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A Novel Approach for New Indian Paper Currency Recognition and Counting System Based on Denomination Value Character

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Abstract: Reserve Bank of India (RBI) has recently released notes and coins of different denominations. In this paper, we have proposed an automation system which will classify Indian new notes of different denominations and calculate the total currency value in terms of Indian Rupees (INR). The Artificial Neural Network based classifier is used here for recognizing the denomination of currency which will be helpful for a blind person to recognize. Two feature vectors are used here. One is the length of the Region of Interest of denomination character and the other is the number of pixels used in contour area of denomination characters. This work will help people to count the amount of currency with 99.97 percent efficiency.

Keywords: ***ANN, Gaussian Blur Filter, Canny, Contour, Pixel, Classifier, RBI, Region of Interest (RoI)***

I. INTRODUCTION

Reserve Bank of India has recently released notes and coins of different denominations [1]. In all walks of life, machine automation is essential to make a sophisticated approach to the mankind. Of course the machines cannot be replaced by human beings in exact recognition of currencies. Nowadays, most of the work of the human being is replaced by machines. The currency classification of various denominations and finding the sum is a tedious process. Our proposed system will take a digital image, as input, crops the different types of currencies and recognizes those. Artificial Neural Network based classifier [2] and Gaussian Blur filter [3] is used for this purpose. The proposed system takes the new Indian Currency available from November 2016 [1]. The target denominations are Rupees 50, 200, 500 and 2000.

All notes of different denominations are kept in a white trey in non-overlapping manner. The pre-processing is used to equalize the dimensions of notes according to denominations. The value of the notes is written in a particular area on notes. That area is dynamically cropped and then the two feature vectors, the length of the note's denomination and the number of pixels in contour are extracted. These feature vectors are used to train the ANN classifier which is used to identify the Notes denominations. Finally total amount is calculated by summing up the multiplied value of a denomination number with numbers of notes present.

II. RELATED WORK

There are different researchers from all over the world works on the recognition of currency and coins. Vishnu R and Bini Omman performed lots of work on currency detection. In paper [4], they used Similarity Indices method for currency detection. They compared the similarity among the features extracted from the input note and the template image of the corresponding feature. This currency recognition work became more realistic in their next paper [5] published in September, 2014.

Authors on the paper [5] utilized the principal component analysis (PCA) on Indian currency recognition. They first proposed a method to normalize the images of notes by using histogram equalization. Then they extract five features, namely shape, center, RBI seal, micro letter and latent image from images of currency by placing a rectangular box of specific dimensions to discover the Region of Interest (RoI). Once the features are extracted, PCA (principal component analysis) is applied to each of these features. Finally, the distance between the weight vectors of test images with a weight vector of each training image is calculated using Mahalanobis distance method. They made their works on currency recognition more robust in their next work [6].

In paper [6], they used PCA and WEKA Classifier for data Validation. In this method training model is generated from the extracted features of the training set. This training model classifier is used to decide the class of test feature. The three classification algorithms Random Forest, Support Vector and Naive Bayes are used for model prediction and generation of features of Indian currency recognition.

Authors in [7], proposed a method for currency value classification. They included three features such as aspect ratio, color and shape. They first extracted the color of the note. Then the dimensions of the currency are used to compute the aspect ratio. In the next step, the identification mark area is segmented. "Fourier Descriptor" is used to identify the shape of the I.D. mark. Once the

features are extracted, Artificial Neural Network (ANN) is applied to classify the shapes and on the basis of this classification, values of various Indian Currencies are recognized. In paper [8], authors selected five types of currency for recognition, which are Indian Rupees (INR), Australian Dollar (AUD), Euro (EUR), Saudi Arabia Riyal (SAR) and the US Dollar (USD). They used image pre-processing operations blurring, grayscale conversion, thresholding, and noise removal using filters, color blurring RGB to HSV conversion to detect boundaries, cropping the RoI and Calculating color features. Finally the Euclidian distance equation is used for finding out the average values of the differences between the target and ideal HSV features for currency recognition.

III.PROPOSED WORK

The proposed work is mainly divided into two modules. First module identifies the currency value of the images of notes and second module counts the total value of the currency.

