FAKE CURRENCY DETECTION USING IMAGE PROCESSING

Abstract

The advancement of color printing technology has increased the rate of fake currency note printing and duplicating the notes on a very large scale. Few years back, the printing could be done in a print house, but now anyone can print a currency note with maximum accuracy using a simple laser printer. As a result the issue of fake notes instead of the genuine ones has been increased very largely. India has been unfortunately cursed with the problems like corruption and black money .And counterfeit of currency notes is also a big problem to it. This leads to design of a system that detects the fake currency note in a less time and in a more efficient manner. The proposed system gives an approach to verify the Indian currency notes. Verification of currency note is done by the concepts of image processing. This article describes extraction of various features of Indian currency notes. MATLAB software is used to extract the features of the note. The proposed system has got advantages like simplicity and high performance speed. The result will predict whether the currency note is fake or not. There are Different techniques which are used to distinguish between counterfeit notes and genuine one. By using different components of Image processing such as image acquisition, pre analysis, Initial segmentation, post processing, grayscale conversion, feature extraction, comparing images etc. We can extract the features of genuine notes. It is very Challenging task for detecting fake currency We get at most 81% of Accuracy in system Fake Currency Detection using Algorithm: Distance weighted.

Introduction

Different countries around the world use different types of currencies for the monetary exchange of some kinds of goods. One common problem faced by many countries related to currency is the inclusion of fake currency in the system[1]. Bangladesh is one of the countries that face a lot of problems and huge losses due to the fake currencies. Due to this there are losses in the overall economy of the country‘s currency value. Technological advancements have made a pathway for currencies to be duplicated such that they cannot be normally recognized [2]. Advanced printers and new editing computer softwares are used to create counterfeit currencies. Fake currencies can just be slipped into bundles of genuine currency which is how they are usually circulated in the market. Commercial areas like banks, malls, jewelry stores, etc have huge amount of transactions on a daily basis. Such places may be able to afford and find it feasible to buy machines that use UV light and other techniques to detect the authenticity of the currency. But for common people it is very difficult to just detect whether the currency is fake or genuine and they may face losses especially during bank deposits or transactions. This system is designed such that any person can use it easily and detect the authenticity of the currency he has by using the visual features of the currency [3]. This system can further be converted into an app so that it is accessible to all the people. Furthermore, this system can be designed to detect currencies of other countries as well. The system is based on Image processing where a number of steps are used to process the image of a currency and give the result to the user whether the currency is genuine or not. The remainder of the paper mentions the following details. In section II, there is brief information on some related papers that are used for reviewing. In section III, the methodology is mentioned which specifies the different steps used in the entire process of currency detection. In section IV, the details of the proposed system are mentioned. Section V shows the result and conclusions. Section VI mentions the referred papers and links.Anti-counterfeiting measures involved including fine detail with raised intaglio printing on bills which would allow non-experts to easily spot forgeries [5] .The acquisition of images is completed at first during processing. Then a conversion from RGB to GRAYSCALE is done. After conversion, the image is segmented, its features are measured, correlation is found, and classification is completed to determine whether the image is real or fake[6]. Technology is growing very fast these days. Consequently the banking sector is also getting modern day by day. This brings a deep need of automatic fake currency detection in automatic teller machine and automatic goods seller machine. Many researchers have been encouraged to develop robust and efficient automatic currency detection machine(Agasti, Burand et al. 2017) [7]. Automatic machine which can detect banknotes are now widely used in dispensers of modern products like candies, soft drinks bottle to bus or railway tickets.In Banking-sector , biggest risk is fake currency generation. Mostly UV light is applying for authentication proving. Main features to detect fake currency are Note value , ink smudge , Security thread , serial number , Intaglio printing , watermark , Reserve bank number panel , LD mark , Topography , Micro-lettering and numbers & alignment. In that important features are watermark , ink smudge , security thread , topography , numbers & place and microlettering(Mandankandy and k.E 2020)[8] Fake currency has always been an issue that has created a lot of problems in the world. Every country has been badly affected by this which has become a major problem. Moreover, it makes the domestic currency lose out its credibility in the global market. Thereby triggering adverse socioeconomic impacts. Counterfeit currency is also usually associated with terror financing. According to an RBI report, fake notes of the new Rs 500 series saw a 37% rise in 2019-20, and there was a fall in circulation of Rs 2000 notes. The increasing technological

advancements have made the possibility of creating more counterfeit currency(Kudalkar, Patil et al. 2022)[9].There are effects on society such as: companies are not being reimbursed for counterfeits. This has led to companies losing buying power.[10] As such, there is a reduction in the value of real money. When the general price level rises, each unit of currency buys fewer goods and services; consequently, inflation corresponds to a reduction in the purchasing power of money.[11][12] In this paper is subdivided into seven main sections. in section (2) describes the introduction of project , in section (3) we will describe Related Work , in section (4&5) we will describe Methodology, in section (6) the result discussion, in section (7) we will finishing abstract , in section (8) conclusion of the project and project discussion.

