Grid Based Feature Extraction for the Recognition of Indian Currency Notes

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Abstract - In this paper, important feature of Indian Currency Note are extracted and recognized. Currency features such as denomination, governor declaration, year of print etc. are segmented for recognition using 3×3 grid. Based on geometrical shape, denomination of currency such as 100, 500, 1000 are determined with the help of Neural Network classifier. Year of print of currency note is extracted using OCR techniques. Proposed method is experimented on a large dataset and demonstrated the efficiency of the approach.

Keywords - Image processing, Feature extraction, Neural Network, Currency Note.

I. INTRODUCTION

First paper money was introduced by the Government of India in the year 1861 by issuing 10 rupee notes. In the year 1864 20 rupee note, 5 rupees in 1872, 10,000 rupee in 1899,100 rupee in 1900, 50 rupee in 1907 and 1000 in 1909. At present, Indian currency system has the denomination Rs. 5, Rs. 10, Rs. 20, Rs. 50, Rs. 100, Rs. 500, and Rs. 1000. Indian currency notes are having their own features such as denomination, shape, color etc. Blind people also can identify the denomination of Indian currency based on special identification marks. At the top right end every Indian currency note has its fixed denomination that one can feel by sensitive touch. But marker may get fade after many circulations. It is very important to develop automated system to extract feature and recognize Indian currency note in different area such as bus station, railway station, shopping mall, banking and ATM machines.

In digital image processing, feature extraction of Indian currency notes involves the extraction of potential feature like Governor Declaration, shape, year of print etc. In India handling banknotes are very difficult. Reserve bank of India given useful tips to detect a fake Indian rupee note as given below:

1. Optical Variable Ink: The color of the numeral 500 appears green when the banknote is held flat but would change to blue when the banknote is held at an angle. The font size is also reduced.

2. Latent Image: When the note is held horizontally, the vertical band on the right shows an image of the number 500.

3. Security Thread: The note also has a three millimeter wide security thread with the inscriptions: one thousand, the word 'Bharat' in Hindi and RBI.

4. Micro lettering: The 'RBI' and the numeral, "500" - which can be viewed with the help of a magnifying glass - are between the Mahatma Gandhi portrait and the vertical band.

5. Watermark: When the note is held against the light, the picture of Gandhi and an electrolyte mark showing the number 500 appear in the white space.

The best way to identify a note is the silver bromide thread that runs vertically through a currency note. Fake currency notes tend to have silver-colored band painted in place of the silver thread. A real note has a

prominent thread with raised 'RBI' markings made on it in English and Hindi. Also, in a real note, the color of the thread shifts from green to blue when viewed from different angles

In the literature there may be many algorithms which are based on texture, pattern or color models for detection of Indian Currency notes. Though, there exists verity of algorithms for currency identification most of the algorithms are degrading because of their high computational cost. The limitation has motivated to look towards extracting unique features from the Indian currency notes. Bhawani Sharma, et al. 2012, presented a system on recognition of Indian paper currency based on LBP. Trupti Pathrabe and Swapnili Karmore, 2011, introduced a methodology on a novel approach of embedded system for Indian Paper Currency recognition. D. A. K. S. Gunaratna, et al. 2008, given an approach on ANN based currency recognition system using compressed gray scale and application for Sri Lankan Currency Notes – SLCRec. Vipin Kumar Jain and Dr. Ritu Vijay, 2013, presented a system on Indian currency denomination identification using image processing technique. Rubeena Mirza and Vinti Nanda, 2012, given an approach on paper currency verification system based on characteristic extraction Using Image Processing. FaridGarcía-Lamont et al. 2012, introduced a methodology on recognition of Mexican banknotes via their color and texture features. Fumiaki Takeda and Sigeru Omatu, 1995, presented a system on high speed paper currency recognition by neural networks. H. Hassanpour and E. Hallajian, 2009, given an approach on using hidden Markov Models for paper currency recognition. H. Hassanpour, et al. 2007, introduced a methodology on feature extraction for paper currency recognition. Masato Aoba, etal. 2003, presented a system on euro banknote recognition system using a tree layered perceptron and RBF network.

In this paper, proposed methodology extracts unique features like governor declaration, year and shape features from the Indian currency note using Grid. Grid divides the currency into six parts on each side which helps to reduce the time complexity of the proposed model. Apply the preprocessing to each block to recognize and extract potential feature of Indian currency note. Neural Network classifier to be used for the purpose of classification accurately.

II. PROPOSED METHODOLOGY

In this section, the proposed methodology is described as per the block diagram shown below.

