



## Identification of Fake Currency: A Case Study of Indian Scenario

Snehlata

Department of Computer Science  
Babasaheb Bhimrao Ambedkar University  
Lucknow-226025, India

Vipin Saxena

Professor, Department of Computer Science  
Babasaheb Bhimrao Ambedkar University  
Lucknow-226025, India

**Abstract:** In every country, many people generate the fake currency which is similar to the original currency. It may be of the form of notes and coins. In the business market, it is very difficult to identify the fake currency and it is also true that original currency in the form of notes and coins are available in the bank custody. Many researchers have applied different methods to identify the fake notes and coins. The present work is in this direction for identification of newly launched 500 and 2000 notes in the Indian market. An object-oriented model is proposed for designing of systematic steps for identification purpose. This is further implemented in the MATLAB. Results are produced in the form of tables and graphs.

**Keywords:** Currency; HSV Image; UML; MATLAB; Gray Scale Image; Security Features.

### I. INTRODUCTION

From the literature it is observed that in the year 1938, Reserve Bank of India (RBI) has issued currency notes of 2, 5, 10, 100, 1000 rupees notes. Later on, RBI has issued denomination of 1, 20, 50 and 500 rupees notes having value in it. As per RBI guidelines currency in Indian scenario has to be changed after interval of every 10 year therefore different designs of the notes along with new series have appeared in Indian Business market and the old series have eliminated by RBI. During past years, it is observed from the business market worldwide that tremendous amount of fake currency in the form of notes and coins are available in the business market also in the bank.

Many researchers have introduced new techniques and some of the techniques for identification are watermarking, latent image, micro lettering, see through register optically variable link, security threads, intaglio printing, fluorescence, identification mark, legal provisions against counterfeit. Automatic tools are also available for fake currency identification. Fake currencies which are available online for the use of banking service but the accuracy may differ from one approach to another approach. Hence, there is need to develop a robust system for the reliable identification with minimum processing speed and accurate of the currency. For this purpose digital image processing is adopted by many researchers in which authors extracts different attribute after image acquisition and considers as an object the attributes may be watermarking, latent image, micro lettering, see through register, optically variable link, security threads, intaglio printing, fluorescence, identification mark, legal provisions against counterfeit. For recognition of the attributes, author generally used MATLAB as computational tool for development and implementation of design steps for the analysis purpose and it supports image acquisition as bmp, jpeg, tiff, gif, png, jpg etc. After Image acquisition characteristics of the attributes are extracted for digital image processing which contains visible as well as invisible features taken from the currency notes. Authors applied different methods of extraction of the image but it should be an excellent and feasible extraction of the image for consideration of input reliable data. The data is further classified into the number of pattern distinct classes having attributed like distinct method HSV image, Edge detection, Segmentation etc. These features

are well described in the literature. Lets us describe some of the important features related to these aspects. Lots of researchers have done work in the field of identification of currency. Many countries have changed the currencies generally after a period of ten years. Recently, Indian Prime Minister has changed currency of note of Rs 500 and Rs 1000 and issued new direction for new currencies.

### II. RELATED WORK

From the literature, it is revealed that many researchers have done work on the identification of fake currency. Let us explain some of the important references. In the year 2008, Yoshida et.al. [1] have studied the Bangladesh currency and designed a machine based system for Identification of Bangladeshi bank notes. The proposed system is based on basically denominations of five hundred and one hundred taka. In proposed system, authors first captured the image of note through scanner then processed in microcontroller PIC-16F648A. After microcontrolling they determine the validity of note based on some characters i.e. dasiaBpsila, dasiaApsila and dasiaNpsila on the OCR technique of scanned Image. The success rate of proposed system of counterfeit detection with properly scanned image is 100% and average processing image is 250 milliseconds. Hassanpour et. al. [3] have proposed a new technique of paper currency recognition which is based on three characteristics of paper currencies including size, color and texture. By using Image histogram, the different color in paper currency is compared to reference paper currency. They presented model texture of the paper currencies based on Markov chain concept. The proposed method can be used for recognizing the paper currency from different countries. With one example of paper currency for training system but they tested more than 100 denomination from the different country. The proposed system recognizes 95% correct data.

