A Novel Approach to the Indian Paper Currency Recognition Using Image Processing

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Abstract— **In this paper, we propose a system for the recognizing the paper currency. This is based on interesting features extractions like colors of paper currencies and correlation between images. Depending on the color of the currency is grouped into three groups-red, green and blue. In this system we are including the new currency notes of Rs.500 and Rs.2000.For Identifying the new currency we developed different database for new and old currency. In this system we are including Rs.10, Rs.20, Rs.50, Rs.100, and Rs.500, Rs.2000 paper currencies and old Rs.500 and RS.1000 currencies too.**

Keywords— **Color grouping, Correlation, Database, Feature extraction, Image processing, Indian Paper currency, Intelligent system, Old and new currency**

I. INTRODUCTION

The currency plays an important role in our day today life. Every day we are dealing with currency for different purposes, so currency recognition is an important need of the current automation systems in the modern world of today and also is a one kind of an assistive aid for visually impaired. It has various potential applications including electronic banking, currency monitoring systems etc.

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In order to make the system more effective and useful the system must able to recognize the folded, wrinkled and faded paper notes. With these goals in mind we developed a computer vision system.There are various techniques for currency recognition that involve texture, pattern or colour based recognition and neural network to address the currency recognition process.In this system three characteristics of paper currencies together with pattern, color and texture are used in the recognition.

Every currency have the dominant color, most of the techniques uses this dominant color for recognition. But in this system taking the color of the vertical band on the extreme right area of the currency. The color of the vertical band is taken as the color of the currency. Then cropped the Denomination part of the each currency and developed a database for each currency and use the correlation between the images for identifying the currency.

This paper is arranged as follows: In Section II, the existing works for the currency recognition system is given, the proposed algorithm and the result for the process are discussed in Section III.

Figure 1.Vertical band of the currency

II. EXISTING WORK

The various methodologies or the techniques that have used to recognize the Indian currency note,

Neural Network

Digital image processing techniques to find the region of interest and after Neural Network and pattern recognition techniques is used for matching the pattern [11].

Security Features

Many security features like watermarking, serial number, identification mark for various denomination part, dominant colour, textures and size etc. should be used for the recognition of paper currency.

Heuristic Analysis

Currency note recognition based on heuristic analysis of the character and digit of serial number. Heuristic analysis of colour separates character and non-character elements on colour basis.

III. PROPOSED ALGORITHM

The current technologies make it essential to build up an automated system.

Flow Diagram

The system is based on Camera, PC, and algorithm. The aid of the algorithm is located in the unique figure, segmentation, pattern matching, etc. [1] we realize there by programing with MATLAB®.

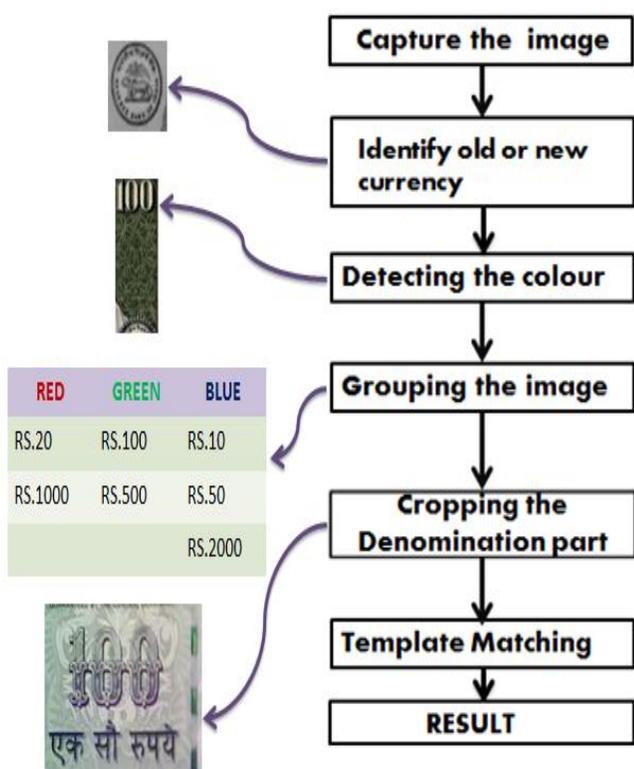Design flow of the system is described below

Figure 2.Design Flow Diagram of currency recognition

The flow diagram shows the prominent features of the currency that are used for the recognition.