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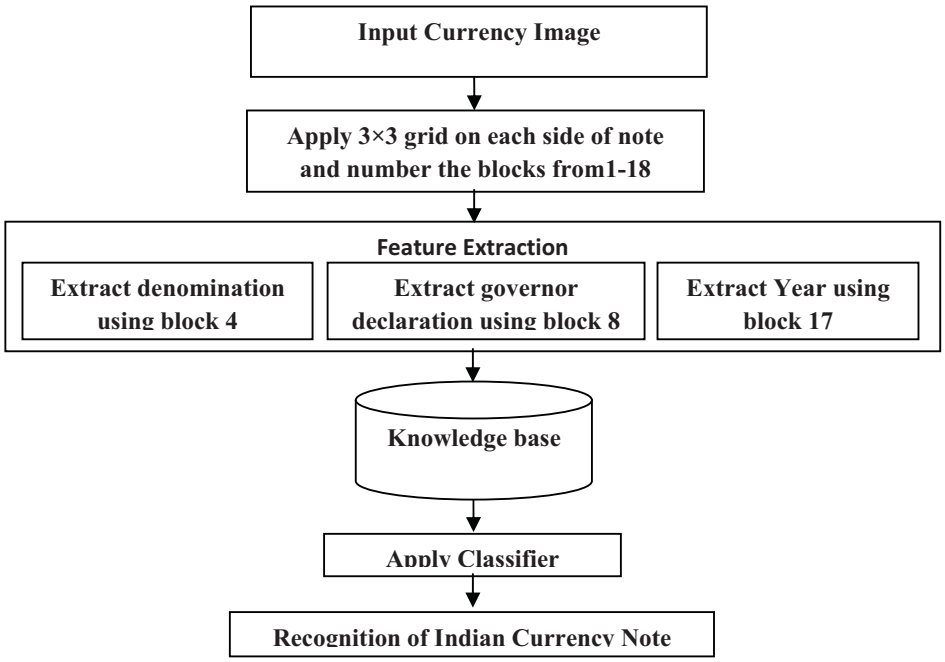

Input currency image is converted from color to grayscale and finally binarized. Further de-noise the binary image and fill any holes to get single connected region. 3×3 grid is determined using bounding box of the region.

Fig 1 shows the sample input currency note image with top and bottom views. Apply 3×3 grid to divide the each side of original image into 9 equal parts as shown in the Fig 2.

a) top view b) bottom view

Fig 1: Sample Indian Currency Image

b) Grid on top view a) Grid on bottom view

Fig 2: 3×3 Grid applied on Currency Note

Blocks 4, 8 and 17 are cropped for further analysis as shown in the Fig 3 and preprocessed them to reduce time complexity.

1. block 4 1. block 8 c) block 17

Fig 3: Cropped image of block 4, 8 and 17

III. FEATURE EXTRACTION

In this section, potential feature of currency note such as denomination, governor declaration and year of print are extracted as follows.

1. Denomination Feature

To extract denomination of Indian Currency Note, consider block 4 (Fig 3(a)) and perform preprocessing by applying filtering function to get a shape without having any noise. Here three different shapes like triangle, circle and rhombus are used to classify denomination of Indian Currency Note. Rs 100, Rs 500 and Rs 1000 denomination of currency contain geometrical shapes such as triangle, circle and rhombus respectively. Now apply geometric properties like Area, Semiperimeter and Circularity to recognize the Indian Currency Note using equation 1, 2, 3 respectively.

$$\text{Area } A = \frac{1}{2} \times L_{ma} \times L_{mi} \quad (1)$$

$$\text{Semiperimeter } S = \frac{P}{2} \quad (2)$$

$$\text{Circularity } C = \frac{4 \times \Pi \times A}{P^2} \quad (3)$$

Where

A : Area of region
L_{ma} : Length of major axis
L_{mi} : Length of minor axis.
P : Perimeter
S : Semiperimeter
C : Circularity

Area, Semiperimeter and Circularity are used as potential features. Neural Network classifier is used to train and classify the denominations of the note as shown in Fig 6.

100 Rs

500 Rs

1000 Rs

Fig 6: Sample Currency Notes with different Denomination

2. Governor Declaration Feature

Block 8 is used to identify the location of governor signature, by converting color image to binary image, then filtered to preprocess. Calculate the maximum orientation and minimum orientation using (equation (4)) for the purpose to recognize the position of governor declaration.

$$A_{max} = \frac{Q_{max}}{C} \quad \text{and} \quad A_{min} = \frac{Q_{min}}{F} \tag{4}$$

Where A_{max} and Q_{max} are maximum area and orientation of a region respectively whose area A is greater than threshold area A_{th}. In our case A_{th} is assumed as 100. C is number of regions whose area is above the threshold area A_{th}. Similarly A_{min} and Q_{min} are minimum area and orientation of a region respectively whose area A is less than threshold area A_{th}. F is number of regions whose area is above the threshold area A_{th}. In this work value of A_{th} is determined empirically.

