

# An Automated System for Indian Currency Denomination Identification

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**ABSTRACT:** An automated system for Indian Currency denomination is required for vendors. This work proposed two methods viz. shape histogram and template matching methods for Indian Currency denomination identification. The currency notes 10, 20, 50 and 100 are identified. The efficiency of the proposed algorithm is tested by collecting the currency samples and the efficiency of the systems is measured using confusion matrix. The test results prove that the proposed algorithm is efficient.

**KEYWORDS:** Indian currency, denomination identification, shape histogram, template matching, confusion matrix.

## I. INTRODUCTION

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.

This work mainly focused on two methods like shape identification and template matching methods. In shape identification, the identification mark from the currency is extracted and with the help of this extracted region, the identification process is performed.

**Table 1. Features of Indian currency**

Serial 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

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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 and 100 contains triangle as identification mark. For currency identification the identification marks from the images are extracted and image histogram is constructed.

In template matching method, the corresponding digit from the notes is extracted. With template matching method further processing is performed.

## II. LITERATURE REVIEW

Pathrabe and Bawane [1] proposed a method for recognizing paper currencies of different countries. The technique uses three characteristics of paper currencies including size, color, and template. In this technique the system can be trained for a new denomination banknote by just introducing one intact example of the banknote to it. In calculation the system may recognize the banknote on each side or any direction.

Sannakki and Gunjale [2] recognize and classify the currency notes by using dissimilar steps starting from image acquisition, preprocessing, testing and training. The features are extracted using Discrete Wavelet Transform (DWT) and coefficient matrix of the currency image is derived. Statistical features are extracted using coefficient and stored in a vector.

Velu et al. [3] proposed ML-CPNN method for coin verification and the correct classification of acceptance of a coin was achieved for 99.6% in a test sample of 10,000 coins. The Robert's, Laplacian and Canny edge detection methods shows accuracy of 93%, 95% and 97.25%. The ML-CPNN yields 99.47% recognition rate.

Ravi and Ravi [4] extort the surface features of exchange note images. PCA Algorithm extort the features. It is exploiting on a currency note and the inexact coefficient matrix of the distorted image is obtained. A set of coefficient statistical instants are removed from the approximate Coefficient matrix. The extracted features are formed into feature vector which may be employed for appreciation, categorization and retrieval of currency notes.

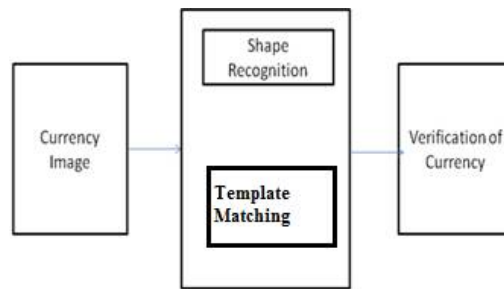
Bhavani and Karthikeyan [5] presented the efficiency of SURF for banknote recognition. The scale-invariant and rotation-invariant attention point detector and descriptor provided by SURF is robust to handle the image rotation, scaling change and enlightenment change.

Sargano et al. [6] is a new intelligent system for paper currency recognition. Pakistani paper currency has been considered as a case study for intelligent recognition. It employs three layers of feed forward reverse promulgation Neural Network for classification. This method is simple and it consumes comparatively less time which makes it suitable for real time applications.

Aggarwal and Kumar [7] produce Currency Recognition System using Localization and Color Recognition. The Indian currency notes have been properly recognized and the quantity has been found with a high level of accuracy. The efficiency of their system is 96%.

## III. PROPOSED SYSTEM

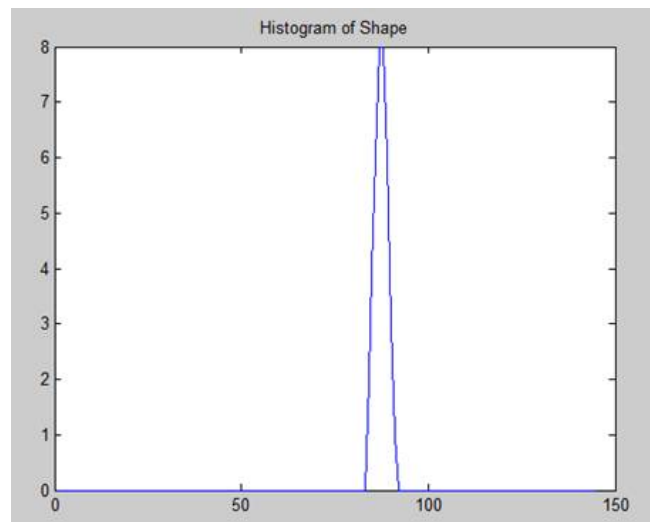
The proposed system is to identify Indian currency denomination using two methods. They are shape identification and template matching methods. In shape identification method the identification mark in the currencies are used. In template matching method the denomination from the notes are extracted and it is compared with templates stored in database images. The block diagram of the proposed system is shown in Fig.1.