Qian et. al. [4] have proposed the new technology of detection of currency. The new technology is based on electromagnetic. Electromagnetic detection introduced the basic principle of pulse eddy current technology, the inspection equipment design, to experimental results analysis and the characteristic quantity extraction. The advantage of technology is based on pulse eddy current technology. Bhattachary et. al. [5] have discussed the comparative study of data mining for credit card fraud. They proposed two advanced data mining approaches for better card fraud detection; with logistic

regression. This study is based on real life data of transaction from an international credit card operation. Santhanam *et. al.* [6] have studied the detection methods to detect the fake currency. These detection methods are based on polarization concept, Image processing technique and Holographic technique. They discussed the methods generally based on physical properties of currency rather than chemical properties to detect the counterfeit currency. They also elaborated the mathematical model, experimental verification and lab view based simulation in the way of fake currency detection. Yan and Lin [7] have designed a money number recognition system and discussed the position of money number when is based on gray value accumulation and through the least square method they detected the edge line of money number using the geometrical rotation gray adjacent interpolation method to correct the number which is based on character structure characteristic to realized the character recognition. The presented system has high accuracy of recognition of money number.

Feng *et. al.* [8] have designed the Renminbi Bank Note (RMB) serial number recognition system. RMB is the paper currency of china and authors presented new system that extracts the RMB characters directly from scanned RMB images. They discussed the two techniques to detect the region which contains RMB serial number that are skew correction and orientation identification. The detected text region is binaried by thresholding technique. After a contrast average method is introduced to extract the RMB character from the finalized result. Jain and Vijay [9] have proposed an image processing to extract paper currency recognition and neural networks matching techniques to extract the region of interest and elaborated the step to extract the paper currency denomination. Firstly authors take image by scanner and adjust their size and pixel level. Through the pattern recognition and neural networks matcher technique is used to match the value of paper currency. Bhasharkar *et.al.* [10] have discussed the currency recognition technique based on Image processing. The image processing approach based on basic steps like Image acquisition, pre-processing and finally recognition of the currency are demonstrated. The image processing approach is discussed with MATLAB to identify the feature of currency note. Finally, the results are demonstrated for genuine or fake currency.

Yan and Chambers [11] have designed a prototype for automated currency detection based on generally color feature and texture feature. They also proposed the feed Forward Neural Network (FNN) and measured the similarity between sample and suspect banknote. Yadav *et. al.* [12] have designed a system for fake currency detection using MATLAB algorithm and feature extraction with HSV color space and other applications of Image processing. Yadav *et. al.* [13] have designed a system for automated recognize and verify the Indian currency using Image processing. Authors described the two characteristics of Indian currency that is based on counterfeit note which included Identification mark and currency serial number. They also used Sobel operator and characteristics extraction which have been performed on the Image of currency and then it is compared with the characteristics of the genuine or original currency. The currency has verified by Image processing technique. They also elaborated the number of steps including Image processing, edge detection, image segmentation, characteristic extraction and comparison.

Thakur and Kaur [14] have presented the different fake currency detection techniques and reviewed different fake currency detection systems. The system has developed using different methods and algorithms. Authors describe the

different methods and algorithm used for fake currency detection system and compared them and also elaborated the ability which depends on the currency note characteristics of particular country and extraction of feature. Ismail and Makone [15] have studied the fake currency of India and presented software for Identification of fake currency with the help of feature extraction classification based on Image processing. Authors also elaborated all processing with the Image by machine. The machine has fitted camera to scan the image of currency note and software processed the image segments with the help of character recognition methods. They also designed software with MATLAB tool. Alekhya *et. al.* [16] have studied the fake currency detection using Image processing and other standard methods and elaborated the some other methods to detect fake currency through security features of currency and using MATLAB.

