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Counterfeit Currency: A Study on recognition Method

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Abstract

Currency has an inseparable significance under the sun. Because of that Counterfeiting currency has become one of the major concerns throughout the globe. Many researchers have been studying on fake currency recognition system for years. After reviewing a number of research papers, it can be concluded that image processing is being used in most of the cases as an initial step. There are some alarming results found from different papers. The review paper will provide a helping hand to the better solution for arresting counterfeit money.

Keywords—image processing; feature extraction; scanner; counterfeit currency; neural network

I. Introduction

Currency forgery is as old as money itself. Fake currency is replicating the original currency without proper authentication in a fraudulent way. Some of the bad effect of counterfeit currency is that it reduces the value of money. (Sowmyashree *et. al*, 2015) WHO comes close to the assumption that there are visually impaired people of about 162 million under the sun, 2.6% of whole inhabitants. 124 million people of them had low sight. Also, 37% of them are blind according to the statistics. These people suffer great problems in recognizing counterfeit currencies.

In today's world of technology economic self-services is in dire need of automated counterfeit currency detection. There are some popular techniques that are being followed by many researchers over the year. They are mostly by using image processing, MATLAB coding, neural network, machine vision based algorithm etc. Significant progress has been made in this field, but a technique for recognizing counterfeit currency efficiently in less time is yet to be built. Though some of the papers of recent years have attempted to meet perfect results like hidden Marklov models, Radial basic function etc.

The basic steps that are being followed are:

Step 1: Image Acquisition
Generally, the image is first taken to the digital scanner and then it is scanned. The captured image is formatted to JPEG format. JPEG (Joint Photographic Experts Group) is a standard for disparaging or loss compromising for digital images.

Step 2: Pre-Processing
The aim of pre-processing in currency image inspection is to wipe out the undesired details from the image data and enrich the looked-for image features central for further processing. Pre-processing is an important step in the sense that, with an operative process, much of the following analysis is simplified.

Step 3: Image Segmentation
First, the image is divided based on unforeseen variations in intensity. In this measure, the edges of the currencies image are taken into consideration for division. The second categorization is based on taking parallel images and partition the image into sections according to a set of predefined criteria Currency note segmentation is done by applying scan line algorithm on the image after edge detection. As a final point, there is a distinct area formed by the intersection of both the scans. The shape is a rectangle which covers the currency note present in the image. This forms the localized part of the image. These features have not been redesigned in a while and continues to be like this only for a foreseeable future.

Step 4: Region of Interest Extraction
After the primary phases such as image acquisition and image preprocessing methods are materialized; the dissimilar regions, is checked or compared unconventionally. After segmentation of an image analysis of the required region of interest comes the decisive part of processing.

Step 5: RGB to CIE Luv Conversion
A colour can be described as a mixture of three other colours. Naturally, RGB for CRT based system or XYZ (fundamental measurements), it is often utilized to separate the colour definition into “luminance” and “chromaticity”. Though the conversions are reversible, it is a linear colour space. Colouring information is positioned on the colour of the white point of the system, subscription.

Step 6: Feature Extraction of Image
Feature extraction is defined as simplifying the number of resources essential to describe the large set of data. Colour features refer to the standard deviation, variance and skew are calculated from the input template image that is called the ROI. Just like that texture feature correlation of an image, entropy is also calculated which and used in the categorization of image. For correlation input partitioned image which is in RGB form, is compared with the images exists in the database and output of maximum correlation is display based on which additional analysis is attained.

Step 7: Classification of Image

It means standard deviation and skew in other words the colour feature of an input template image as well entropy and correlation which are actually the texture feature also matched with the value of database image. It is similar to a major point matching since the main features of an input template image are compared with the key points of the required image. Major facts from the distinguished image will be compared with the trained database image's key points, Based on the matching sums of the input image key points and that from database template. Thus the input is recognized as a counterfeit or actual (Lamsal *et. al*, 2015).

II. STUDY ON COUNTERFEIT CURRENCY RECOGNITION

A. Using Neural networking method

In 2014, Thakur *et. al* presented the approach of an acceptable Neuro fuzzy system for determining the fake currency and the application they have proposed here able to accomplish the task with all the type of paper. Here at first the image of the note which is scanned, first accomplish preprocessed, then changing it into grey level image, then calculate and compare the Fuzzy rules of the normalized histogram and detect if the currency is fake or original. In the second part, by using the technique of the first part as input the Fuzzy rules are applied to detect if the currency is fake or real. In this system, they have made the process of testing on each and every documentation (Rs.100, Rs.500, Rs.1000) along with real and fake notes. ANFIS can purifying Fuzzy if-then rules taken from human experts to define the input, the output behavior of the system. This proposed system in this paper is more effective, poor time consuming and more perfect method (Thakur *et. al*, 2014).