**Fig.1. Block Diagram of proposed system**

### A. SHAPE IDENTIFICATION

The shape of an object refers to its physical structure and profile. Shape features are mostly used for finding and matching shapes, recognizing objects or making measurement of shapes. The histogram of an image normally refers to a histogram of the pixel intensity values. The histogram is a graph showing the number of pixels in an image at each different intensity value found in that image. For an 8-bit grayscale image there are 256 different possible intensities, and so the histogram will graphically displays 256 numbers showing the distribution of pixels amongst those grayscale value. Fig.2 shows the histogram of triangle shape of hundred rupees.



**Fig.2. Histogram of triangle shape of hundred rupees.**

The Algorithm for shape identification of Currency using shape Histogram is given below.

- 1) Find row wise histogram count
- 2) Follow preprocessing steps to remove noise.
- 3) Find row wise histogram count for cleaned image.
- 4) Plot in each row, the number of object pixels
- 5) For shape identification using histogram of shape do following steps

Find peaks of histogram if sum of row count is zero then there is no shape

- Find the count of first peak
- Find the ratio between the peak element count and the peak element i.e. width / length
- if ratio greater than 1.1 then it is rectangle else it is square
- if the peak is less than two , check whether the peaks next count is zero, then it is triangle
- else it is either circle or diamond
- if the unique elements in row count is more than it is diamond else it is circle

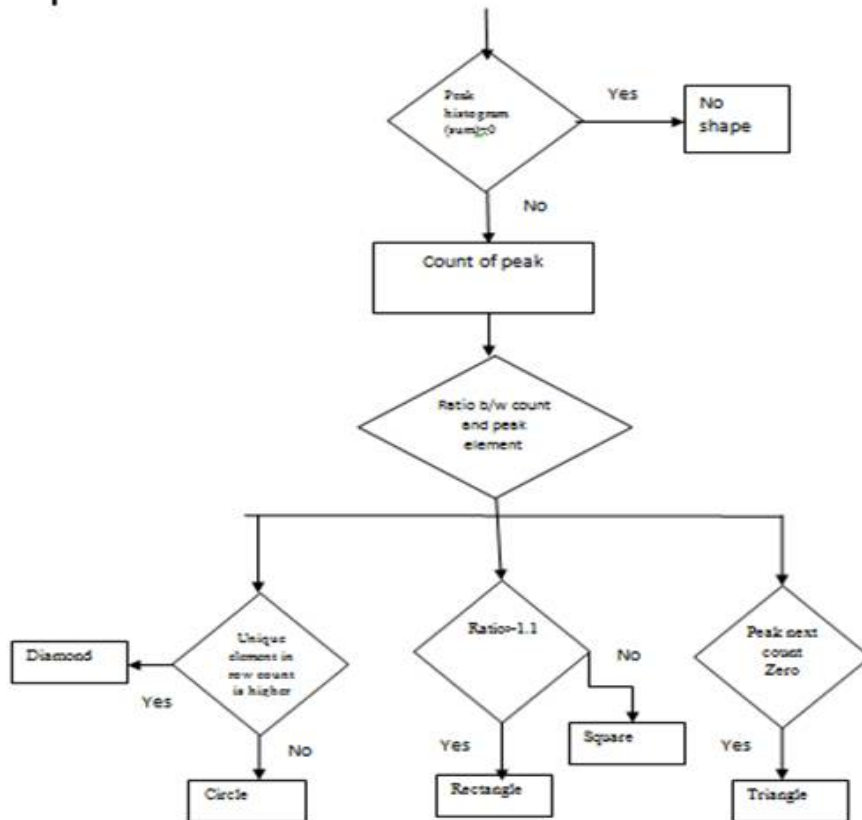
Fig.3 shows the flowchart for Shape Identification of Currency using Shape histogram.