Bhurke *et. al.* [17] have designed a algorithm for currency recognition. The proposed algorithm based on image processing approach has discussed with MATLAB to detect the feature of paper currency. They discussed basic requirement for an algorithm which have simplicity, less complexity, high speed and efficiency and proposed an algorithm design an easy but efficient algorithm that useful for maximum number of currencies. Authors used five currencies to work on for this project and selected currencies are Indian Rupees (INR), Australian Dollar (AUD), Euro(EUR), Saudi Arabia Riyal(SAR) and US Dollar (USD). R and Omman [18] have studied the Indian currency recognition system and proposed a method to recognize the fake currency using Image processing approach and also identified by extracting feature like Central Numeral, Shape, RBI seal, Latent Image and Micro Letter. Authors also elaborated the principle component analysis which has used to reduce the dimensions and a similarity based classifier constructed to predict test sample. Results have also validated by constructing models using classifier implemented using WEKA and testing with unseen samples not considered in feature extraction. Authors also studied the central numeral results in an accuracy of 100% with all family of currencies. Ahmad *et. al.* [19] have designed a machine based system for identification of Bangladeshi currency in the form of taka and presented a core software system to built a robust system for detection of fake currency through extraction of important features like security thread, ultraviolet lines, watermark contour Analysis, face Recognition *et.c.* Authors also elaborated the advantages and disadvantages of the proposed system for improving currency authentication system.

Vora *et.al.* [20] have designed an algorithm for currency detection based on feature extraction methods and used two dimension discrete wavelet transform (2D DWT) which has used to develop a currency recognition system after the pre processed of system with example of serial number feature method by implementing the OCR technique to found better results. Walke and Chanwadkar [21] have designed a machine that recognizes the fake currency using SVM with Note to coin Exchanger and presented a machine to provide coin for genuine note Firstly an image is taken then used Image processing technique to process it if note has genuine then machine provides the coin to its equivalent value. Rathee *et.al.* [22] have studied the physical and chemical properties of fake currency and presented a core software system to build a robust system for detection of fake currency using physical properties. In Image processing algorithm, they adopted the extraction of important feature such as security thread, intaglio printing (RBI LOGO) and identification mark which have been adopted as security feature of Indian currency and elaborated the difference between real and fake currency based on above three

security features. Authors also measured the performance of proposed system based on accuracy and mean square error.

Abdallah *et al.* [23] have presented the survey paper on Fraud Detection System (FDS) and described the issue and challenges during Fraud detection on electronic commerce system. They discussed the fraud detection system has important as well as fraud prevention system. C and G [24] have proposed an algorithm to currency note number recognition using Image processing for an Automated Teller Machine (ATM) and elaborated the algorithm that has automatically noting and saving the currency note number to server at the time of withdrawal, so that customer has benefitted in recovering their currency back and also described that their proposed algorithm makes the ATM more reliable and user friendly. Paliana and Arora [29] have designed a system that recognized the fake currency based on security thread feature of currency. Authors described the counterfeit notes are a very big problem of every country so they presented a system that verified the Indian currency & other countries using Image Processing technique with fast speed and less time. Other related references are [2], [25], [26], [27] and [28].

### III. MATERIALS AND METHODS

In Indian scenario, Reserve Bank of India (RBI) has issued the guidelines related to currency under Act 1935. Before this silver coins were used during 1540-45. On the basis of 1934 Act, in the year 1917 Government of India (GOI) introduced a note of Rs 1, there after a Rs 5 in 1938 and Rs 2 in 1943. These notes were having a less security features hence for improving the security features like watermarking, micro lettering etc. and other technique has discussed.

After that GOI has introduced Rs 10, Rs 20, and Rs 50, Rs 100, Rs 500 and 1000 from time to time which contains the features watermarking, Window Security Thread, Latent Image and Intaglio, etc. as per rules of RBI the series were absolute after series of notes after 10 year. In 2011 new series of Rs 1, Rs 2, Rs 5, Rs 10 were introduced with new Rupees symbols while before this year series of Mahatama Gandhi watermark were introduced were Rs 10, Rs 20, Rs 50, Rs 100 and Rs 1000.