Related work

The persistent challenge of counterfeit currency necessitates cutting-edge approaches for accurate identification. This overview examines notable contributions in the field of fake currency detection, highlighting diverse techniques, datasets, and corresponding results.

Colaco, Rencita Maria et al. chose to use the programming language Python and OpenCV for their project using Canny Edge Detection algorithm. To make comparisons and determine the outcome, a number of characteristics that define genuine currency apart from counterfeit ones were taken into account. Identification marks, see-through registers, optical variable ink, currency color codes, security threads, watermarks, latent images, and micro-lettering were a few of these features. The accuracy of the proposed system was close to 80%. The goal of this research was to create a low-cost system with quick computations so that even the average person, who is unable to use more advanced resources, can identify counterfeit money. [1] In this project, Vadnere, Koneri et al. used digital image processing algorithms to make currency authentication. In essence, some features were extracted using image-based segmentation and template matching, which worked well throughout the entire process and required little computation time. The technique was incredibly easy & simple to use. Using this method in the real world is highly adaptable. The folks who are unfamiliar with currencies will be benefitted from this effort. [2]In this experiment, Jamkhandikar, Dayanand et al.used two different currencies, and it was discovered that the suggested method based on color and feature analysis is effective for currencies. This project was done using image processing algorithm. The accuracy found in this system was 70%. Doing this project allowed them to identify counterfeit money, which is particularly helpful in preventing high-order counterfeiting that makes use of low-cost but highquality machinery. [3] Sangogi, Mrs Jyoti et al. made it possible for someone who is blind to tell whether money is real or phony. Based on the parameters of the HSV values of the currency note, the Python technique, which was implemented in a Raspberry Pi with a scanner, could capture the currency note and carried out the image processing techniques mandated in the project to determine whether the currency is genuine or counterfeit. [13] 10 Shiby, Ashik et al. used image processing, this project aided in the acquisition of fake currency. In certain ways, this can stop the propagation of fraudulent notes in the system. It can provide the user with the opportunity to ascertain the note's legitimacy without having to visit a bank using machine learning algorithms.The accuracy of this proposed system is approximately 80%. The initiative covered the acquisition of Indian paper money. [14]]Warke, Kanthi et al. compared their project with other previous methodologies, image processing techniques allow for more accurate examination of the currency image while also saving time and money. The suggested method was designed to efficiently extract and check features from photos of Indian cash using so many algorithms like fluorescence detection

algorithm, dimension detection algorithm, color composition algorithm etc. [15] Aditya Sharma, Shweta Poojary et al. worked using the help of the Tensorflow and Keras libraries, this system primarily focused on the picture categorization part of deep learning using deep learning network algorithms, deep neural network algorithms, and convolutional neural network algorithms. The detection of currency tooks only a few seconds, and currency recognition was simple. The system has an excellent overall accuracy level for differentiating between real and fraudulent cash. [16] Kudalkar et al. proposed a technique which was appeared to be effective in determining whether the currency is real or fake using image acquisition, noise removal, gray scale conversion, edge detection, segmentation, feature extraction, comparison, supervised learning algorithm. According to the project's findings, the primary security features—bleed lines, security thread, and micro lettering—were needed to be precisely computed. [17] Pallavi, S. et al. detect and identify banknotes of different denominations. This study presented a system that use convolutional neural networks with deep training using CNN (Convolutional Neural Network) model training, currency pre-processing algorithm. By acting as a feature extractor, their ML-CNN (Machine Learning Convolutional Neural Network) based project eliminated the need for image processing and the need for manually confirming the existence of security characteristics in the note. The project's audio output, which will also be useful to blind 11 people, will be its final product. Further experiments with different ML-CNN (Machine Learning Convolutional Neural Network) architectures will increase the model's accuracy. [18] Potluri, Jahnavi et al. suggested an approach which offered a more effective way to spot a phony banknote using data augmentation, transfer learning. This CNN (Convolutional Neural Network) model (Mobilenetv2-FCD) was developed for a mobile application after being trained on a realtime dataset. With smart phones, this mobile application can be used to detect counterfeit money notes. This suggested network had an accuracy of 85% in identifying counterfeit notes. Any currency can be used with the network after it has been trained for it. [19] Khan, Mudassir and Mahtab Alam showed how machine learning can be used to accurately identify fake currency. It is possible to distinguish between real and fake banknotes quickly by using the K-Means algorithm with many clusters of size two. A third group of banknotes that could be subject to additional analysis, such as genuine banknotes in poor condition that could be mistaken for forgeries, can aid when there are three clusters instead of two. The model had some flaws. In this point, an accuracy of 87% might be sufficient. Yet, it is still more precise than human detection. Additionally, the model's accuracy can be increased any further with more data and better analysis. [20].

