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Currency Authentication Using Image Processing

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ABSTRACT: The characteristics of paper notes vary from country to country. Currency authenticity or say identification is one among the important applications of pattern recognition. We have proposed a system for the automation of currency recognition using image processing techniques. The proposed system can be used for recognizing as well as authenticating given Indian banknotes. Only paper currency will be considered. This method works by identifying certain predefined areas of interest, and then extracting the denomination value using various characteristics such as color and text on the note. Our system identifies currency quickly and accurately. Initially, our system will be taking the front side and backside of the currency (your note) as an input and then crop it into specific predefined areas of interest. Then each image is divided into three channels. Filtering is applied to each channel, the red, green, and blue channels are recombined to get back the RGB image. Different features such as HSV are extracted from the RGB image. The proposed model is based on a feature extraction and k-Nearest Neighbor (k-NN) classifier for recognizing test banknote. The recognition system indicates that the proposed approach is one among the foremost effective strategies for identifying currency patterns to read its face value and determine its authenticity for Indian currency notes.

KEYWORDS: -Indian Currency Recognition, Feature Extraction, HSV, k-Nearest Neighbor.

I. INTRODUCTION

The identification of currency depends on the characteristics of currency notes of a particular country. Due to use for a long time, currency notes may be contaminated by noises. To identify whether the currency is authentic or not there are many features. Although it may not be practically possible to accurately identify a counterfeit in a paper currency which can only be identified by an intelligent machine.

Modern automation systems in the real world requires a system that will recognize currency. It has various potential applications that includes banknote counting machines, money exchange machines, assisting blind persons, electronic banking, currency monitoring systems etc. The recognition of currency is a very important need for visually impaired people. They are not being able to differentiate between currencies correctly, so it is very easy for them to be cheated by the others. Therefore, there is an urgent need to design a system that will recognize the currency authenticity and its value.

II. CURRENCY DETECTION

Identifying distinguishable regions:

Once the pre-processing steps have been done, we can identify which regions of the note are relatively distinguishable. This is done based on certain predefined areas. All the currencies have certain regions with fixed coordinates which we crop out for classification of notes. We have chosen 5 features from each currency note that are highlighted below within the images. Grouping is completed by checking out the values for pictorial features like hue and saturation for every feature then those values are compared with the original pictures of currency. The values chosen to classify the notes are found experimentally.