Due to counterfeit problem faced by RBI and availability of the high resolution scanners, any person can print the counterfeit note through computer by a color laser printer. In the banks, there are some machines which are available with the bank persons used to detect counterfeit persons but sometimes fail to detect these kinds of notes. In the present work, these kinds of problems resolve through a small piece of code which is based upon the following aspects:-

#### A. MATLAB

A Matrix Laboratory (MATLAB) is software of Library is used for designing for finding these kinds of features in the available of currency. There are so many security feature of Indian currency that are based on generally color, size and some Identification mark. The color is most important feature of currency recognition.

MATLAB is generally computational tool for research, development and analysis. This tool is supported all type of image formats like BMP, HDF, JPEG, PCX, TIFF, XWB, PNG etc. In present time characteristics extraction of Image is very challenging work in the field of Digital Image Processing.

In MATLAB technique, we have created different classes of Digital Image Processing steps including Image Acquisition, HSV conversion, and Edge detection, Image Segmentation, Characteristics Extraction and Comparison of Images. Each

class has its own attributes and methods represented in the following Table I.

Table I. Representation of UML Classes and Attributes

Sr. No.	Name of Class	Attributes	Methods
1.	IA	IAReal IAFake	imread( );
2.	HSV	IAReal IAFake hsvReal hsvFake	rgb2hsv( );
3.	ED	cropReal cropFake satThresh valThresh BIRReal BIFake	hsvReal(:, :, :); hsvFake(:, :, :); cropReal(:, :, :); cropFake(:, :, :); figure; subplot(, , ); imshow( ); title(' ');
4.	IS	se closeReal closeFake	strel(' ', , ); imclose(, ); figure;
5.	IE	openReal openFake closeReal closeFake	bwareaopen(, ); imshow( ); title(' '); figure;
6.	COMP	openReal openFake lineReal lineFake	bwlabel( ); disp(' : '); num2str( );

IA is the class of Image Acquisition that has its own attributes and methods to obtain the image using camera, scanner etc. HSV is the class of Hue-Saturation-Value to convert the RGB Image into each different component. ED is the class of Edge Detection that resizes the image and extracts the region of interest using its own Attributes and Methods. IS is the class of Image Segmentation that divides the image into its constituent region or objects. IE is the Image Extraction that extract the characteristics of Image. COMP is the class of comparison that compares the image on the base of characteristics.

#### B. UML

Unified Modeling Language (UML) is a standard language which is used for software design based on the object-oriented technique. It is a tool for producing the pictorial designs which are classified as static or dynamic design.

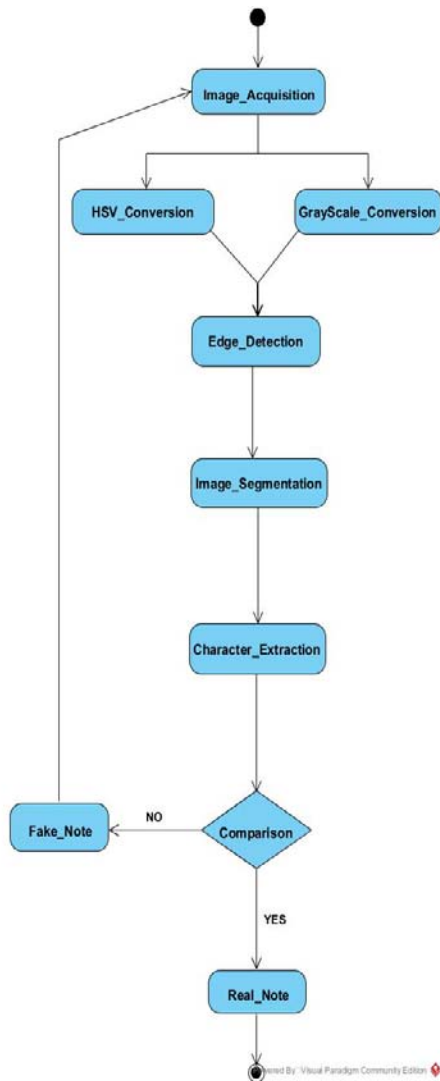


Figure 1. UML Activity Diagram for Fake Currency Detection

In the present work, we have designed UML activity diagram which is used to represent run time behavior of software. This diagram consists of grouped together which perform by the Actor for the present work a UML activity diagram for the detection for fake currency in the Figure 1. It consists of the following activities:-

