AUTHENTICATION OF PAPER CURRENCY AND CONVERSION INTO LOWER DENOMINATIONS

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ABSTRACT

Over the past few year, as a result of the great technological advances in color printing, duplicating and scanning, counterfeiting problems have become more and more serious. In the past, only the printing house has the ability to make counterfeit paper currency, but today it is possible for any person to print counterfeit bank notes simply by using a computer and a laser printer at house. Therefore the issue of efficiently distinguishing counterfeit banknotes from genuine ones via automatic machines has become more and more important. There is a need to design a system that is helpful in recognition of paper currency notes with fast speed and in less time.

The proposed solution focuses on fake currency detection and recognition of currency value and converts it into lower denominations using the image processing. Fake currency detection is a process of finding the forgery currency. Once the image is chosen first step would be image pre-processing. In pre-processing the image has to be cropped, adjusted and smoothened. After pre-processing convert the image into gray color. After conversion apply the image segmentation and extract the features, now reduce them for further processing. Finally compare the image into original or forgery. After the currency is detected to be correct, the denomination of the currency is recognized and it can be exchanged with lower denominations currency. In recognition technique, three characteristics of paper currencies including size, color and are used in the recognition. By using image histogram, plenitude of different colors in the paper currency is computed and compared with the one in the reference paper currency. The Markov chain concept has been employed to model texture of the paper currencies as a random process. The method proposed in this paper can be used for recognizing paper currencies from different countries. In this method, using only one intact example of paper currency from each denomination is enough for training the system. he embedded part controls and handles the assembly of insertion of the paper currency in the system and dispatch of the lower denomination currency.

Keyword: - *Atmega328, L293D, 16x2 LCD, PL2303, Motor.*

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1. Introduction

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. Counterfeiting is almost as old as money itself. Plated copies have been found of Lydian coins which are thought to be among the first western coins. Before the introduction of paper money, the most prevalent method of counterfeiting involved mixing base metals with pure gold or silver. A form of counterfeiting is the production of documents by legitimate printers in response to fraudulent instructions. With development of modern banking services, automatic methods for paper currency recognition become important in many applications such as in automated teller machines and automatic goods seller machines. The needs for automatic banknote recognition systems encouraged many researchers to develop corresponding robust and reliable techniques. Processing speed and recognition accuracy are generally two

important targets in such systems. Modernization of the financial system is a milestone in protecting the economic prosperity, and maintaining social harmony. Automatic machines capable of recognizing banknotes are massively used in automatic dispensers of a number of different products, ranging from cigarettes to bus tickets, as well as in many automatic banking operations. The needs for automatic banknote recognition systems encouraged many researchers to develop corresponding robust and reliable techniques [1-5]. Processing speed and recognition accuracy are generally two important targets in such systems. The technology of currency recognition aims to search and extract the visible and hidden marks on paper currency for efficient classification.

The method we present here is simple, less complex and efficient and can meet the high speed requirements in practical applications. Digital image processing is an area characterized by the need for extensive experimental work to establish the validity of proposed solutions to the given problem. It has become economical in many fields of research and in industrial and military applications. Digital image processing encompasses processes whose inputs and outputs are images and encompasses processes that extract attributes from images up to and including the recognition of individual objects. The method we proposed in this paper is inspired by the analysis of hidden marks on the image of the paper currency. How to extract the hidden attributes of paper currency is a challenging task in image processing. Indian bank notes are taken as reference to show how a system can be developed for discriminating fake notes from genuine ones. The ability of the embedded security aspects is thoroughly analyzed for detecting fake currencies. Real forensic samples are involved in the experiment that shows a high precision machine can be developed for authentication of paper money. The system performance is reported in terms of both accuracy and processing speed. Comparison with human subject namely forensic experts and bank staff clearly shows its applicability for mass checking of currency notes in the real world. The analysis of security features to protect counterfeiting highlights some facts that should be taken care of in future designing of currency notes. In this method, using only one intact example of paper currency from each denomination is enough for training the system. The embedded part controls and handles the assembly of insertion of the paper currency in the system and dispatch of the lower denomination currency.

2. Review of Existing Systems

Until now, there are many methods proposed for paper currency recognition. The simplest way is to make use of the visible features of the paper currency, for example, the size and color of the paper currency [1]. However, this kind of methods has great limitations as banknotes are getting worn and torn with the passing of time and they are even dirtier when holding by dirty hands or in dirt. If any banknote is dirty or it may be changed into any other color then the color content of banknote may change largely. The edge information on paper currency have extracted [2] and then used a three-layer BP NN for recognition. Although the NN technology has the ability of self organization, generalization and parallel processing, and has a good fit for pattern recognition, it also has some weakness. First, it needs a large number of training samples, which are used to avoid over fitting and poor generalization. Second, if the distribution of training sample is not uniform, the result will probably converge to a local optimal or will even diverge unreasonably. Therefore, the selection of the training set is a crucial issue for the NN. In currency circulation, the original information on paper currency may have a loss because paper currency may be worn, blurry, or even damaged. Furthermore the complex designs of different kinds of paper currencies make automatic currency recognition difficult to work well. So it is important how to extract the characteristic information from currency image and select proper recognition algorithms to improve the accuracy of currency recognition.