In 2010, Kalyan Kumar Debnath proposed a currency recognition system using ensemble neural network (ENN). The dissimilar neural networks are taken and taught in a method. The method is called NCL, negative correlation Learning. The goal of using Negative correlation learning (NCL) is to skill the individuals on not the same parts of input patterns in an ensemble. The NCL is a simple addition to the standard BP (Back-propagation) algorithm. In most of the researches, the size of the currency's image is determined by using preprocessing. After that the grey scale image is taken for further calculations. By choosing the ensemble neural network size and their Learning parameters the ensemble NN are taught according to the formatted Parameters. To teach the ENN, NCL is applied. Inaccuracies are reduced to an anticipated range. Than testing takes place in the ensemble NN with testing patterns and/or artificially included noisy patterns. The subject of producing skilled device that automatically contradicts the undesired notes is not being discussed. The identification rate is better than particular network. Though the experiment has been performed for Bangladeshi currency but it is equally applicable in any paper currency recognition (Debnath *et. al*, 2010)

B. Using MATLAB technique

In 2014, Binod Prasad Yadav presented a technique for tracing imitative currency note applying MATLAB and attribute infusion using HSV color space and different employment of image processing. When the note is stick in ahead of camera, the image taken by the camera of the notes is anatomize by MATLAB coding. In this project, by degrading the cost system applying efficacious and expeditious image processing simulation and algorithm, constitutional zed precise and dependable result at preachy outturn (Yadav *et. al*, 2015).

In 2015, S.M. Safiullah describes the approaches for verification of Bangladeshi currency banknote whether it is real or fake. The currency will be verified by using image processing techniques and the system is designed by the MATLAB. Here necessary process such as image scanning, reading, image pre-processing, segmentation, features extraction along with a code that is done in MATLAB software. MATLAB simulation tool is used for image processing and for analyzing the simulated on, the recognition may fail and the user has to do the processing again. Result. One drawback of this system they have mentioned is if the image exhibit information losses such as surface damage, noise loud, sharpness issues and so (Saifullah *et. al*, 2015).

C. *Machine vision based method*

In (Sajal, 2008), an organized algorithm was used which is based on machine vision for inspection of the real time image and reveal the attribute of our country notes which are dissimilar from each other formatted by a mechanical banknote grouping system. Here the notes are placed on the system tray and the system draws them sequentially and catch the images of a specific sides of the banknote with a CCD sensor. The found images are then verified with microcontroller, LPC-H2106, where they implement the algorithm. When analysing the result, this application was able to determine the accurate values for 96.08% of the images which are given. In the other 3.92% cases the system was able to detect the notes as the medium one because of too much old, irregularly torn or corrupted by noise. But there was no case of wrong situation.

Roy *et. al* proposed a system that is developed for recognizing fake notes from actual ones and applied it to Indian banknotes (Roy e, 2015). Pattern recognition and image processing techniques are applied to construct the whole method. The capability of the implanted security phases is carefully scrutinized for distinguishing forged currencies. This breakdown comforts the regulatory bodies realize which security feature is under what type of threat of breach and what revisions could be done to develop the design, making it less susceptible to counterfeiting. The intaglio printing technique, ink properties, art work also have been taken into consideration because they are hard to duplicate. Scanning is used to image the currency. There are four techniques for scanning, which have been used. Support vector machine and Artificial Neural Network are used for classification. The principle objective was to build a system that would be reliable. The method met most of its objectives by using hidden layer technique. After feature extraction, the accumulated specific features are taken to process for further matching. This is important because by taking some specific features as standards helps to reduce the load from the machine and at the same time the accuracy is also intact. Though, it may be pointed out that the study on the discrete feature strength presented in here intensely depends on the samples that are used during the training is problematic to prove in general process, and hence, the uniformity of the problem in many countries.

Yoshida *et. al* proposed a method which is machine based, cheap. It is processed by choosing one of the unique characteristic from the currency (Yoshida, 2007). The micro printed portion of the notes is taken as the unique factor in this field. The area is chosen by grid scanner and processed by microcontroller later. The technique is applied on both five hundred and one hundred takas. The micro printed text on those notes is "BANGLADESHBANK". The identification is independent of alternation. But there is uncertainty in the operation time. Because when an image is taken to process, the letters "B" "A" "N" is combed throughout the note. If the letters are detected, then the system presents the result faster. On the other hand, in case of not discovering the desired letter, the system begins probing the whole currency. The second scenario of the method kills a lot of time. There exists another concern for this method which is the positioning of the grid scanner. The system reports excellently when the scanner positioning (to pose it precipitously) is flawless. The inclination rate of the scanner results in the fabrication of the characteristics that has been captured from the images and as a consequence the system gives an incorrect identification product. If the use of microcontroller PIC 16F648A was replaced with ARM architecture based MC, then the recognition could be a lot faster. Even the detection speed could be faster by simplifying the optimized rotation independent image recognition algorithms.