Table1. Comparison Between Different Related works

Ref.No	Used Dataset	Technique	Result
[1]	Image type dataset of currencies	Canny edge detection algorithm.	They ended up using OpenCV along with python programming language to detect fake currencies. Accuracy: 88%.
[2]	Image type dataset of currencies	Digital image processing algorithms are used.	In this project, the authentication of currency is made by applying image processing. Accuracy: 92%.
[3]	Indian currency note of 500 and 2000.	Grey Scaling algorithm,Edge Detection algorithm	By making this project they recognized fake currencies by taking advantage of cheaper and high quality equipment. Accuracy: 86%.
[13]	Image type dataset of currencies	Image Scaling, binarization algorithm, KNN classifier	This project enables a visually impaired person to detect whether the currency is original or fake. Accuracy: 94%.
[14]	Image type dataset of currencies	Machine learning algorithms.	This project helps to obtain false money through image processing. Accuracy: 90%.
[15]	Image type dataset. Sample items: 1372	SML, Decision tree, KNN SVM algorithm.	In this project, SML algorithm SVM, DT, and KNN are applied to authenticate banknotes. Accuracy: 82%.
[16]	Image type dataset	Digital image processing algorithm	The proposed system seems to be useful to detect whether the currency is genuine or not. Accuracy: 89%.
[17]	Image type dataset	Digital image processing algorithm	The study includes effective method for recognizing the properties to detect fake notes. Accuracy: 93%.
[18]	Image type dataset.	Fluorescence, dimension Detection and color composition algorithm.	using image processing techniques they detected the fake currencies. Accuracy: 87%.
[19]	Image type dataset. Source: Kaggle	CNN model training, currency pre-processing algorithm.	A system that uses convolutional neural networks using deep training to detect fake currencies. Accuracy: 85%.
[20]	Image type dataset, having 3 columns: type, filter shape and input size. Sample items: 500	Data Augmentation, Transfer Learning algorithm	This CNN model (Mobilenetv2-FCD) has been trained on a real time dataset to determine fake currencies. Accuracy: 87%.

METHODOLOGY

The current systems that are present are only machine based i.e. it is only for commercial use. The systems that use image processing are performed on MATLAB [21], [24]. These machines are based on optical sensing or proximity detection. In optical detection , the currency is kept under the machine and the UV light is scanned over the currency and if the currency shines due to fluorescence then it is a genuine currency. In proxy detection the ink used to make the currency contains ferromagnetic properties, so when the currency is passed through a magnetic belt and if it shows some movement then it is concluded that it is a genuine currency [25].

Figure 1 is the flowchart that shows the general methods used to detect fake currency using image processing.

A. Image Acquisition The image of the currency that has to be checked or verified as a genuine currency is taken as an input for the system. The input image can be acquired using techniques like scanning the image or clicking a picture with the phone and then uploading it to the system.

B. Gray Scale Conversion Conversion of a color image to a grayscale image requires more knowledge about the color image. A pixel color in an image is a combination of three colors Red, Green, and Blue (RGB).Similarly, A Grayscale image can be viewed as a single layered image. Different techniques can be used to convert a coloured image to grayscale image. [26]

C. Edge Detection Edge detection is an image processing technique for finding the boundaries of objects within images [29]. It works by detecting discontinuities in brightness. Edge detection is used for image segmentation and data extraction in areas such as image processing, computer vision, and machine vision. The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world. Edge detection helps to detect all the edges of the necessary ROI to perform various operations in the latter stages.

D. Segmentation Image segmentation is the process of dividing an image into multiple parts. This is typically used to identify objects or other relevant information in digital images. [27] shows a few examples of the techniques that can be used to perform segmentation.

