

Intelligent Currency Recognition System

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ABSTRACT: There are many different currency in the world. Knowing each and every currency by its feature is very difficult and sorting them is a tedious job. Practically it is not possible to recognize them. Our aim is to solve this problem and make the currency recognition an easy task. Each and every currency have a unique feature and a hidden identity. The process of currency recognition helps to extract the visible and also the hidden features on the currency. This system of currency recognition is used in places where there are money exchange taking place on a larger scale. For them sorting the difference currency of different countries and different monetary value become a difficult task. So, to help them out currency recognition system is implemented. This system help to identify the currency which have blur or damage features, because the currency with damage or blur feature is difficult to recognize. The software used can be implemented on any currencies. The algorithm implemented should be simple but efficient, the speed of execution should be fast. There are many security features available on the currency and it is not feasible to take into account all the features present on the currencies, so we need to consider only those features which have unique identification for that currency. Our aim is to generate one such algorithm that is more efficient and easy to implement and sometime it is a tedious job to implement one single algorithm for all the available currencies. The main purpose of this system is to recognize the currency.

KEYWORDS: Currency Recognition; Digital Image Processing

I. INTRODUCTION

All the currencies around the world are different from each other. For instance, the size of the paper is different, same as the colour and pattern. The staffs who work in offices like money exchange for them to remember each and every symbol for all the different currencies become a tedious job. This may result into wrong recognition, so we need an efficient and a full proof system. The aim of our system is to help people to recognize different currencies and work with convenience and efficiently. With development of modern banking system, it is necessary to develop an automatic system for currency recognition. This project proposes image processing technique for currency recognition. The image processing approach is discussed using MATLAB to detect the features of the currency. Image processing involves changing the nature of the image in order to improve the pictorial information for human interpretation. There are various techniques for currency recognition, texture, pattern and colour based [4]. The proposed system will work on two images one is the original image and other is the test image on which the verification need to be done.

II. RELATED WORK

The system is based on a camera, pc and algorithm as shown in fig 1. The aid of algorithm is located in unique figure, RGB to grey, colour matching etc.

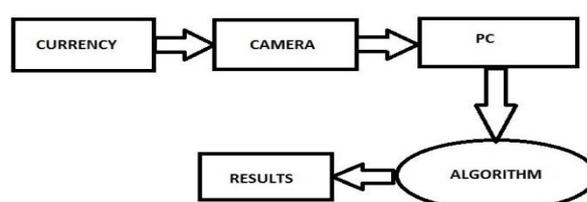


FIG 1. BLOCK DIAGRAM

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The image we get from the camera is in the JPEG format. A distinctive point extraction method use a coordinate data extraction method for a specific part of the currency representing same colour.

A. SECURITY FEATURES

Watermark: The Mahatma Gandhi Series of banknotes contain the Mahatma Gandhi watermark with a light and shade effect and multi-directional lines in the watermark window. The fig2 show the watermark image of the currency.



FIG 2. WATERMARK

Security thread: Rs.2000 notes introduced contain a readable, windowed security thread alternately visible on the obverse with the inscriptions 'Bharat' (in Hindi), '2000' and 'RBI', but totally embedded on the reverse. The Rs.500 and Rs.100 notes have a security thread with similar visible features and inscription 'Bharat' (in Hindi), and 'RBI'. When held against the light, the security thread on Rs.2000, Rs.500 and Rs.100 can be seen as one continuous line fig 3 show the difference of the optical thread when hold against light and in normal condition. Notes issued prior to the introduction of the Mahatma Gandhi Series have a plain, non-readable fully embedded security thread.



FIG 3. OPTICAL STRIP

Optically Variable Ink: This is a new security feature incorporated in the Rs.2000 and Rs.500 notes with revised colour scheme. The numeral 2000 and 500 on the obverse of Rs.2000 and Rs.500 notes respectively is printed in optically variable ink viz., a colour-shifting ink. The colour of the numeral 2000/500 appears green when the note is held flat but would change to blue when the note is held at an angle.



FIG 4. VARIABLE INK

Eurion pattern: The EURion constellation (also known as Omron rings or doughnuts) is a pattern of symbols incorporated into a number of banknote designs worldwide. It is added to help imaging software detect the presence of a banknote in a digital image. Such software can then block the user from reproducing banknotes to prevent counterfeiting using colour photocopiers. Research shows that the eurion constellation is used for colour photocopiers but probably not used in computer software.^[1] It has been reported that Adobe Photoshop will not allow editing of an image of a banknote, but this is believed to be due to a different, unknown digital watermark rather than the eurion constellation.