A. Currency Value Determination

This module focuses the two parameters of a currency which are the length of the note character in the Region of Interest (RoI) and number of pixels present in contour. The steps are as follows

1) *Image Acquisition:* Notes of different denominations are kept in a wooden table in non-overlapping condition and captured by an 8 megapixel camera. The training database is created with 5 images of each denomination of notes. Fig. 1 shows the sample captured images.

Fig. 1 New Indian Available Currencies (50, 200, 500, 2000)

2) *Pre-processing and Image Enhancement:* In this stage Image is at first resized into 540 × 200 resolutions and then converted into grayscale image from Blue-Green-Red (BGR). Resized images are shown in Fig. 2. The Gaussian Blur Filter is used on this grayscale image for enhancement.

Fig. 2 Resized into 540 x 200 Dimension

3) *Selection of Region of Interest (RoI) and Cropping:* The Region of Interest (RoI) of each image is passed through canny edge detection algorithm presented in Fig. 3. This algorithm uses double hysteresis thresholding to find the edges in the notes images.

Fig. 3 Character Edge Detection by Canny Edge Detector

The left top point and right bottom point of the RoI is calculated from the edges of the note denomination and cropped by using a rectangle which has the same size with note value character to find the exact RoI. Fig. 4 and 5 showed the images after left top and right bottom corner identification.

Fig. 4 Left Top Corner of Denomination Value Character Calculation

Fig. 5 Right Bottom Corner of Denomination Value Character Calculation

4) *Features Extraction:* In this process two features are identified which are the length of the note's characters in terms of pixels and number of pixels present in contour area. The length of notes character differs significantly with the number of digits present in the note's denomination. The notes of the rupees 50 carries two digits while 100, 200, 500 rupees notes carry three digits and rupees 2000 carries four digits. The edges of the note value character are computed from the numbers of pixels present in contour area.
5) *Preparing the Training Database:* The training database is prepared with the feature vectors extracted in the step 4.
6) *Classifier Design:* Multi Level Artificial Neural Network (ANN) is used to classify the data set into clusters. The ANN classifier is trained by feature value and the whole data set is divided into four clusters shown in Fig 6. The X and Y axes represent the length of the note's characters in terms of pixels and the number of pixels present in the contour area respectively.

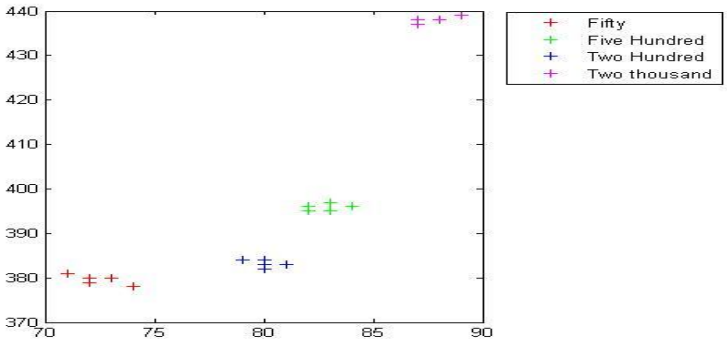

Fig. 6 Representation of Trained Data Set

7) *Testing:* The target note images are captured in the same way and feature values are extracted. The extracted feature values are passed through trained ANN for note's denomination identification.

B. Total Value of Currency Calculation

In this step the total currency amount is calculated using the equation 1.

$$\text{Total Currency Amount} = \sum_{i=1}^{n} \text{number of Notes Denomination}_i \times \text{Denomination Value}_i \quad \ldots\ldots\ldots\ldots (1)$$

IV. RESULTS

Sample training feature data sets used for training the ANN classifier is shown in Table I.

TABLE I
TRAINING DATA SET

Serial Number	Denomination of Notes	Length of Notes Denomination Characters	Number of Pixel in Contour
1	50	72	379
2		73	380
3		72	380
4		74	378
5	200	81	383
6		80	382
7		79	384
8		80	383
9	500	83	395
10		84	396
11		83	397
12		82	396
13	2000	87	437
14		88	438

15		87	438
16		89	439

The result of notes denomination identification is shown in table II

TABLE III
RESULT

Denomination of Note	Number of Tests	Number of Success	Number of Failures
50	42	41	0
200	38	36	2
500	47	46	1
2000	52	50	2

The overall results show that our proposed system reports 99.97 precents correct result.

