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AUTHENTICATION AND COUNTERFEIT DETECTION OF CURRENCY USING IMAGE PROCESSING

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ABSTRACT

Counterfeiting is as old as money itself, and is sufficiently prevalent throughout history that it has been called "the world's second oldest profession." Coinage of money began in the Greek city of Lydia around 600 B.C. Before the introduction of paper money, the most prevalent method of counterfeiting involved mixing base metals with pure gold or silver. A common practice was to "shave" the edges of a coin [1].

Counterfeit money is imitation currency produced without the legal sanction of the state or government. Producing or using counterfeit money is a form of fraud or forgery. Plated copies have been found of Lydian coins which are thought to be among the first western coins. A form of counterfeiting is the production of documents by legitimate printers in response to fraudulent instructions. During World War II, the Nazis forged British pounds and American dollars.

Keywords: ***currency, counterfeit***

I. INTRODUCTION

Some of the ill-effects that counterfeit money has on society include a reduction in the value of real money; and increase in prices (inflation) due to more money getting circulated in the economy - an unauthorized artificial increase in the money supply; a decrease in the acceptability of paper money; and losses, when traders are not reimbursed for counterfeit money detected by banks, even if it is confiscated [2].

Traditionally, anti-counterfeiting measures involved including fine detail with raised intaglio printing on bills which allows non-experts to easily spot forgeries. On coins, milled or reeded (marked with parallel grooves) edges are used to show that none of the valuable metal has been scraped off.

There has been a rapid growth in the counterfeiting of euro banknotes and coins since the launch of the currency in 2002. In 2003, 551,287 fake euro notes and 26,191 bogus euro coins were removed from EU circulation. In 2004, French police seized fake 10 euro and 20 euro notes worth a total of around €1.8 million from two laboratories and estimated that 145,000 notes had already entered circulation. [2]

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II. LITERATURE SURVEY

2.1. Early Research

Angelo Frosini, Marco Gori, Paolo Priami [5] [1996] describes the neural-based recognition and verification techniques used in early banknote machine, implemented for accepting paper currency of different countries. The perception mechanism is based on low-cost optoelectronic devices which produce a signal associated with the light refracted by the banknotes. The classification and verification steps are carried out by a society of multilayer perception's whose operation is properly scheduled by an external controlling algorithm, which guarantees real-time implementation on a standard microcontroller-based platform. The verification relies mainly on the property of auto-associators to generate closed separation surfaces in the pattern space. In this implementation a fixed-point representation was chosen for the weights and the squash function was simply computed by means of a look-up table. The fixed-point representation was designed by a proper scaling of the weights, which is based on the weight range developed during the learning.

Fumiaki Takeda, Toshihiro Nishikage, and Yoshiyuki Matsumoto [6] [1996] have proposed mask concept to extract characteristics of the paper currency and have adapted a genetic algorithm to a mask optimization. The work represents a unique mask which has symmetrical masked area against axis which divides a long side of the currency, equally and obtained same value from both upright image and inverse one of the currency through the mask processor using the axis-symmetrical mask. This means these values are invariant to upright and inverse of the currency conveyance. We can recognize twice number of currency kinds compared with the conventional mask though the NN construction is same.

M. Tanaka, F. Takeda, K. Ohkouchi and Y. Michiyuki [7] [1998], proposed a simple statistical test which is been used as the verification step, where univariate Gaussian distribution is employed. They proposed probability density formed by a multivariable Gaussian function, where the input data space is transferred to a lower dimensional subspace. Due to the structure of this model, we call the total processing system as a hybrid neural network. The successful classification system consists of two parts: recognition stage and verification stage. MLP has been used in the recognition stage. The key point of success is using the optimal mask to extract the feature vectors. Since the computation of the verification model is only to take inner product and square, the computational load is very small. In this paper, the method and the numerical experimental results are shown by using the real data and the recognition machine.