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FIG 5.EURION PATTERN

III. ALGORITHM USED

A. Algorithm

- i) Obtain the image of the currency from camera.
- ii) On the image obtain use the pre-processing algorithm to extract the desired features from the currency.
- iii) Detect the boundaries and extract the ROI (Region of Interest) by cropping.
- iv) Extract the desired features of currency.
- v) Compare the extracted features of the currency with the reference data calculated.
- vi) Display the result.

B. Description of Algorithm

The aim of this algorithm is to develop an algorithm that can be implemented on any currencies.

Step 1: Obtain an image

We can obtain an image from the camera or from the scanner, but we need to consider that the environment condition should not affect it that is they should be controllable.

Step 2: Pre-processing operation

Pre-processing helps to alter the nature of the currency. It helps to segment the obtain currency and also used to convert it to gray image. It helps to identify the boundary of the image and ROI. The pre-processing does not increase image information content but decrease it if entropy is an information measure [1]

Step 3: Boundary detection and cropping

This helps to separate the background and foreground of the image and also help to extract the ROI for further processing.

Step 4: Feature extraction

In this step, we extract the features from the cropped ROI image. The cropped portion is compared with the reference image. In this we extract the watermark and the amount watermark image and compare it with the reference image and if the SSIM (structural similarity index) of the two is in the range between 0.8 to 1 the currency detected is less deteriorated and if the range is not meet the currency is on the verge of deterioration. The next feature extracted is the latent image (optical variable ink). In this if you observed the image normally you can see that the image appears to be blue in colour but when you hold it at an angle of 45° the image colour change from blue to green, hence this feature help to identify that whether the currency is fake or real. The next feature is the optical strip. This feature has RBI and denomination printed on the strip, normally the strip appears to be green in colour and if the currency is held against the light the strip appears to be black. The strip is also useful to detect whether the currency is real or fake. The fig 6 shown below represent the algorithm flow of the process explain above.

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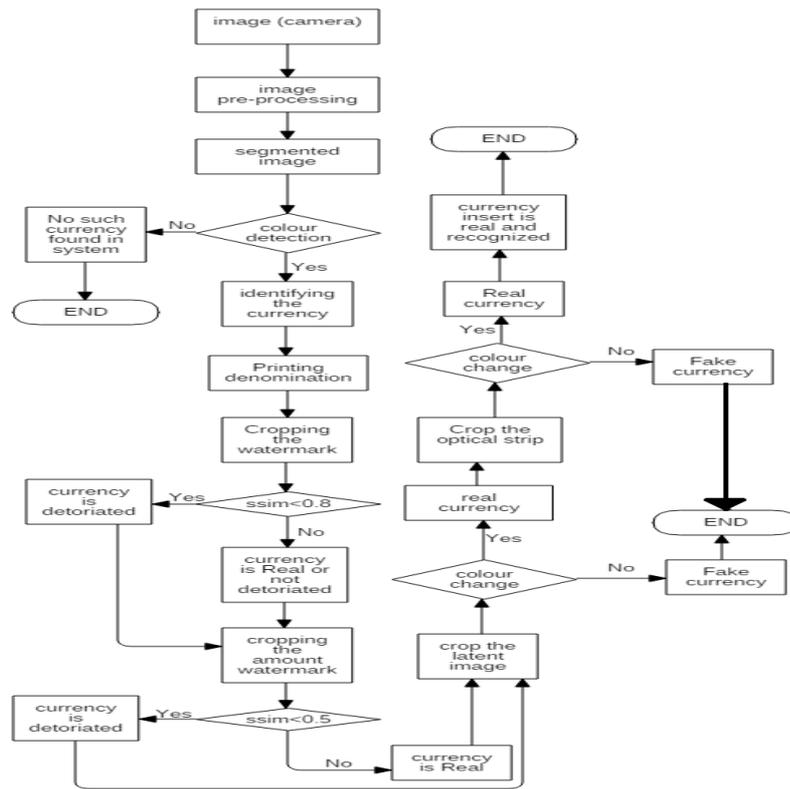


FIG 6. ALGORITHM

IV. TECHNIQUES AND FUNCTIONS USED

I) SEGMENTATION

Segmentation is one of the important parts to process image data. It aims to divide an image into parts that have a strong correlation with objects. In our project, we should use it to segment the captured image i.e. to extract the currency from the background as shown in fig7 is the captured image and fig 8 show the segmented image.



FIG 7. CAPTURED IMAGE

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FIG 8.SEGMENTED IMAGE

II) HISTOGRAM EQUALIZATION

Histogram equalization is used to adjust contrast based on the image's histogram. This method is useful for the image with background and foreground that are both bright or both dark. The fig 9 show the histogram for the colour change in the latent image of Rs 500 currency. where the red, blue and green colour show the RGB form of the image.