IV. IMAGE CAPTURING

The image is acquired using camera which is used as input image. The image should be of decent quality. The Image capture resolution is 640 x 480. The images of similar quality and size are stored in the database. The input image and the stored image are used for pattern matching to get the result .i.e. the denomination part, position of RBI emblem of new currency (round part). The image is usually stored in jpg file format.

V. FEATURE EXTRACTION

In pattern recognition and image processing, feature extraction is a special form of dimensionality reduction. If the features extracted are carefully chosen, it is expected that the features set will perform the desired task using the reduced representation instead of the full size [2].In this process first identifying the new currency or old currency, second step is to identifying the color of the vertical band on the right of the paper currency and the third process is to extract the denomination part.

Figure 3: Features extracted

Identifying the new currency: The pattern of new currency (Rs.500 and Rs.2000) [13] is entirely different from that of old currency (Rs.10, Rs.20, Rs.50, Rs.100, and Rs.1000)[12] So in this process first identifying the whether it is new or old currency. In order to identifying the new currency, cropping the RBI emblem position of the new currency. In the old currency same position has another pattern so we made a database of that position. Then use the RBI emblem of the currency as a template to match using correlation. If match found then that currency is new otherwise it is old currency.

Identifying the color: An RGB image, sometimes referred to as a truecolor image, is stored in MATLAB as an M-by-N-by-3 data array that defines red, green, and blue color components for each individual pixel[1],[3]. RGB images do not use a palette. The color of each pixel is determined by the combination of the red, green, and blue intensities stored in each color plane at the pixel's location.

In order to identifying the color of the currency, extracting the vertical band on the extreme right area of the currency. Cropped image will be scanned for the individual channel of R, G and B intensities of the pixels.

Depending upon the color of the part, the currency is grouped into three groups – red, green and blue. Under the red group Rs.20 and Rs.1000, under the green group Rs.100 and Rs.500 and under the blue group Rs.10, Rs.50 and Rs.2000.The main advantage of grouping is to reduce the probability for finding the currency.

Extracting the Denomination: Pattern of currency notes Rs.500 and Rs.2000 is entirely different from the old notes. In the case of new currency the denomination is at the right end of the currency and that of old currency have the denomination at the centre .During the extraction of the denomination part of the currency, according to the currency we extract the different position. Extracted denomination part is matched with the database by template matching using correlation.

VI. TEMPLATE MATCHING

The template is sample image used to recognize the similar objects in source image. The template matching means that the position of the given pattern is determined by a pixel-wise comparison of the image with a given template that contains the desired pattern. For the pattern comparison correlation is used.

The width of the template is taken as [2W,2H] and the correlation response between two images *f* and *t* at each position (x,y) is defined [10]as:

$$C = \sum_{k=-W}^{W} \sum_{l=-H}^{H} (f(x+k, y+l) t(k, l)$$

This is often called cross-correlation.

A common way to calculate the position of the pattern in the image *f* is to evaluate the normalized cross correlation value at each point for *f* and template *t* .This equation gives a basic definition for the normalized cross correlation coefficient

$$c = \frac{\sum_{x,y} [f(x,y) - \bar{f}][t(x,y) - \bar{t}]}{\left(\sum_{x,y} [f(x,y) - \bar{f}]^2 \sum_{x,y} [t(x,y) - \bar{t}]^2 \right)^{1/2}}$$

Normalized correlation returns values with a maximum range of "1"Accepted matches with a threshold value c(x,y) > 0.9.In practice coefficient greater than about 0.7 or 0.8 indicates a good match[10].

VII. RESULT ANALYSIS

To evaluate the performance of the proposed system, we tested unknown dataset of 80 banknotes which includes Rs.10, Rs.20, Rs.50, Rs.100, Rs.500, Rs.1000 and Rs. 2000. The test database includes clean, worn, torn, and noisy banknotes. For the recognition of new currency (Rs.500 & Rs.2000) and the old currency (Rs.10, Rs.20, Rs.50, Rs.100, Rs.500 & Rs.1000) we made a database of 80 bank notes of corresponding position.The result indicates system has 100% recognition ability.