Ali Ahmadi, SigeruOmatu, ToshihisaKosaka [8] [2003] have studied the reliability of the paper currency classifiers and proposed a new method for improving the reliability based on the local principal components analysis (PCA). At first the data space is partitioned into regions by using a self-organizing map (SOW model and then the PCA is performed in each region. A learning vector quantization (LVQ) network is employed as the main classifier of the system. The reliability of classification is evaluated by using an algorithm which employs a function of winning class probability and second maximal probability. By using a set of test data, one can estimate the overall reliability of the system. The experimental results taken 60, 1200 samples of US dollar bills show that the reliability is increased up to 100% when the numbers of regions as well as the number of codebook vectors in the LVQ classifier are taken properly.

Ali Ahmadi, SigeruOmatu and ToshihisaKosaka [9] [2003] address the reliability of neuro-classifiers for paper currency recognition. A local principal component analysis (PCA) method is applied to remove nonlinear

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dependencies among variables and extract the main principal features of data. At first the data space is partitioned into regions by using a self-organizing map (SOM) model and then the PCA is performed in each region. A learning vector quantization (LVQ) network is employed as the main classifier of the system. By defining a new algorithm for rating the reliability and using a set of test data, we estimate the reliability of the system. The experimental results taken from 1,200 samples of US dollar bills show that the reliability is increased up to 100% when the number of regions as well as the number of codebook vectors in the LVQ classifier are taken properly.

Fan-Hui Kong, Ji-Quan Ma, Jia-Feng Liu [10][2006] present paper currency recognition using GMM based on Structural Risk Minimization (SRM). By selecting the proper number of the components with SRM, the system can overcome the demerit by the number of the Gaussian components selected artificially. A total number of 8 bill types including 5, 10(new and old model), 20, 50(new and old model), 100(new and old model) are considered as classification categories. The experiments show that GMM which employs SRM is a more flexible alternative and lead to improved results for Chinese paper currency recognition. The theoretical basis of GMM is that probability density function can be approximated to any degree of accuracy with the Gaussian probability density basis functions. A mixture of Gaussians was used to model the features extracted from the paper currency sample.

III. RECENT RESEARCH

Kamesh Santhanam, SairamSekaran ,SriramVaikundam ,Anbu Mani Kumarasamy [11] [2013]have included 2 kinds of mechanism to identify counterfeit currency. One is using Ultra Violet (UV) detection using lab view; the other is using the polarization of light when passed through the currency. Only if both the results are positive the output is positive. Then existing device which performs the UV test is capable of testing only one currency at a time, and the process is not automatic, as well as it requires humans to check the genuineness of the currency, which are prone to human errors. Using NI-IMAQ this process can be automated using a computer. The process mainly depends on human observations.

Shafin Rahman, PriankaBanik and Shujon Naha [12] [2014] propose an LDA based paper currency recognition method using Edge Histogram Descriptor (EHD). Applying this method, we succeed to represent anode image by a very low dimensional feature vector (around only15 dimensions). Besides adjusting the scatter of different classes, this method has the ability to tolerate noise of a certain level. We have performed different experiments to support all attractive features of the proposed system. For those experiments, we have used banknotes of different countries and achieved high accuracy with low dimensional feature vector. Unlike traditional method, the proposed methods do not consider any specific portion of notes.

Zahid Ahmed, Sabina Yasmin, MdNahidul Islam, Raihan Uddin Ahmed [13] [2014] present a core software system to build a robust automated counterfeit currency detection tool for Bangladeshi bank notes. The software detects fake currency by extracting existing features of banknotes such as micro-printing, optically variable ink (OVI), water-mark, iridescent ink, security thread and ultraviolet lines using OCR (Optical Character recognition), Contour Analysis, Face Recognition, Speeded UP Robust Features (SURF) and Canny Edge & Hough transformation algorithm of Open CV. The success rate of this software can be measured in terms of

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accuracy and speed. This paper also focuses on the pros and cons of implementation details that may degrade the performance of image processing based paper currency authentication systems.