V. CONCLUSION & FUTURE SCOPE

This proposed work is only identifies the total amount of the notes denomination of new Indian rupees. In this work, ANN classifier and Gaussian Blur filter along with image processing is used. The result shows that our proposed system works with 99.97 percent efficiency. But this system cannot be used to recognize foreign currencies such as Dollar, Pound, and Taka. In order to make this work more useful and accurate, we will include foreign currencies recognition, identification of new 20, 100 rupees notes and identification of fake notes and coins in the future.

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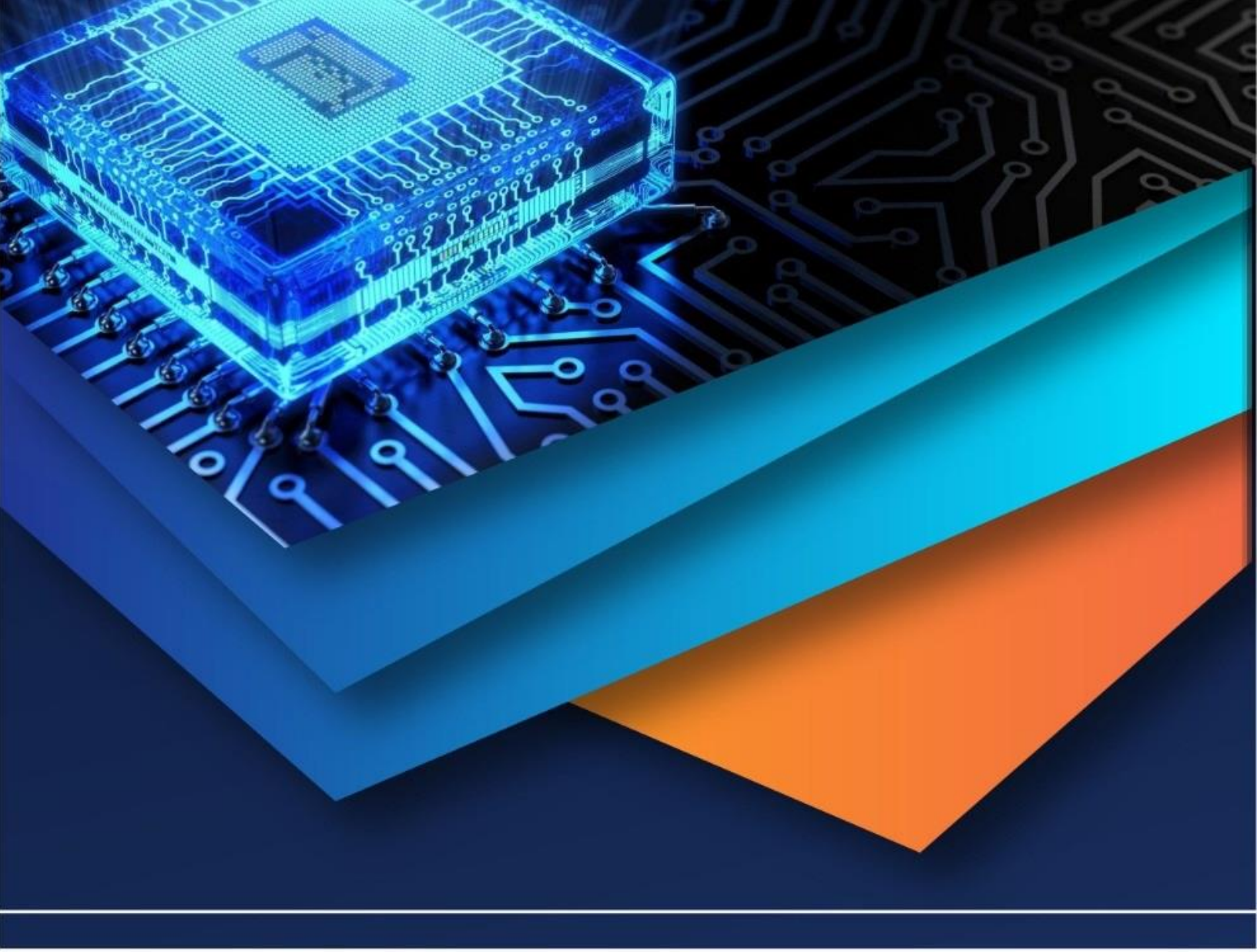

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