In the second step, different banknotes denominations have been tested individually. The results indicate that system has 100% recognition ability for all kinds of Indian Rupee banknotes.

In the third step, we tested the collective recognition ability of the system, by passing 80 banknotes, which includes 10 banknotes from each class

Implementation steps are follows

Step 1: Capturing the image using camera

Step 2: Extracting the round part position (RBI Emblem) and convert to gray scale and find the match from the database.

Step 3: Extracting the vertical band on the extreme right area of the currency.

Step 4: Detecting the color of the vertical band.

Step 5: Grouping the image according to the color of the currency.

Step 6: Extracting the Denomination of the currency.

Step 7: Find the corresponding match from the database.

Step 8: Display the Output.
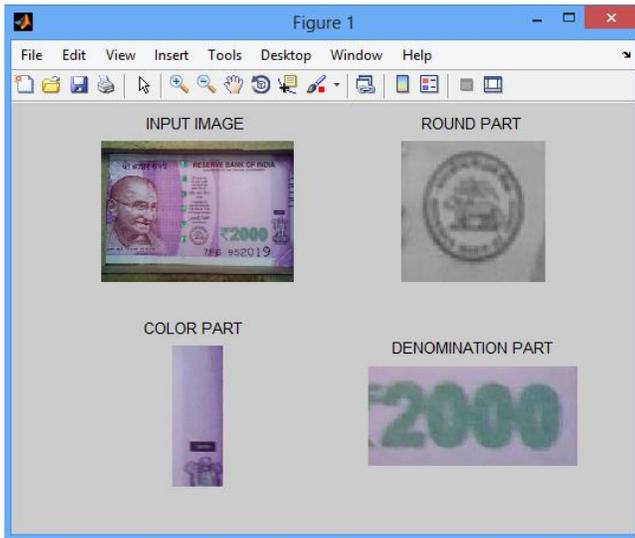
Results are follows:

Output for the new currency

Figure 4: Extracted features of the new currency

Output for old currency

Figure 6:Extracted features of the old currency


```
maxmatch =

    0.9910

NEW CURRENCY
red pixels=
    28

blue pixels=
    14243

green pixels=
    0

Total pixels=
    14271

Currancy is
BLUE

It can be 10,50 or 2000

rsout =

    2000
```
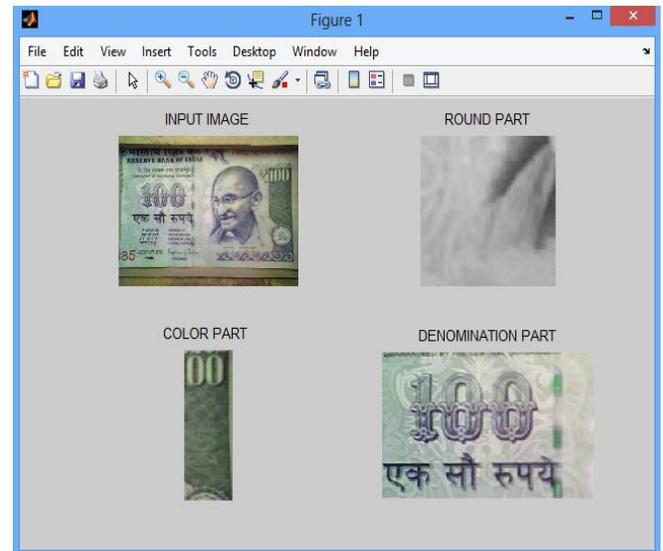
Figure 5: Output for the new currency


```
maxmatch =

    0.9961

OLD CUURENCY
red pixels=
    1487

blue pixels=
    37

green pixels=
    12747

Total pixels=
    14271

Currancy is
GREEN

It can be of 100 or 500

rsout =

    100
```

Figure 7: Output for the old currency

VIII. CONCLUSION

In this paper, we have proposed a new technique and system for Indian Rupee banknotes recognition. It is based on robust monetary characteristics of the banknotes rather than processing the whole image. These features are selected by keeping in mind the two important criteria. Firstly, the features should have good discrimination power. Secondly, the features should be easily extractable. The selected feature include, Aspect Ratio, set of effective color features etc. Due to less number of features, the methodology adopted is less time consuming as compared to the recognition techniques that are based on processing of the whole image.

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