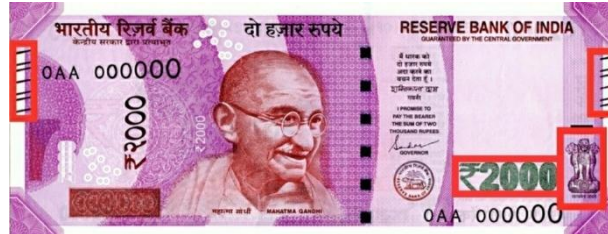


Fig. II.A: Frontside of Rs 2000 banknote



Fig. II.B: Backside of Rs 2000 banknote

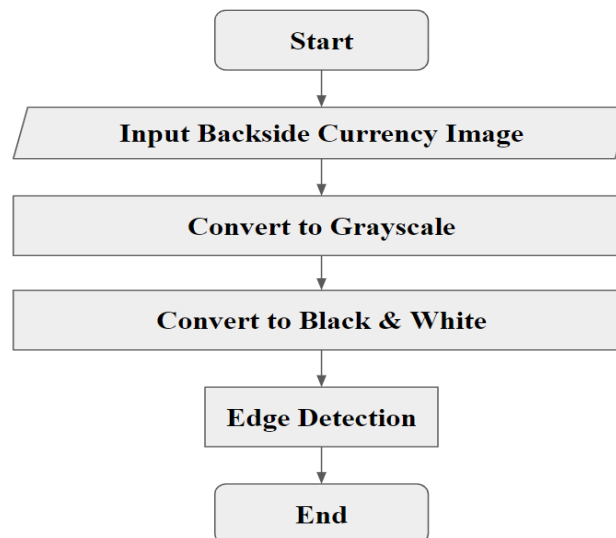


Fig. II.C: Value Detection Flowchart

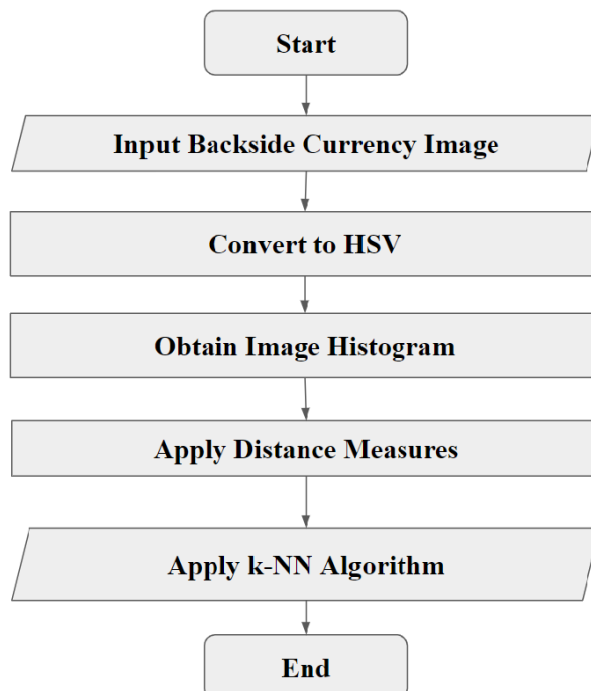


Fig. II.D: Currency Authentication Flowchart

III. METHODOLOGY

1) RGB Splitting:

RGB Color Model: - Basic Color Model

The basic color model consists of rgb and alpha channels.

Which makes it a rgba model.

R-Red, G-Green, B-Blue, A-Alpha (Transparency of image).

The pixel is 32bits.

R-G-B 8bits each and Alpha-8 bits.

2) Color Blur:

The blurring of image is applied to remove noise from the image.

It makes the images smooth for processing.

There are two types of Image Blurring one is grayscale blurring and other is color blurring.

We use windowing technique to blur an image.

Window can be of 3*3, 5*5 etc.

3) RGB TO HSV Conversion:

HSV Color Model: It is most Stable Color Model and best for detecting natural colors.

h-Hue (Denotes the original color)

s-Saturation--(Concentration of color and mixture of white color)

v-Value/Luminous --Brightness

- Divide r, g, b by 255
- Compute cmax, cmin, difference
- Hue calculation:
 - if cmax and cmin equal 0, then h = 0
 - if cmax equal r, then compute $h = (60 * ((g - b) / \text{diff}) + 360) \% 360$
 - if cmax equal g then compute $h = (60 * ((b - r) / \text{diff}) + 120) \% 360$

- if cmax equal b then compute $h = (60 * ((r - g) / \text{diff}) + 240) \% 360$
- Saturation computation:
 - if cmax = 0, then s = 0
 - if cmax does not equal 0 then compute $s = (\text{diff}/\text{cmax}) * 100$
- Value computation:

$$v = \text{cmax} * 100$$

IV. IMPLEMENTATION

The image of the banknote must first be pre-processed to remove any extraneous noise. This is done by applying a simple de-noising filter and some basic pre-processing steps. The image is then converted to a binary image using adaptive thresholding. Although there may be some background patterns, these will be removed by de-noising followed by converting to a binary image. The image is also resized to allow for easier computations.

1) Image Resizing:

The resized image with the standard size (800x160) is used in this system. The figure below shows the resized image.



Fig. IV.A: Resized Images

2) Cropping Image:

When an image is obtained from a camera, the size of the image is too large. In order to reduce the calculation, the image size should be reduced. The smaller the image is, the faster the extraction.



Fig. IV.B: Cropped Images

3) Binarization:

In order to make the image texture feature for image binarization processing, the gray image is needed to convert the binary image. Figure below shows binarization of images.

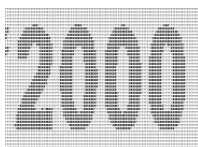


Fig. IV.C: Binarization

4) Noise Removing:

The image acquired by the scanner, there are many kinds of noise. Removing the noise is an important step in image processing. These noises are removed using a median filter. The figure below shows the image after removing noise.

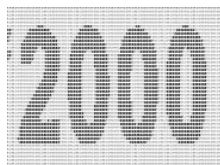


Fig. IV.D: Noise Removed Image

5) Applying OCR:

Optical Character Recognition is the electronic conversion of images into machine encoded text from an image in this case it is a currency note. We are using OCR to extract the value of a note to determine its value.

.V. FEATURE EXTRACTION OF IMAGE

There are various features of an image like homogeneity, contrast, energy, correlation, entropy, angular secondary momentum, hue, saturation, etc. To reduce the computational complexity, only some of these features were selected to use. In this paper we are working on HSV color model, that is we extracted hue and saturation values of cropped images to reduce the computation. HSV color models remap the RGB primary colors into dimensions that are easier to know. Hue specifies the angle of the color on the RGB color wheel. A 0° hue results in red, 120° results in green, and 240° results in blue. Saturation controls the amount of color used. A color with 100% saturation is going to be the purest color possible, while 0% saturation yields grayscale. Value controls the brightness of the color. A color with 0% brightness is pure black while a color with 100% brightness has no black mixed with the color. HSV value is calculated for each pixel for further comparison with the original image.