E. Feature Extraction Feature extraction is a type of dimensionality reduction that efficiently represents interesting parts of an image as a compact feature vector. This approach is useful when image sizes are large and a reduced feature representation is required to quickly complete tasks such as image matching and retrieval. The features are extracted and then used for comparison in the further step.

F. Comparison The features that are extracted from the previous step are used for comparison with the stored features and then the results are displayed as to the currency being genuine or fake.

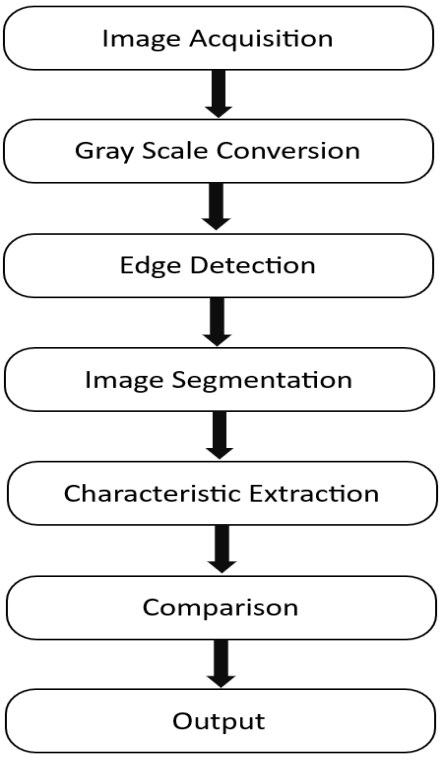

Fig. 1 Flowchart to Detect Fake Currency using Image Processing

The proposed system is using image processing to detect the currency. The input is a photographed or scanned image that is given to the system which can be of .png and the output tells whether the currency is genuine or not. The process contains techniques such as image pre-processing, gray scale conversion, edge detection, segmentation, feature extraction and comparison of features.

Figure 2 shows the architecture diagram for the proposed system.

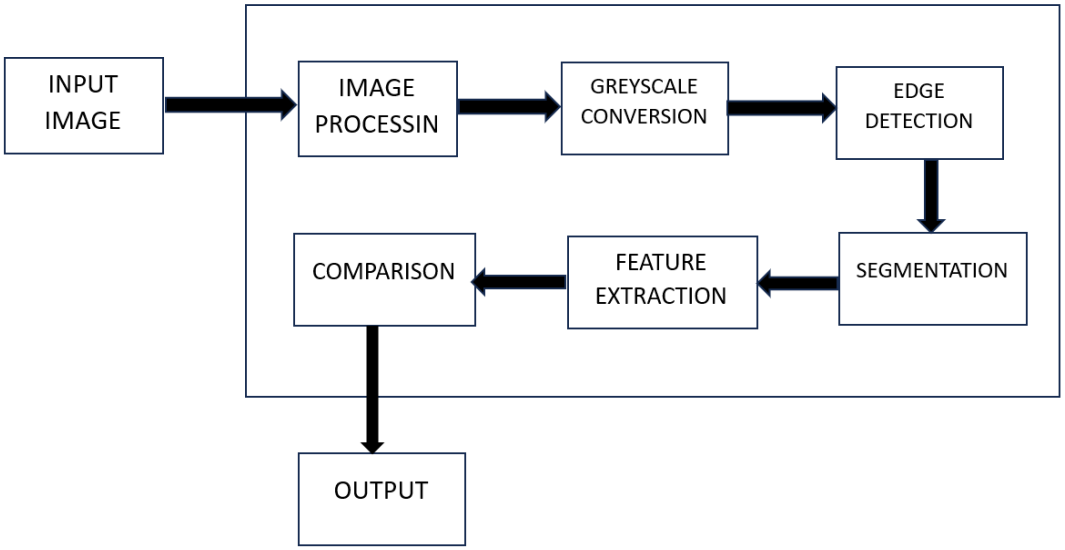

Fig. 2 Architecture diagram of proposed System

Step 1: Image Pre-processing Pre-processing is a common name for operations with images at the lowest level of abstraction — both input and output are intensity images. The aim of pre-processing is an improvement of the image data that suppresses unwilling distortions or enhances some image features important for further processing. In this system, noise filtration is done in image pre-processing [28]. Here, the salt and pepper type of noise is removed.

Step 2: Grey scale conversion The image is converted to a grayscale image as it reduces the complexity of code. There are many methods that can be used to convert an RGB image to a grayscale image such as the averaging method, luminance method, desaturation method,etc. [32]. The system uses the luminance method to perform grayscale conversion.

