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Fake Currency Detection using Clustering and SVM Classification

Achal Kamble, Prof. Mrudula Nimbarte
Department of Computer Engineering Bapurao Deskmukh College of Engineering Wardha, Maharashtra, India

ABSTRACT

Coins and note currency are widely used in our daily life such as vending machines, parking meters, telephone booths and so on. In addition to being used as currency, people enjoy collecting coins and notes as they usually have artistic value and can give a vivid insight to the social life in history. However, in recent years, a lot of illegal counterfeiting rings manufacture and sell fake coins and at the same time fake note currency is printed as well, which have caused great loss and damage to the society. Thus it is imperative to be able to detect fake currency. We propose a new approach to detect fake Indian notes using their images. A currency image is represented in the dissimilarity space, which is a vector space constructed by comparing the image with a set of prototypes. Each dimension measures the dissimilarity between the image under consideration and a prototype. In order to obtain the dissimilarity between two coin images, the local key points on each image are detected and described. Based on the characteristics of the coin, the matched key points between the two images can be identified in an efficient manner. A post processing procedure is further proposed to remove mismatched key points. Due to the limited number of fake currency in real life, one-class learning is conducted for fake currency detection, so only genuine currency are needed to train the classifier.

Keywords: Fake currency, fake currency detection, currency image representation, dissimilarity space, class learning.

I. INTRODUCTION

Human rapid approach is towards mechanization and manpower removal of the service work as much as possible and using this force in the development of scientific and research issues. This approach will lead to advances in science and technology. Automated payment systems, including mechanized systems are considered more in recent years over the past and many activities in this regard is yielded. One of the main parts in most automated payment systems is vision systems. One of the important science that is used in vision systems is science image processing. Image processing has flexibility and as a result it provides stronger algorithms in the field of creativity. Efficient algorithms (in automatic payment systems) have two factors of speed and the ability to tolerate noise. Banknote recognition system is a device that is able to recognize the value of banknotes intelligently and approve their forgery.

Automatic recognition of fake Indian currency note is important in many applications such as automated goods seller machine and automated goods tellers machine. This system is used to detect the valid Indian currency note. The system consists of eight steps including image acquisition, grey scale conversion, edge detection, feature extraction, image segmentation, comparisons of images and output [1]. Automatic machine more helpful in banks because banks faces the problem of counterfeit currency notes or destroyed notes. Therefore involving machine makes note recognition process simpler and systematic. Automatic machine is more important to

detect fake currency note in every country. The system designed to check the Indian currency note 100, 500 and 2000 rupees. The system will display currency is genuine or fake and currency denomination.

A. Commonly Used Methods to Detect Fake Notes

1) See Through Register The small floral design is printed in the middle of the vertical band and next to watermark. The floral designed on the front is hollow and in back is filled up. The floral design has back to back registration. The design will seen as one floral design when seen against the light [1].
2) Water marking The mahatma Gandhi watermark is present on the bank notes. The mahatma Gandhi watermark is with a shade effect and multidirectional lines in watermark [5].
3) Optically Variable Ink Optically variable ink is used for security feature; this type of feature is in the Rs.1000 and Rs.500 bank note. Optically variable ink as security feature for bank note is introduced in Nov.2000. The denomination value is printed with the help of optical variable ink. The colour of numerical 1000 or 500 appear green, when note is flat but change the colour to blue when is held in an angle [4].
4) Fluorescence Fluorescent ink is used to print number panels of the notes. The note also contains optical fibre. The number pannel in fluorescent ink and optical fibre can be seen when exposed to UV light.
5) Security Thread The security thread is in 1000 and 500 note, which appears on the left of the Mahatma Gandhi's portrait. In security thread the visible feature of "RBI" and "BHARAT". When note is held against the light, the security thread can be seen as one continuous line [4].
6) Latent Image The latent image shows the respective denomination value in numerical. On the observe side of notes, the latent image is present on the right side of Mahatma Gandhi portrait on vertical band. When the note is held horizontally at eye level then the latent image is visible.
7) Micro Lettering The micro letter's appears in between the portrait of Mahatma Gandhi and vertical band. Micro letter's contains the denomination value of bank note in micro letters. The denomination value can be seen well under magnifying glass.
8) Identification Mark Each note has its special identification mark. There are different shapes of identification mark for different denomination (Rs.100-Triangle, Rs.500-circle and Rs.1000-Diamond). The identification mark is present on the left of water mark [1].

Image Segmentation

In computer vision, image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics.

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s).When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like Marching cubes.

Segmentation using Thresholding

The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image. There is also a balanced histogram Thresholding The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy method, Otsu's method (maximum variance), and k-means clustering. Recently, methods have been developed for thresholding computed tomography (CT) images. The key idea is that, unlike Otsu's method, the thresholds are derived from the radiographs instead of the (reconstructed) image. New methods suggested the usage of multi-dimensional fuzzy rule-based non-linear thresholds. In these works decision over each pixel's membership to a segment is based on multi-dimensional rules derived from fuzzy logic and evolutionary algorithms based on image lighting environment and application.