**B. TEMPLATE MATCHING**

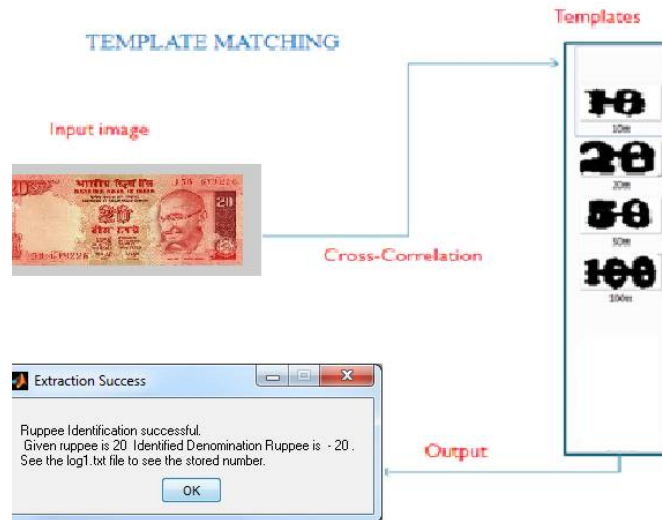
The algorithm for Currency Identification using template matching method is given below.

- Extract the digit region
- Perform the preprocessing operations
- Load the test image
- Perform morphological operations
- Resize the image
- Apply sobel operator
- Compare the resized images with template images with correlation matching.
- If the extracted image is more similar with any one of the template then print the corresponding denomination.

The fig.4 shows the template matching process.



**Fig.3. Flowchart for Shape Identification of Currency using Shape histogram**



**Fig.4. Template Matching**

#### IV. EXPERIMENTAL RESULTS

In this work, different types of Indian currency notes are selected. Some of them are collected from internet and some currency images are obtained with the help of digital camera and scanner. The collected images are stored as a database and future operations are performed.

The collections of images are shown in Fig.5. Fig.6 shows the intermediated outputs obtained in template matching process and Fig.7 shows the sample Images of Denomination Identification using Shape Histogram. A total of 20 images are collected. Table 2 shows the total number of test images.

**Table 2. Total Number of Test Images**

Class	Number of images
10	5
20	5
50	5
100	5

Table 3 shows the confusion matrix. The outputs of the proposed system are given below. The result of this system can be seen from accuracy that calculated from confusion matrix.

**Table 3. Confusion matrix**

Actual Class	Detected Class	
	True positive(TP)	False positive(FP)
	False negative(FN)	True negative(TN)

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To assess the accuracy of an image classification, it is common practice to create a confusion matrix. In a confusion matrix, your classification results are compared to additional ground truth information. The strength of a confusion matrix is that it identifies the nature of the classification errors, as well as their quantities. Classifier Accuracy or recognition rate: percentage of test set tuples that are correctly classified. The accuracy of the classification system is given in equation 1.

$$Accuracy = \frac{TP + TN}{TP + FN + FP + FN} \dots(1)$$

For result analysis five sample notes from each currency notes are taken. Total of 20 images are tested. Table 4 shows the confusion matrix of Template matching method for Currency Identification and Table 5 shows the confusion matrix of shape histogram method for Currency Identification.

**Table 4. Confusion matrix of Template matching method for Currency Identification**

Actual class	Detected Class			
	10	20	50	100
10	3	2	0	0
20	0	5	0	0
50	0	0	5	0
100	0	0	1	4

Accuracy=17/20 × 100 = 85%

Error rate=3/20 × 100=15%

**Table 5. Confusion matrix of shape histogram method for Currency Identification**

Actual class	Detected Class			
	10	20	50	100
10	4	0	1	0
20	0	5	0	0
50	0	0	5	0
100	0	0	1	4
Total				20

Accuracy=18/20 × 100 = 90%

Error rate=2/20 × 100 = 10%

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Fig.5. Sample Test Images.