Step 3: Edge Detection The grayscale image is the input to this step. The system uses Canny Edge detection as it gives best results compared to the other techniques [30]. Canny edge detection is a technique to extract useful structural information from different vision objects and dramatically reduce the amount of data to be processed.

Step 4: Segmentation There are various methods like thresholding, clustering methods, region based segmentation, etc. to perform segmentation in image processing. Here the thresholding method is used to perform segmentation where threshold values which are obtained from the histogram of the edges of the original image are used. [31].

Step 5: Feature Extraction and Comparison If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data. The system uses the SSIM (Structure Similarity Index Method) method for feature comparison.

Step 6: Output The output shows the different features marked that are used for feature extraction and comparison. In the output, the system first asks the user to upload an image of the currency. The output shows four different types of images. The first image is that of the original image with which the uploaded currency is compared. Next the image is of the currency that is uploaded by the user. The third image is the overlapped images of the features in grayscale.

This result output helps to see the difference between the two images i.e. the original image and the uploaded image. The overlapping of these two images shows where exactly the changes are in the uploaded image if it is fake. The next image is of segmentation of the overlapped image. The overlapped image of the features is performed by thresholding on and is shown as a result to detect the difference in the images more clearly, if any. The system finally displays if the image is fake or genuine.

Results and Discussion

Results: There are other ways to detect if the money is phony or not, but they all follow the same basic stages. Image capture, edge recognition, segmentation, grayscale conversion, and feature extraction are among them. Most of the articles use MATLAB as their computation tool, however we ultimately used OpenCV and Python as our programming language. To perform comparisons and determine the outcome, a number of characteristics that identify genuine currency apart from counterfeit ones are taken into account.We are aware that these tools are used at banks and businesses to help identify counterfeit money, but the average person who lacks these resources is susceptible to this. Our goal is to offer a low-cost system with quick computations that can make decisions in a matter of seconds. The entire process ought to function for Indian denomination 2000. It would be simple for the general public to use, relatively portable, and reasonably priced. The model has some limitations. We can get at most 81% of accuracy which may be sufficient. However, it is still more precise than human detection. It can currently be utilized as an additional tool to lessen human mistake. Additionally, the model's accuracy can be increased any further with more data and better analysis.

Accuracy: The percentage of accurately classified data samples over all the data is known as accuracy. Accuracy can be calculated by the following equation. [33].

Accuracy = (TP+TN)/(TP+FP+TN+FN)

Discussion: The comparision between accuracy that we found in our project with others project:

Table2. Comparison Between Different Result Discussion

Ref.No	Name of Paper	Algorithm	Accuracy
[20]	Big Data Analytics to Authenticate Bank Notes Using KMeans Clustering	Algorithm: K-Means Clustering	87%
[19]	Mobilenet V2-FCD: Fake Currency Note Detection	Algorithm: CNN	85%
[34]	Detection of fake currency using image processing	Algorithm: K-means algorithm	99%
[35]	A review of Fake Currency Recognition Methods	Algorithm: SVM	82.7%
[35]	A review of Fake Currency Recognition Methods	Algorithm: Edge detection	90.45%
[Our Proposed system]	Fake Currency Detection	Algorithm: Distance weighted	81%

Our Proposed system Fake Currency Detection using Algorithm: Distance weighted has 81% of Accuracy.

Output from the system showing the comparison of features

Fig .3 The Output of Real image

Fig .4 The Output of Fake image

Output showing the result if the currency is fake or genuine

Fig .5 The result if the currency is fake or genuine

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correlevance of  mujib < 0.5
currency is fake
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Conclusion

In summary, the “ Fake Currency” project has proven instrumental in advancing our understanding of various techniques and technologies to identify counterfeit currency. Through rigorous experimentation and analysis, it has highlighted the significance of cutting-edge detection methods, including UV lights, watermark examination, microprinting, and more. The project’s findings underscore the necessity of continuous research and development in devising robust, reliable, and accessible tools for financial institutions and the public to combat counterfeit currency. Furthermore, it emphasizes the importance of educating individuals on these detection methods to minimize the circulation of fake currency and uphold the integrity of monetary systems.Currency use is a necessity for survival and hence it is always necessary to keep in track of its originality. Paper currencies are used much more in Bangladesh and hence a system to detect the fake currency is needed. As the new currencies are used in the market, the proposed system seems to be useful to detect whether the currency is genuine or not. This system compares more features for feature extraction than other proposed systems. It also shows where the differences are in the currencies instead of simply displaying the result. This system can be further implemented for foreign currencies like Dollars, Euros, Rupee, etc. as a future Scope.

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