II. LITERATURE SURVEY

1. Li Liu, Yue Lu "An Image-Based Approach to Detection of Fake Coins" in IEEE TRANSACTIONS ON INFORMATION FORENSICS AND SECURITY June 2017.. [1]

Authors propose a new approach to detect fake coins using their images in this paper. A coin image is represented in the dissimilarity space, which is a vector space constructed by comparing the image with a set of prototypes. Each dimension measures the dissimilarity between the image under consideration and a prototype.

Disadvantages:

Detect only coins while much of trade is done in terms of notes not coins.

2. Jianxiao Liu, Zonglin Tian, Panbiao Liu, Jiawei Jiang, "An Approach of Semantic Web Service Classification Based on Naive Bayes" in 2016 IEEE International Conference On Services Computing, September 2016 [2]

Author describe a system developed for discriminating fake notes from genuine ones and apply it to Indian banknotes. Image processing and pattern recognition techniques are used to design the overall approach. The ability of the embedded security aspects is thoroughly analyzed for detecting fake currencies.

Disadvantages:

Accuracy is less than 50% and work on very limited sets.

3. Bo Tang, Student Member, IEEE, Steven Kay, Fellow, IEEE, And Haibo He, Senior Member, IEEE "Toward Optimal Feature Selection In Naive Bayes For Text Categorization" In IEEE Transactions On Knowledge And Data Engineering, 9 Feb 2016.[3]

Author propose a novel shape feature— angle-distance. After images are segmented, a vector of size 360*1 is deployed to represent each shape. For classification, a dissimilarity measurement is used to quantize the difference between two shapes. The results show it can recognize the fake coins successfully.

Disadvantages:

System is very complex and works on US coins only. None of research is conducted for Indian coins.

4. Amruta Pandit , Prof. Manisha Naoghare, "Efficiently Harvesting Deep Web Interface with Reranking and Clustering", in International Journal of Advanced Research in Computer and Communication Engineering Vol. 5, Issue 1, January 2016.[4]

Author propose a variable-length signature for near-duplicate image matching in this paper. An image is represented by a signature, the length of which varies with respect to the number of patches in the image. A new visual descriptor, viz., probabilistic center-symmetric local binary pattern, is proposed to characterize the appearance of each image patch. Beyond each individual patch, the spatial relationships among the patches are captured.

Disadvantages:

System won't work for Indian coins.

5. Anand Kumar , Rahul Kumar, Sachin Nigle, Minal Shahakar, "Review on Extracting the Web Data through Deep Web Interfaces, Mechanism", in International Journal of Innovative Research in Computer and Communication Engineering, Vol. 4, Issue 1, January 2016. [5]

Author propose an automatic recognition method for ancient Roman coins. The proposed method exploits the structure of the coin by using a spatially local coding method. Results show that the proposed method outperforms traditional rigid spatial structure models such as the spatial pyramid.

Disadvantages:

Works on ancient Roman coins. Indian coins shapes and sizes are very different and thus won't work with this system.

6. Faiz M. Hasanuzzaman, Xiaodong Yang, and YingLi Tian, Senior Member, IEEE Robust and Effective Component-based Banknote Recognition for the Blind IEEE Trans Syst Man Cybern C Appl Rev. 2012 Nov; 42(6): 1021–1030

The paper [6] presented by Ying Li Tian describe by Effective Component-based Banknote Recognition for the Blind. In this paper ,For the detection of forged notes it needs to identify the denomination every time they use the device which consist of ultraviolet light. The bank employee keeps the paper currency note on the device and try to find whether the watermark identification, serial number and other characteristics of the notes are proper to get the denomination and check its authentication. This increases the work of the employee. Instead, if the banker uses this system, the result could be more accurate . motion blur affects the system performance, thereby true note recognition rate get decreases. Problems can be summarized as follows, i) Motion Blur Problem. ii) Noise imposed by image capture instrument. iii) Different type of note. iv) Less efficient feature extraction technique.

7. Mohammad H Alshayeji, Mohammad Al-Rousan and Dunya T. Hassoun, Detection Method for Counterfeit Currency Based on Bit-Plane Slicing Technique ,International Journal of Multimedia and Ubiquitous Engineering Vol.10, No.11 (2015).

The paper [7], presented by Mohammad H Alshayeji has a technique to Detection Method for Counterfeit Currency Based on Bit-Plane Slicing Technique. A new approach is presented in this paper using the bitplane slicing technique to extract the most significant data from counterfeit banknote images with the application of an edge detector algorithm. The proposed technique consists of decomposing original images of 256 gray levels into their equivalent 8 binary images. This is useful in analyzing the relative importance contributed by each bit of the original image. Higher order bit levels are evaluated for grayscale banknote images with the application of Canny edge detection algorithm. The results are then compared with genuine banknotes and with other existing techniques used for detecting counterfeit notes.