IV. RESEARCH REGARDING INDIAN CURRENCY

Vishnu R, Bini Omman [14] [2014] proposes a robust method to recognize the paper currency using the pattern matching. In the proposed algorithm a similarity measure is used to classify the currency based on the similarity of the extracted features. To evaluate the performance of the proposed method experiments were conducted over 200 of currencies of different denominations. Authors state that on performing the experiment the proposed method gives 97% accuracy. In his method 6 features are extracted from a currency. Among this two features are used to detect the denomination of the currency and which helps system to select the currency template. Thus the system will compute similarity for each feature that extracted from the input currency image with the corresponding feature's template of particular denomination. The features with higher similarity will vote one and other features will vote zero. Finally system will count the votes and if the number of features that voted one is greater than the currency will be classified as known else the currency will be classified as unknown.

MrigankaGogoi, Syed EjazAli,Subra Mukherjee [15] [2015] introduce a new recognition method for Indian currency using computer vision. It is shown that Indian currencies can be classified based on a set of unique non discriminating features such as color, dimension and most importantly the Identification Mark (unique for each denomination) mentioned in RBI guidelines. Firstly the dominant color and the aspect ratio of the note are extracted. After this the segmentation of the portion of the note containing the unique I.D. Mark is done. From this segmented image, feature extraction is done using Fourier Descriptors. As each note has a unique shape as the I.D. Mark, the classification of these shapes is done with the help of Artificial Neural Network. After feature extraction, the denominations are recognized based on the developed algorithm. In this paper, authors propose a method wherein we have developed a method for denomination classification based on not just one feature but rather using a combination of three features i.e. "Color", "Aspect Ratio" and most importantly the "I.D. Mark".

V. WAYS OF FIGHTING AGAINST CURRENCY COUNTERFEITING

When paper money was introduced in China in the 1200s, wood from mulberry trees was used to make the money. To control access to the paper, guards were stationed around mulberry forests, while counterfeiters were punished by death. [1]

Traditionally, anti-counterfeiting measures involved including fine detail with raised intaglio printing on bills which would allow non-experts to easily spot forgeries. This detects the shaving or clipping (paring off) of the rim of the coin. However, it does not detect sweating, or shaking coins in a bag and collecting the resulting dust. Since this technique removes a smaller amount, it is primarily used on the most valuable coins, such as gold. In early paper money in Colonial North America, one creative means of deterring counterfeiters was to print the impression of a leaf in the bill. Since the patterns found in a leaf were unique and complex, they were nearly impossible to reproduce. [2]

In the late twentieth century advances in computer and photocopy technology made it possible for people without sophisticated training to copy currency easily. In response, national engraving bureaus began to include new more sophisticated anti-counterfeiting systems such as holograms, multi-colored bills, embedded devices

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such as strips, micro printing, watermarks and inks whose colors changed depending on the angle of the light, and the use of design features such as the "Euro constellation" which disables modern photocopiers. Software programs such as Adobe Photoshop have been modified by their manufacturers to obstruct manipulation of scanned images of banknotes. [3]

VI. APPROACH OF IMAGE PROCESSING

Conventionally, designers are used to apply discriminative inequalities to recognize paper currency. This section describes conventional method and its problems. These discriminative inequalities were determined manually. Namely, to recognize the paper currency, discriminative points are selected from each sensor. The characteristics of each paper currency from a set of discriminative points are extracted by the trial and error. The discriminative inequalities that contain the representative values of the paper currency are then determined. Using this method, paper currency recognition is executed with these discriminative inequalities [4].

The detection of the paper consistency, and particularly of special identification signs, usually requires very sophisticated and costly sensors. A very straightforward approach of detecting banknotes is that of using ordinary optoelectronic sensors that can collect information from small strips of the whole picture of the banknote.