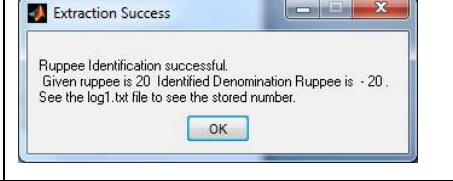
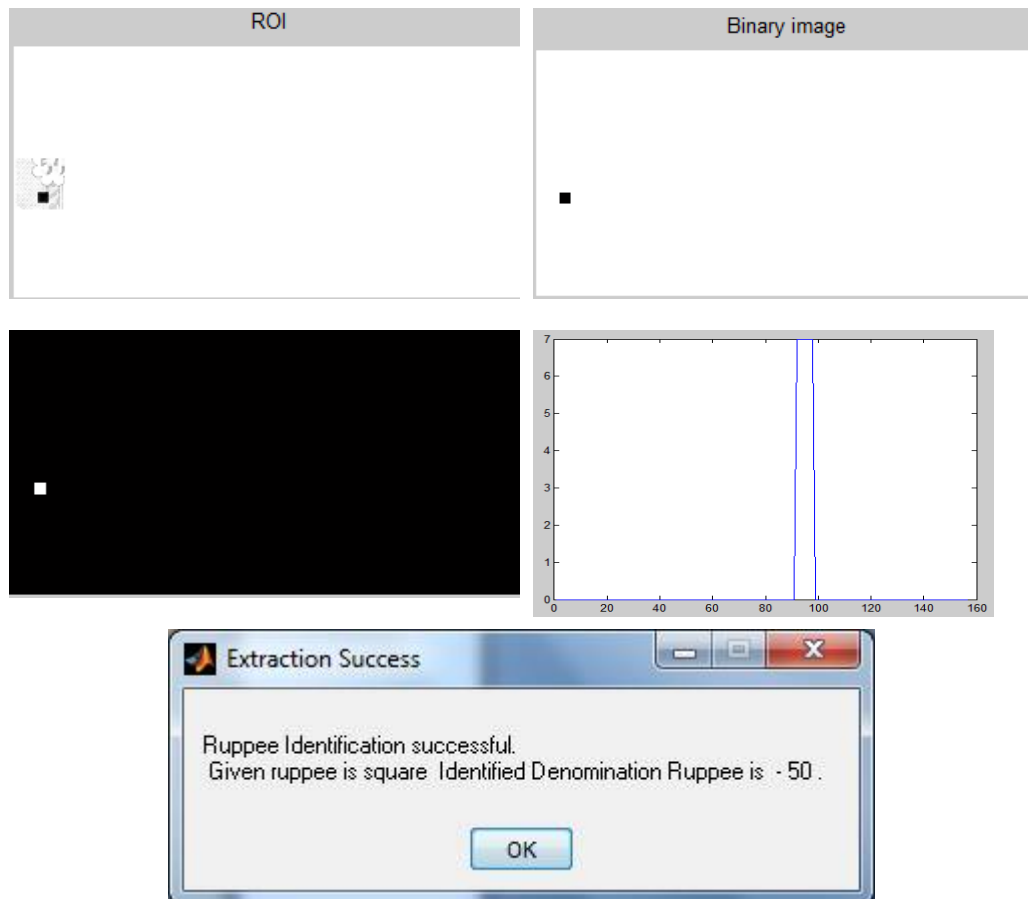
	
<p>a) Input Image</p>	<p>b) Gray-scale Image</p>
	
<p>c) Region of Interest</p>	<p>d) Black and White image</p>
	
<p>e) Template Image of Test input</p>	<p>f) Output of Template matching process</p>

Fig.6 Sample Images of Template Matching Process





**Fig.7. Sample Images of Denomination Identification using Shape Histogram**

With this confusion matrix, the accuracy of the two methods is compared. It shows the accuracy of the template matching method is 85% and accuracy of the shape identification is 90%. From the analysis it shows that shape identification is more accurate when compared to template matching method for currency identification system.

The problem for template matching method is the shapes of the templates are not accurate so it does not recognize all images. The recognition method of Indian paper currency which is described in this paper is quite simple, efficient and easy to be understood clearly because denomination numerals are used for identification which can be extracted easily from paper currency. These denomination numerals are matched and are found exact match for identification.

## V. CONCLUSION

In this paper the identification of Indian currency is described by applying shape identification and template matching methods. When compared to template matching method, shape histogram method shows high recognition accuracy. This methodology works for different Indian denomination such as 10, 20, 50 and 100. It also works well for old notes of 500 and 1000. In this work, the disadvantage is that it does not recognize all test images. Indian currency identification system requires high recognition accuracy.

The future work is to extract shape, color and texture features from currency and classify it using Support Vector Machine Classifier. The future work is to identify the new currency notes of 500 and 2000. The new notes do not have



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shapes. Thus feature extraction method would be employed. Another method is to identify the currency through invisible features that are present in the Indian currency.

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