8. Nayana Susan Jose, Shermin Siby, Juby Mathew, Mrudula Das ,Android Based Currency Recognition System for Blind, International Journal of Engineering Research in Computer Science and Engineering (IJERCSE) Vol 2, Issue 4, April 2015

The paper [8], presented by Nayana Susan Jose and Shermin Siby describe by Android Based Currency Recognition System for Blind .This paper is mainly built to support them and make them easier to get used to the currencies. Here, we propose an android based application for recognizing currencies of different countries and also their denominations mainly for visually impaired people. Image processing techniques like feature extraction and matching are used to identify currencies. This application runs on a low end smartphone. We give an audio message as the input to start the app and to capture the image. Then the image is captured and is compared with the test image. If the features of both the images are spatially consistent, then an audio

output is given to the user about the denomination of the currency and to which country it belongs to. Otherwise, an error message is given as output.

[4] Rubeena Mirza, Vinti Nanda, Characteristic Extraction Parameters for Genuine Paper Currency Verification Based on Image Processing, IFRSA International Journal of Computing, Volume 2, Issue 2, April 2012.

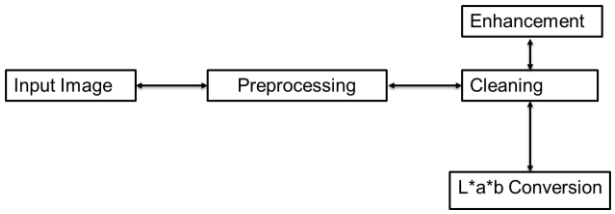
The paper [4], presented by Mirza and Nanda describe an Automated paper currency recognition system can be a very good utility in banking systems and other field of commerce. In this article, recognition of paper currency with the help of digital image processing techniques is described. Three characteristics of Indian paper currency is selected for counterfeit detection included identification mark, security thread and watermark. The characteristics extraction is performed on the image of the currency and it is compared with the characteristics of the genuine currency. The sobel operator with gradient magnitude is used for characteristic extraction. Paper currency recognition with good accuracy and high processing speed has great importance for banking system. The proposed method has advantages of simplicity and high speed

III. PROPOSED APPROACH

The proposed work is planned to be carried out in the following manner

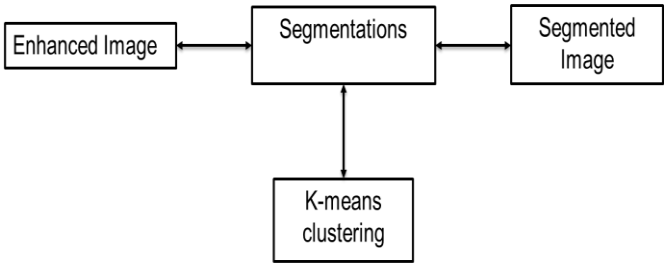
Phase 1 Currency Pre-processing

Images are enhanced by sharpening and removing unwanted outliers.



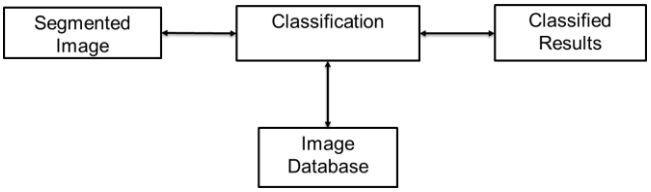
Phase 2 Segmentation

Image will be segmented to fetch out the image edges and then detected all required parameters



Phase 3 Recognition and Classification

Ones the image is segmented it can be tested to recognize it first and then classify it into original or fraud image using SVM algorithm.



In the proposed work, we will develop a system to detect fraud coins and notes currency for Indian Notes. Clustering will be done using k-means algorithm. Recognition and classification will be done using SVM algorithm.

K-means Algorithm

k-means clustering is a method of vector quantization, originally from signal processing, that is popular for cluster analysis in data mining. k-means clustering aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster.

The algorithm has a loose relationship to the k-nearest neighbor classifier, a popular machine learning technique for classification that is often confused with k-means because of the k in the name. One can apply the 1-nearest neighbor classifier on the cluster centers obtained by k-means to classify new data into the existing clusters. This is known as nearest centroid classifier or Rocchio algorithm.

SVM Algorithm

In machine learning, support vector machines (SVMs, also support vector networks) are supervised learning

models with associated learning algorithms that analyze data used for classification and regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier (although methods such as Platt scaling exist to use SVM in a probabilistic classification setting). An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces.

When data are not labeled, supervised learning is not possible, and an unsupervised learning approach is required, which attempts to find natural clustering of the data to groups, and then map new data to these formed groups. The clustering algorithm which provides an improvement to the support vector machines is called support vector clustering and is often used in industrial applications either when data are not labeled or when only some data are labeled as a preprocessing for a classification pass.

IV. CONCLUSION

By using digital image processing, analysis of Currency image is more accurate as well as this method is efficient in terms of cost and time consuming compared to existing techniques. MATLAB Software use for this analysis .Day by day research work is increasing in this field and various image processing techniques are implemented in order to get more accurate result. The proposed system is worked effectively for extracting feature of Indian currency images. Extracted features of currency image will be using for currency value recognition as well as for its verification. Application based system shall be designed to get proper result whether currency image is fake or genuine.

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