VI. RECOGNITION USING K-NEAREST NEIGHBOR

The k-nearest neighbor (k-NN) algorithm may be a method for classifying objects supporting training examples. The k-nearest neighbor algorithm proposed by Cover and Hart in 1968. The k-NN classifier computes the distance between the query instance and all the training samples. Distance is a key word in this algorithm. Euclidean distance calculates the distance between two vectors, $X = (X_1, X_2, \dots, x_n)$ and $Y = (Y_1, Y_2, \dots, Y_n)$ as follows:

$$E = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Where, E = Euclidean distance, x = hue value for that pixel, y = saturation of that pixel. And for the k-NN algorithm the value of k is used to decide the number of neighbors to be considered for classification. If $k = 1$, then the thing is simply assigned to the category of its nearest neighbor. The k-NN algorithm used neighborhood classification. After the calculations of Euclidean distances are done, it is normalized to a single value and then compared with threshold value for that specific note whose value has been determined previously and finally authenticated as Fake/Real Currency Note.

VII. RESULTS



Fig. VII.A: Introduction

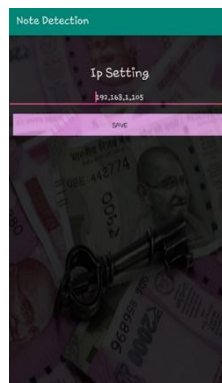


Fig. VII.B: Ip Setting

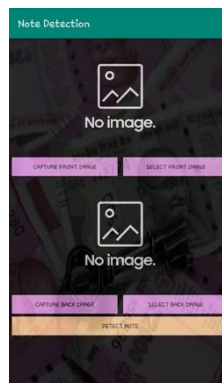


Fig. VII.C: Image Capture



Fig. VII.D: Captured Notes Pre-Processing



Fig. VII.E: Result for Original



Fig. VII.F: Result for Duplicate

VIII. ADVANTAGES AND DISADVANTAGES

Advantages

1. User Friendly
2. Free of Cost
3. Fast Processing
4. Compatible to most of the Android Versions
5. Only mobile application for currency recognition as well as authentication on Android platform.

Disadvantages

1. Recognition accuracy decreases in low light environment and blur images.
2. Does not work on another mobile operating system.

IX. LITERATURE SURVEY

There are also different methods of the currency recognition system using image processing techniques.

Vedasamhitha Abbaru *et.al* [1] proposed a method used for recognition of banknotes in which the system can identify the denomination as well as the country or origin of a given paper currency. The proposed method works by first identifying the country or origin using some certain predefined areas of interest and then extracting the value using characteristics like size, color, text on the note depending on differences of the notes within the same country.

Jesmin Akhter *et.al* [2] proposed a system which focuses on Bangladeshi Paper Currency based on supervised learning. First the system receives images of banknotes and then each image is divided into three channels. filtering is applied on each channel and recombined to get an RGB image respectively. Features like HSV, edge and grey-level co-occurrence matrix is calculated and stored. Euclidean distances are calculated from the reference values and the minimum distance gives required output.

Noura Semary *et.al* [3] proposed a system which uses basic image processing techniques on Egyptian banknotes with an accuracy around 89%. The techniques utilized include image segmentation, Region of Interest (ROI), histogram enhancement and finally template matching based on the cross-correlation between the image and training dataset.

Ahmed Yousry *et.al* [4] proposed a currency recognition system based on Oriented FAST and rotated Brief (ORB) algorithm. ORB is a FAST detector and the visual descriptor BRIEF (Binary Robust Independent Elementary Features) and aims to provide fast and effective alternatives to Local Scale Invariant Features (SIFT). After the preprocessing of images, ROI are extracted and then an ORB algorithm is applied.

X. CONCLUSION

In this paper, the authentication and recognition of Indian paper currency is described by applying machine learning and image processing techniques. Basically, five features are extracted including numeral value from frontside and backside, national emblem, left and right bleed lines from the image of currency. The currency denomination is extracted from the backside image using Optical Character Recognition (OCR) and pictorial features like Hue, Saturation, Value (HSV) are extracted for authentication of the currency, and then k-Nearest Neighbor Algorithm is applied for identification by considering a specific threshold value and determine its authenticity. This methodology works for Indian denominations 10, 20, 50, 100, 500 and 2000. The method is easy and simple for implementation. AS the actual computation is carried on the server, this application works well even on low end android smartphones. The decision making is done within a second. The system implemented is a low-cost system.

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