VII. PROBLEM STATEMENT

Every Indian Currency has certain security features which help in identification and recognition of the denomination. Each denomination has a dominant color. Most of the work in literature is based on finding the dominant color component of a particular currency, however the problem that lies in color based recognition is the increased error rate for old currencies as the color of old currencies generally become faded due to wear and tear.

The proposed system is used for anti-counterfeit money and fake currency recognition using multiple image processing algorithms. The algorithms will include an “Optical Character Recognition” block solely designed for currency value detection.

Then later the localization of visible and prominent features of currency takes place which include logos, emblems, shapes which determine the authenticity of that particular currency and usually are specific for that case of currency.

OBJECTIVES

The objectives can be described in two stages

1. Designing an algorithm for feature localization.
2. Designing a feature extraction and recognition.
3. Designing an optical character recognition for value detection.

JUSTIFICATION AND BENEFITS

The need of the proposed system can be described in further description

1. A completely image processing based system for fake currency recognition will simplify the day-to-day process of human perception based currency authentication process.

2. The developed system can easily solve the problem of currency authentication process even if the person, institute is unaware of the authentication features of currency.

METHODOLOGY

The flow includes

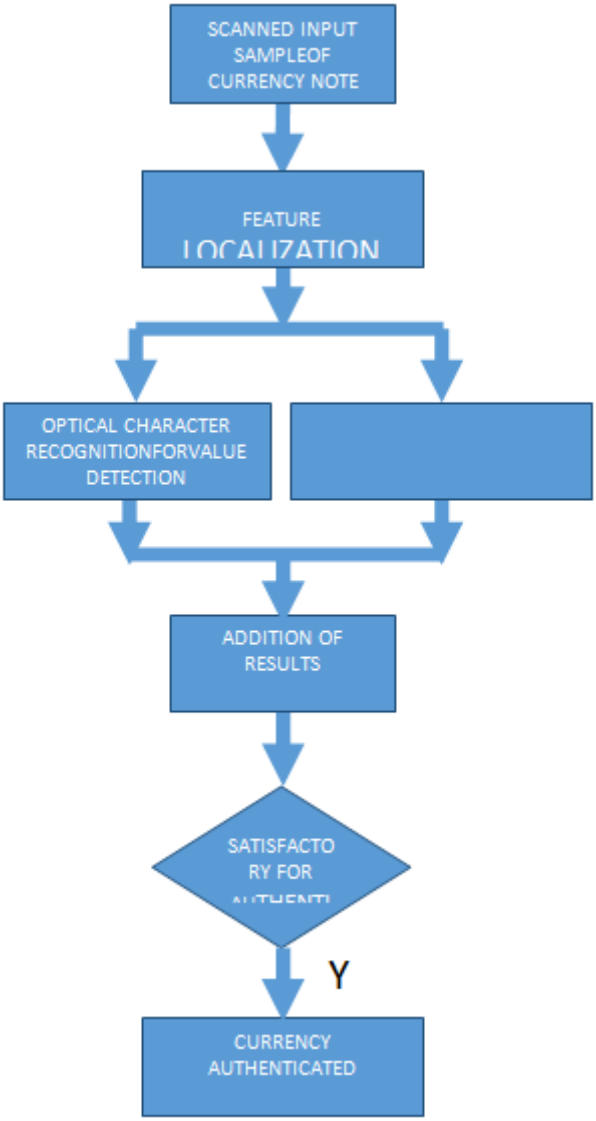

Figure 1: General Flow Chart

There are various ways to acquire image such as with the help of camera or scanner. Acquired image should retain all the features. Pre-processing of image are those operations that are normally required prior to the main data analysis and extraction of information. The aim of image preprocessing is to suppress undesired distortions or enhance some image features that are important for further processing or analysis.

Optical character recognition in various ways for value detection and advanced feature extraction techniques are used to characterize the feature of currency and combined results are checked for the authentication of the currency.

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By using advance image processing approach, color, aspect ratio and the Unique identification mark is extracted. With the help of this algorithm developed the currencies can be detected with a higher success rate so it can avoid counterfeit.

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