In pattern recognition and in image processing, feature extraction is the special form of dimensionality reduction. It is the method of capturing the visual content of images for indexing and retrieval. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (much data but not much information) then the input data will be transformed into a reduced representation set of features (also named feature vector). If the attributes extracted are carefully chosen, it is expected that the attributes set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input. Feature extraction involves simplifying the amount of resources required to describe the large set of data. Visual attributes of images are of two types

1. Domain specific attributes which include fingerprints, human faces.
2. General attributes which include color, texture, and shape.

There are two types of attributes categorized under the shape attribute extraction-

1. Global attributes include moment invariant, aspect ratio and circularity.
2. Local attributes include boundary segments.

In this approach we extract the general attributes of the paper currency that is shape including identification mark, security thread and watermark etc. These features are extracted by detecting the edges and estimating the gradient of the image at every point to generate a gradient image and threshold gradient image to accomplish image segmentation.

3. Proposed System

a. System Overview

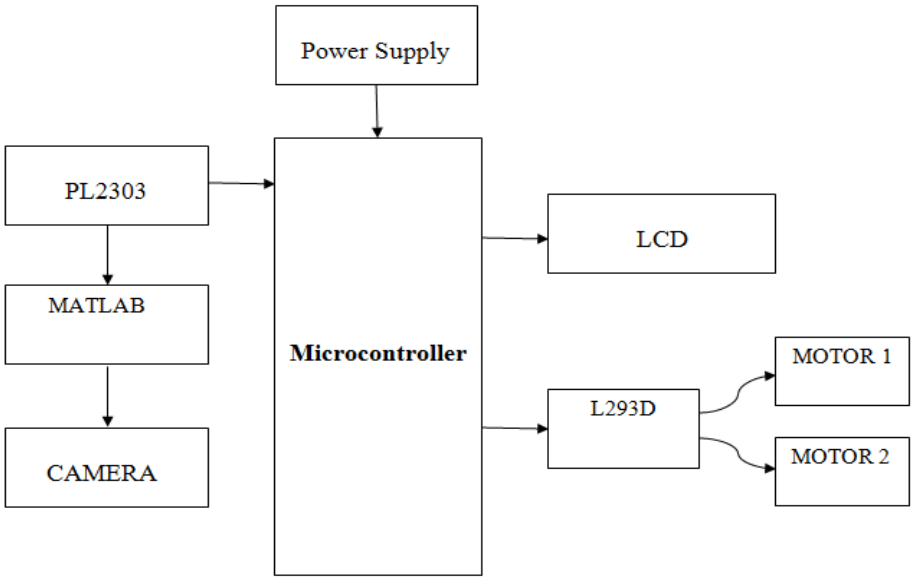

Fig.1 Architecture

The proposed system will work on two images, one is original image of the paper currency and other is the test image on which verification is to be performed. The proposed algorithm for the discussed paper currency verification system is presented as follows-

1. Image of paper currency will be acquired by simple scanner or digital camera.
2. The image acquired is RGB image and then it will be converted into gray scale.
3. Edge detection of the whole gray scale image will be performed.
4. After detecting edges, the six characteristic features of the paper currency will be cropped and segmented.
5. After segmentation, the characteristics of the paper currency will be extracted.
6. The characteristics of test image are compared with the original pre-stored image in the system.
7. If the conditions are satisfied, then the currency is said to be genuine otherwise counterfeit.

In the proposed method characteristics of paper currencies are employed that are used by people for differentiating different banknote denominations. Basically, at first instance, people may not pay attention to the details and exact characteristics of banknotes for their recognition, rather they consider the common characteristics of banknotes such as the size, the background color (the basic color), and texture present on the banknotes.

b. Characteristic Features:-

In this method, these characteristics will be used to differentiate between different banknote denominations-

1. Security thread:-It is a 3.00 mm wide strip with inscriptions ―.art― and ―RBI‖ and color shift from green to blue when viewed from different angles. The thread is visible as a continuous line from behind when held up against light.

2. Latent image:-It is a vertical band on front side of denomination at right hand side. It contains latent image showing the numeral of the denomination when the banknote is held horizontally at eye level.
3. Watermark:-The portrait of Mahatma Gandhi, the multidirectional lines and on electrolyte mark showing the denominational numeral appear in this section and these can be viewed better when the banknote is held against light
4. Identification mark:-A symbol with intaglio prints which can be felt by touch, helps the visually impaired to identify the denomination. In 500 denominations the identification mark is a circle. In 1000 denominations the identification mark is a diamond. The below diagram shows the step by step process of this paper currency verification system.