D. Marklov Model method

In 2009, Hamid *et. al* proposed a firm paper currency recognition method based on Hidden Markov Model (HMM). The tryouts of the work shows that to capture basic characteristics from currencies there are better techniques than the histogram for bank note acknowledgement. Rather, it was proposed that texture base feature capturing method is far more error free and accurate. To discover the accurate measuring for calculation several experiments have been materialized in different bank notes around the world. In each experiment, the notes are divided into segments and are measured very carefully. The dirty notes are pre- processed, the images are transformed in gray scaling form and at last information are gathered by texture based feature capturing method. Then the data are fed to the neural network based algorithms to compare the quantized level of the notes with the original ones. The results represent that the proposed method operates effortlessly with spotless correctness in recognizing genuine currencies from number quantities. The experiment proposed that, if the threshold value is set to 0.02 then it provides even better result. Applying the texture appearances of currencies, the system can be taught to recognize the genuine banknotes. The experiments on banknote denominations of 23 countries showed that the method can be 98% accurate (Hamid, 2009).

E. Radial Basis Function

Sarfraz *et. al* anticipated an automatic paper currency recognition system for paper currency (Sarfraz, 2015). It uses Radial Basis Function Network for classification. Saudi Arabian paper currency is used in this case as a model. In building such a structure, diverse dimensions, areas, Euler numbers, and correlations as features are all checked profoundly. The objective of the paper is to accomplish the best precision in spotting designs with the discounted cost possible. In radial basis neural networks, there are three layers: input layer, hidden layer and output layer. The input layer contains the construction or configuration of the image which are considered as

data. The hidden layer is used to transform the image into non-linear transformation from input layer space to hidden layer space. The technique requires high number of neurons. The output layer does the opposite. It transforms the image's non-liner form and converts it to linear form. the radial basis function network classifier was verified with a database of 110 images, 10 of which are tilted with an angle less than 150. 91.51% was seen as average acknowledgement rate. The masses of the connections between neurons works as a negative factor towards congregate the best values. The mentioned error eradication can make the method more sophisticated in detecting fake notes.

F. Software Based Method

An efficient automated counterfeit currency uncovering tool for Bangladeshi currencies was proposed in 2014 by Ahamed *et. al*, which is cheap and reliable compared to other valuable techniques as UV light pen tool and digital systems. First, in this technique the unique features are being extracted using image processing. The features which are taken into consideration are many. So the chances of detecting fake notes become high. Some of the features includes canny edges, water mark, indecent ink, contour analysis, optical character recognition, micro-printing etc. The system takes only 3 seconds to recognize a fake note. If some of the calculations for the features are reduced, the output can be achieved faster. It will not affect the whole result as each of the features are unique enough for holding the authenticity of the currencies. The limitations worth mentioning are: the hardware adaptation is weak and some of the genuine notes are detected as fake cause the system is unable to recognize the notes who have security threads written in a wrong way, also the system must be applied with great perfection that it is harder for the bankers to process. Though the system is considered a strong shield to fight against currency fraud, some changes could make it even better (Ahmed, 2014).

G. Using Bit-Sclicing method

In 2015, Alshayeji *et al* suggested a unique method. In this paper a new approach is applied "Bit Plane Slicing" which extract the important data from the counterfeit notes image including with the application of an algorithm called Canny edge detector. This technique decomposes the original image of 256 gray levels to equivalent 8 binary images. Then we perform the process of image segmentation and feature extraction. Then the result is compared between genuine and fake notes. In this paper we find that this edge detection algorithm provides low error rate and give significant result at a much faster rate applying on higher bit planes. In this system they have used eight-bit plane and they suggest by using sixth and seventh Bit Plane we can do better and find accurate result (Alshayeji, 2015).

H. Other Recognition Methods

A survey for likening the perception systems hav been relieved in 2014 (Thakur, 2014). Sensing capacity depends on the currency note symptomatic of definite country and infusion of attribute. There are few communal methodology regarding this: observing through the register, water marking, fluorescence, intaglio printing, latent image, micro lettering, identifying mark, optically variable ink. There are few elementary steps for the image processing in a digitalized technique for generalize fake currency. They are: image assumption, pre-processing: image focusing, image smoothening, gray-scale conversion, edge detection, image portioning, feature extraction, likening. applying matlab coding, anybody can split the red, blue, green plot element. The

operating procedure is done by the threshold value of regality by resolve the standardized deviation. If equality is above 40% then it can be idealized as original note. Counterfeit detection pen: a counterfeit pen is a merely a sensible device whose motivation is to numerate whether the currency is genuine or fake. Other techniques: There are some other anti-counterfeit device for the money that is called ultraviolet counterfeit detection scanner. The paper simply denoted assorted simulation for fake currency perception; it doesn't decently compare or conduce an effective technique.

III. Conclusion

This paper focused on several existing works and their techniques for finding a solution towards counterfeit money. The problem demands an efficient and less time consuming method for applied use. Although the results are promising, the 100% accurate automated detection method is yet to be assembled.

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