- STEP 1:-** Activity Name : Image Acquisition  
Description : Obtain the Image of Real and Fake currency through Camera or Scanner.
- STEP 2:-** Activity Name : HSV Conversion  
Description : The acquire RGB images are converted into HSV on the based on what information extracted.
- STEP 3:-** Activity Name : Edge Detection  
Description : The edge detection technique is used to detect the boundary of Image using cropping.
- STEP 4:-** Activity Name : Image Segmentation  
Description : In this process the Image is divided into different segment.

**STEP 5:-** Activity Name : Character Extraction  
Description : After segmentation the distinguish feature of Image is extracted in this steps.

**STEP 6:-** Activity Name : Comparison  
Description : Compare the characteristics of Image and display the outputs.

#### IV. RESULTS AND DISCUSSION

The above UML diagram has been implemented through code written in MATLAB. The different parameters have been selected for getting the optimized result. A 2000 rupee real and fake notes are first scanned by a scanner and outlook of notes are represented in Figure 2(a) and (b).



(a)



(b)

Figure 2. Images of (a) Real currency and (b) Fake currency

The Government of India (GOI) has launched this new currency of an Rs 2000 note in November, 2016. Since the value of note is very high, therefore there is lot of chances by intruders to generate the fake currency and during the subsequent months police department of India has also recovered the big chunks of Rs 2000 from the various places.

Later on these two acquired images have been in RGB color and converted into the Hue-saturation-value (HSV) format. By this process the complete image has been separately looked each Red, Green, Blue component and these two images are represented below.

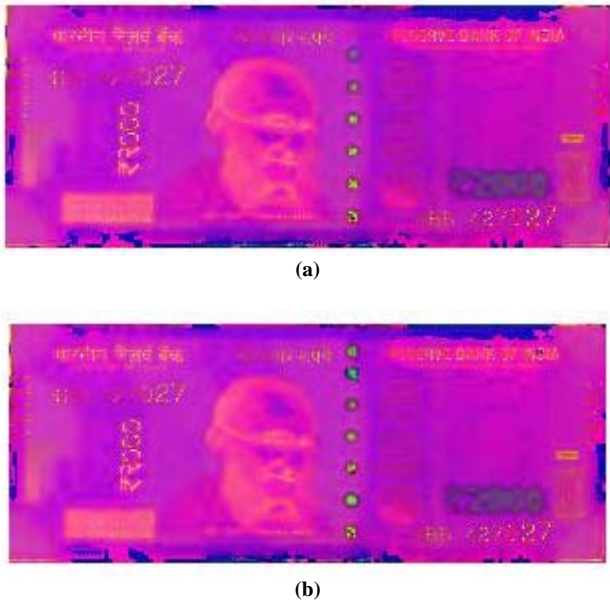


Figure 3. Conversion of RGB into HSV Image (a) Real currency and (b) Fake currency

Since the image contains the number of segmented parts therefore one can apply security threads as a region of Interest (ROI) to these parts. In the present case, a strip is considered as a security thread for checking whether the rupee 2000 note is real or fake. These Security Threads in the forms of strips are shown below in the following Figures 4(a) and (b).