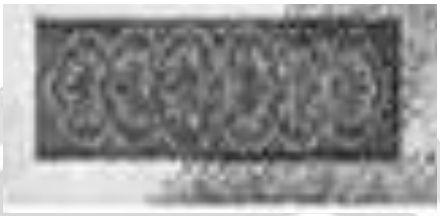

Fig.1 See Through Register

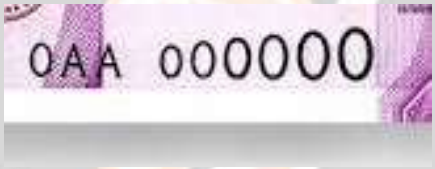

Fig. 2 Serial Numbers

Fig. 3 Seven Angular Bleed Lines

Fig. 4 Security Thread

Fig. 5 Devnagari Symbol

c. Methodology:-

The approach consists of the following steps:-

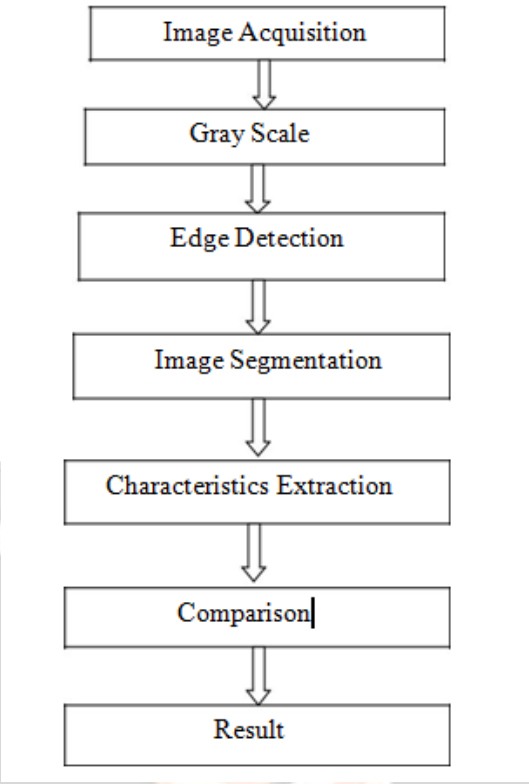

Fig .1 Design Flow of Indian Paper Currency Recognition System

1) Image acquisition: Image is acquired by digital camera by applying the white backlighting against the paper currency so that the hidden attributes are able to appear on the image of the currency. Here image acquisition of 500 denominations is shown below

Fig. 2 Original Indian 500 denomination

2) Image pre-processing: pre-processing of image are those operations that are normally required prior to the main data analysis and extraction of information. Here image resizing is performed because the currency image is too large to process.

Fig. 3 Indian 500 denomination after resizing

3) Gray-scale conversion: the image acquired is in RGB color. It is converted into gray scale because it carries only the intensity information which is easy to process instead of processing three components R(Red), G(Green), B(Blue).

Fig. 4 Gray Scale Image

4) Edge detection: Edges are detected of the gray scale image of paper currency using Gray Scale Conversion Edge Detection Image Segmentation Segmentation Result Comparison Characteristics Extraction Image Acquisition Sobel operator. It smoothes the image and calculate the gradient of the image.

Fig.5 Edge Detection (Gradient magnitude of the image)

5) Image segmentation: segmentation is the process of partitioning a digital image into multiple segments. It is typically used to distinguish objects from backgrounds. Here edge based segmentation is performed on the image.
6) Feature extraction: Now the features are extracted using edge based segmentation and objects and background are separated.

4. CONCLUSIONS

In this article, the automatic authentication of paper money and conversion into lower denominations of Indian paper currency is described by applying image processing techniques. Basically six features are extracted including identification mark, security thread, watermark, numeral, floral design, micro lettering from the image of the currency. The process begins from image acquisition and end at comparison of features. After authentication, the serial number of the note is extracted. The use of serial number extraction is if any counterfeit note is encountered we can immediately send the report about that counterfeit note. The features are extracted using edge based segmentation by Sobel operator and works well in the whole process with less computation time. The complete methodology works for India denomination 20, 50, 100, 500 and 1000.

The method is very simple and easy to implement. If the hardware part of image acquisition is designed then it is surely help us to minimize the problem of counterfeiting currency. This technique is used to extract six characteristics of paper currency including identification mark, security thread, floral design, numeral watermark, watermark, micro lettering in security thread. The system may extract the hidden features i.e. latent image of the paper currency. The proposed work is an effort to

suggest an approach for the characteristic extraction of Indian paper currency. Detailed approach is suggested from the beginning of image acquisition to converting it to gray scale image and up to characteristic features extraction. The decision making is done within 0.5 seconds. The system designed is a low cost system. The system is able to extract the features even the note has scribbling on it. The system can extract features even the test image sizes are different when compared to reference image.

5. REFERENCES

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