000. In this paper SVM classifier with polynomial kernel is used as classifier. The proposed method is very simple and easy to implement.

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