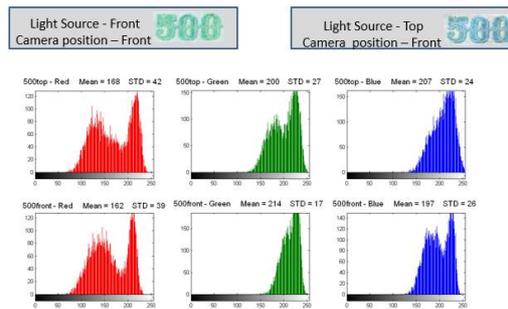


FIG 9. HISTOGRAM

III) STRUCTURAL SIMILARITY INDEX (SSIM)

ssim (A, REF) calculates the Structural Similarity Index (ssim) value for image A, with the image REF as the reference. A and REF can be 2D gray scale or 3D volume images, and must be of the same size and class [9].

IV) COLOUR

Colour is a property of enormous importance to human visual perception. Hardware will generally deliver or display colour via an RGB or HSV model. RGB model is often used in computer graphics as the basis of a colour space [2]. The RGB model is an additive colour model based on primary colours red, green and blue. Each colour appears in its primary spectral components. The main purpose of the RGB colour model is for the sensing, representation, and displays of images in electronic systems, though it has also been used in conventional photography. Fig 10 show the HSV model is one of several colour systems used by people to select colours from a colour wheel or palette. This colour model is considerably closer than the RGB model in the way how humans experience and describe colour sensations [6].

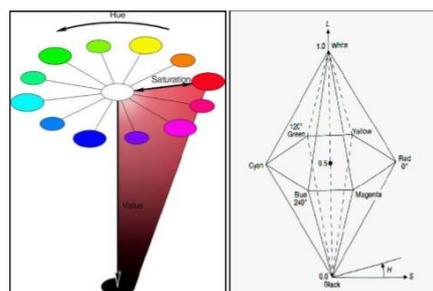


FIG 10.HSV MODEL

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V) CEIL

Ceil Round towards plus infinity. Ceil (X) rounds the elements of X to the nearest integers towards infinity.

VI) EUCLIDEAN DISTANCE

Euclidean distance weight function. Weight functions apply weights to an input to get weighted inputs. The Euclidean distance d between two vectors X and Y is $d = \sum((x-y).^2).^0.5$. $Z = \text{dist}(W,P,FP)$ takes these inputs, and returns the S -by- Q matrix of vector distances. $\text{dim} = \text{dist}(\text{'size'},S,R,FP)$ takes the layer dimension S , input dimension R , and function parameters, and returns the weight size $[S\text{-by-}R]$.

$\text{dw} = \text{dist}(\text{'dw'},W,P,Z,FP)$ returns the derivative of Z with respect to W . dist is also a layer distance function which can be used to find the distances between neurons in a layer.

VII) BWAREAOPEN

`bwareaopen` Remove small objects from binary image. $\text{BW2} = \text{bwareaopen}(\text{BW},P)$ removes from a binary image all connected components (objects) that have fewer than P pixels, producing another binary image BW2 . This operation is known as an area opening. The default connectivity is 8 for two dimensions, 26 for three dimensions, and $\text{CONNDEF}(\text{NDIMS}(\text{BW}),\text{'maximal'})$ for higher dimensions.

VIII) REGIONPROPS

`regionprops` Measure properties of image regions. $\text{STATS} = \text{regionprops}(\text{BW},\text{PROPERTIES})$ measures a set of properties for each connected component (object) in the binary image BW , which must be a logical array; it can have any dimension. If PROPERTIES is the string 'all', `regionprops` returns all of the Shape measurements. If called with a gray scale image, `regionprops` also returns Pixel value measurements. If PROPERTIES are not specified or if it is the string 'basic', these measurements are computed: 'Area', 'Centroid', and 'Bounding Box'.

V. RESULTS

From now the system can check the Indian currency of bigger denomination. The system can be modified for different currency of different denomination and of different countries, just by adding there feature to the database. For now, the system gets the image from the camera and the light intensity is also kept under control.



FIG 12. RESULTS

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The above fig (12) show that the currency is identified and the features are correctly extracted. The green box show that the currency is proper or we can say that the currency is real.

VI. CONCLUSION

From the project we conclude that, the proposed algorithm is based on the colour and different identification features on the currency. We segment the pattern from the currency and then we matched it with the database for checking the currency. Currency is differentiated based on their colour and size related features. The experiment based on proposed algorithm is accurate and since we have used system based on image processing it is quick and accurate. This system can also face some drawbacks, such as quality of currency, damage level of the currency can affect the recognition rate. It may also face the problem of light intense. In order to use this system widely we can work on involving the first sight inspection method in algorithm so that the system become more useful and effective. This system may be a very useful tool in order to prevent higher order counterfeiting by taking advantage of cheaper and high quality equipment.

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