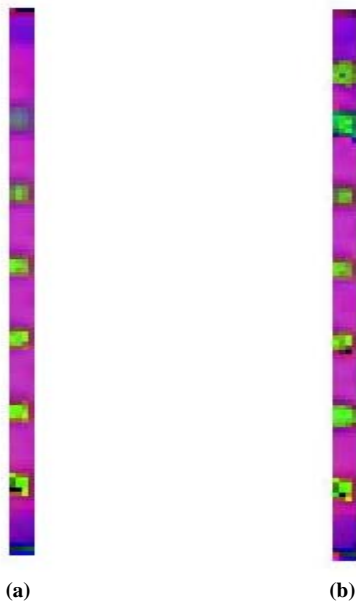


Figure 4. Crop Image of (a) Real strip and (b) Fake strip

From the below, we compared the number of black pixels of real and fake currency. We got strip which contains number of black pixel as one and three in real and fake currencies respectively which have been clearly represented in the following Figures 5(a) and (b).

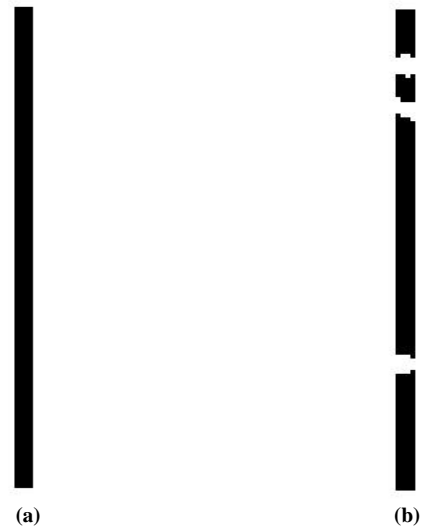
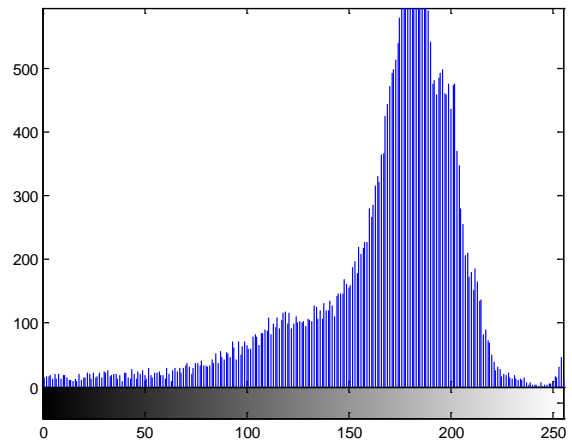
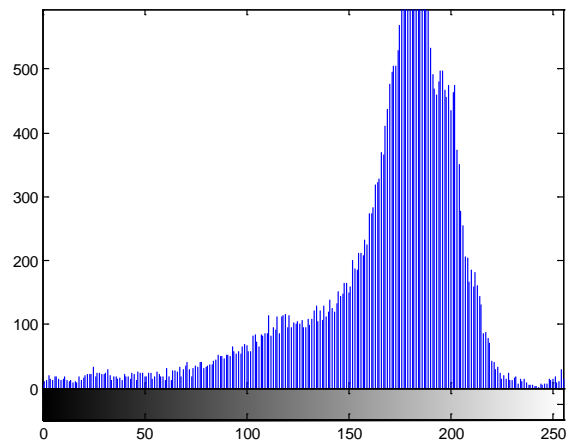


Figure 5. Number of black pixels in (a) Real currency and (b) Fake currency

The variation between the real and fake note is also represented through a histogram and from the Figure 6(a) and (b) it clearly represented the relative frequency of the various gray levels of real and fake currency.



(a)



(b)

Figure 6. Histogram of (a) Real currency and (b) Fake currency

## V. CONCLUSIONS

From the above work it is concluded that UML is an important modeling language used to represent static and dynamic aspects of the research problem. In the present work, a UML activity model is designed to represent the dynamic aspects for identification of fake currency and successfully implemented on newly launched a note of Rs 2000 by an Indian Government. A MATLAB code is generated and through a code, we got class descriptions for real and fake Images of the currency. This is because of selection of optimized class and attributes. The above aspects can be extended for the another kinds of currencies of different countries.

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