Fig 4: Currency Note with Governor Declaration Shown in the box

3. Year of print Feature

To extract year of the Indian Currency Note consider block 17 (Fig 3(c)). Then segment the characters and recognize for further processing. This involves process like feature extraction, comparing with correlation coefficient, edge direction feature and classification. During training, the characters are normalized to standard dimension. Templates are prepared and normalized into blocks with no borders or white spaces that surround the characters. Similar process is used to segment the characters from the test image. Each character is matched with the standard template using correlation technique to measure the similarity between them using equation.5. Correlation coefficients value ranges from 0 to 1. The value 0 indicates minimum match and value 1 indicates maximum match.

Where X and Y are test and template image respectively, i and j are rows & columns of the image.

$$\text{correlation } r = \frac{\sum_{i=1:n}\sum_{j=1:m}(X_{i,j} - \bar{X})(Y_{i,j} - \bar{Y})}{\sqrt{\sum_{i=1:n}\sum_{j=1:m}(X_{i,j} - \bar{X})^2}\sqrt{\sum_{i=1:n}\sum_{j=1:m}(Y_{i,j} - \bar{Y})^2}} \tag{5}$$

Fig 5: Sample Currency Note with Detected year shown in box

IV. PROPOSED ALGORITHM

INPUT: Indian Currency Note in RGB image

OUTPUT: Recognition of Currency denomination, Year, Governor Declaration

Step 1: Input Indian Currency Image in RGB.

Step 2: convert RGB to binary image and Y=0.

Step 3: Apply 3×3 grid on each side of image and each block numbered from 1 to 18

Step 4: Select block 4 from the grid to detect denomination.

Step 5: Apply Neural Network Classifier to determine whether currency denomination is Rs. 100, Rs.500 or Rs. 1000. As described in section 3.1

Step 6: Select block 8 from the grid to detect governor declaration

Step 7: Apply bounding boxes to all the regions to locate governor declaration using the equation (4) as described in section 3.2

Step 8: Select block 17 from the grid to detect year of print described in section 3.3

Step 9: Segment each character $X_{i,j}$ using vertical profiling.

Step10: For each $X_{i,j}$ find correlation r using equation 52) for a pair of $X_{i,j}$ and standard template $Y_{i,j}$.

Step11: consider $Y_{i,j}$ whose correlation r is maximum.

Step 12: $Y=Y+Y_{i,j}$.

Step 13: Repeat step 10 to 12 for each $X_{i,j}$

Step 16: Consider year using Y.

V. EXPERIMENT AND RESULT

Proposed model is experimented on sample of 90 images in which 30 images are Rs 100 denomination and 30 images are Rs 500 and 30 images are Rs 1000. Average success rate achieved for denomination 100, 500 and 1000 is 92.30% as given in Table 1.

Fig 7 shows performance of Neural Network classifier here totally 65 Epochs helps to perform training data. Here the best validation performance obtained is 0.11981 at epoch 59. Y-axis shows the test line that can be measured using mean squared error with regularization.

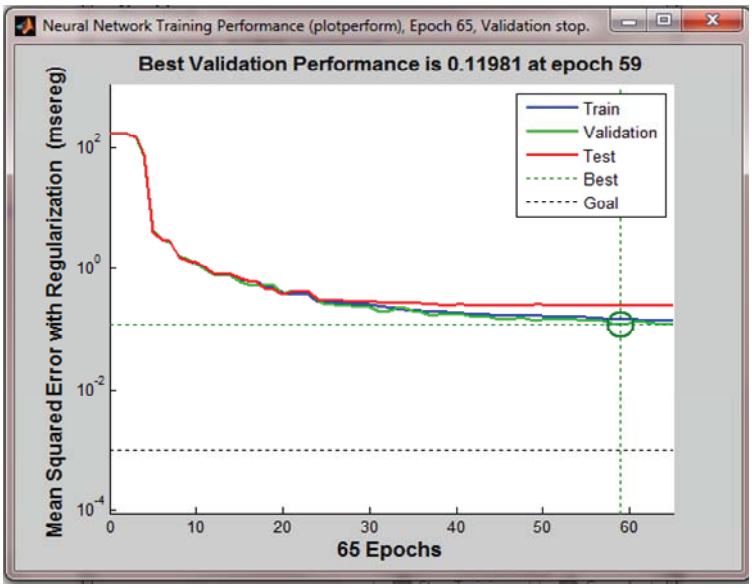

Fig7: Neural Network Training performance

Table -1 Experiment Result

S.No	Currency Denomination	Images Correctly recognized/total no. of images	Recognition rate (in %)
1	100 Rs	12/13	92.30%
2	500 Rs	12/13	92.30%
3	1000 Rs	12/13	92.30%

VI. CONCLUSION

In this paper, grid based feature extraction for the recognition of Indian Currency Note is proposed. Important features such as denomination, governor declaration and year as printed are recognized. Geometrical shape are extracted to recognize denominations such as Rs 100, 500 and 1000 using the help of feed forward neural network classifier. Governor declaration is extracted using the region properties. Year of print is extracted using OCR technique. Proposed approach is experimented on our dataset and obtained 92.30% recognition as success rate.

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