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Deep Learning Approach for Fake Currency Recognition

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Abstract: *In this method, the Automatic fake Currency Recognition System is used to identify fake paper money and determine if it is genuine or not. The current counterfeit issue brought on by demonetization has an impact on the financial system as well as other sectors. This strategy, which is comparatively superior to earlier image processing methods, examines a novel Convolution Neural Network approach for the identification of fake money notes through their images. This approach is based on Deep Learning, which has recently shown outstanding results in image categorization problems. Through the use of an image of the fake money note, this approach can assist both humans and machines in instantly recognizing the note. In this system original and fake notes images are used to perform training and classification operation. The proposed system achieved an accuracy of 99.46% and loss of 0.0033 using CNN algorithm.*

Keywords: CNN, Deep Learning, Fake Currency Detection, Neural Network.

I. INTRODUCTION

The Reserve Bank of India deals with damaged or fake currency notes every year. The handling of a huge quantity of fake currency presents new challenges. Therefore, using robots with human specialists to identify notes simplifies and streamlines the process. Every time they utilize the ultraviolet light-based gadget to detect fake notes, they have to identify the denomination. In order to ascertain the denomination and confirm the legitimacy of the paper money note, the bank employee keeps it on the device and checks to see if the watermark, serial number, and other details are accurate. The employee now has more work to do as a result. Instead, the outcome could be more accurate if the banker uses this technique. The same is true for places where such technologies may be deployed, such as shopping malls and investing businesses. Making it simpler to recognize cash notes is a pressing necessity.

In many applications, such automatic sellers' goods machines and automatic teller goods machines, automatic fake currency identification is crucial. This technique allows us to identify genuine Indian rupee notes. The system we'll use consists of eight processes: image capture, conversion of RGB to grayscale, edge detection, feature extraction, segmentation and classification. Due to the issue of fake currency notes, automated machines are more beneficial in banks as well as any small business. hence, it is easier and more organized to use this machine for currency recognition.

Currently, one of the primary methods for exchanging goods and services is still the usage of paper money. The detection of counterfeit banknotes, however, continues to be a challenge since they increasingly resemble genuine notes, making it challenging for non-specialists to identify them. On the other hand, there exist devices for spotting fake currency [1]; nevertheless, they are frequently expensive, therefore identifying and keeping counterfeits is mostly the responsibility of financial and governmental organizations [2].

Generally speaking, a big collection of visual data is required in order to create a deep neural network. But because of the transfer learning approach, we just require a few data sets. Using a model that has previously been trained on a huge amount of data, we rebuild the tiny amount of data we have. This eliminates the need for a sizable data collection and ensures that the model is constructed properly.

The creation of a quick and simple-to-use solution for the average person was the primary driving force behind this project. This deep learning-based system can automatically distinguish between counterfeit and real Indian cash. This inexpensive system uses powerful and effective image processing algorithms to deliver precise and reliable results at a respectable throughput.

Different kinds of devices are now available that can detect counterfeit money, but they are far more expensive. Therefore, it is imperative to create a system that can instantly identify the currency's denomination and determine if it

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is real or fraudulent. Such a technology is beneficial for automatic ticket counters, automatic mobile money recharging, and automatic vending machines. The aim of this project is to implement the Convolutional Neural Network (CNN) algorithm for handwritten character recognition. With the help of this algorithm, the approach will be generalized and accurate.

II. LITERATURE SURVEY

The printing firm has the capacity to produce counterfeit paper money, but anyone with access to a computer and a laser printer at home is able to create fake banknotes. Therefore, it has become more and more crucial to effectively differentiate fake banknotes from real ones using automatic devices.

A novel method was developed by Trupti Pathrabe and Swapnili Karmore[3] to enhance the classification of Japanese and American paper cash while accelerating transaction times. Time series data and Fourier power spectra are used to compare the two different sorts of data sets. They are employed as neural network inputs in both instances. They also provide a brand-new technique for assessing identification skills.

A method to derive the denomination of paper cash is described by Mirza and Nanda[4]. The matching approach for Pattern Recognition and Neural Networks may be applied with the retrieved area of interest (ROI). They first just scan a picture at a certain size and _x dpi while setting the pixels level to get the image. To determine the denomination value of the note, a few filters are used. Various denomination notes employ different pixel levels. To compare or locate the value or denomination of a piece of currency, pattern recognition and neural networks are employed in the matching approach.

Pathrabe and Bawane's method[5] has a low computing complexity and is capable of achieving the high speed required in practical applications. It should be mentioned that the suggested method might not be able to tell fake notes from real ones. In fact, methods that employ infrared or ultraviolet spectra may be used to distinguish between real notes and fake ones.

A thorough evaluation of research on the recognition system for paper cash is recommended by Komal Vora[6]. In order to assess the state of the art, a variety of methods used by different researchers are briefly suggested. In this article, the author primarily focuses on cash detection systems, which include many phases such picture capture, feature extraction, and classification systems that employ various algorithms. The categorization outcome makes it easier to identify counterfeit money, especially when optical character recognition is used in conjunction with serial number extraction (OCR). It is discovered that the suggested strategy produces better outcomes.

Gouri Sanjay Tele et al [8] suggestion was to identify fake Indian currency. A key factor in identifying real money from counterfeit is the security features of the cash. The fundamental security features are watermarks, inactive images, security thread, and optically changeable ink. This technology for locating counterfeit cash separates the image of money from the general characteristics of latent photographs and identifying ID marks. It may be exceedingly difficult to extract attributes from photos of currency notes since it involves identifying both obvious and subtle features of Indian cash. Since the 500 and 2000 are the most valuable currency notes still in circulation after demonetization, there is a very high probability that these notes may be copied [1].

Navya Krishna G. et al.'s[9] proposal was to use CNN to identify fraudulent money notes. The Automatic Fake Currency Recognition System (AFCRS) is designed to recognize counterfeit paper money so that it can be determined whether it is genuine or not. The present fake currency problem brought on by demonetization has an influence on the banking system as well as other areas. This research examines a different approach to convolution neural networks that is considerably superior to earlier image processing techniques for identifying fraudulent note evidence through their photographs. It hinges on deep learning, which recently achieved great success in picture categorization. Through the use of an analogous picture, this process can assist both humans and machines in gradually identifying counterfeit notes. The suggested system, AFCRS, can also be presented as a smartphone app that helps the general public tell the difference between authentic and phony notes. The original phony notes can be used to increase the undertaking's accuracy.

A vision-based system for banknote recognition using various machine learning and deep learning approaches is proposed by N.A.J. Sufri, et al. [10]. They utilized the rgb values as features and the deep learning algorithms alexnet,

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DT, NB, KNN, and SVM. Both kNN and DTC were accurate to 99.7%, however SVM and BC perform better by being accurate to 100%.

III. PROPOSED METHODOLOGY

The block diagram of the proposed system is given in Fig.3.1.

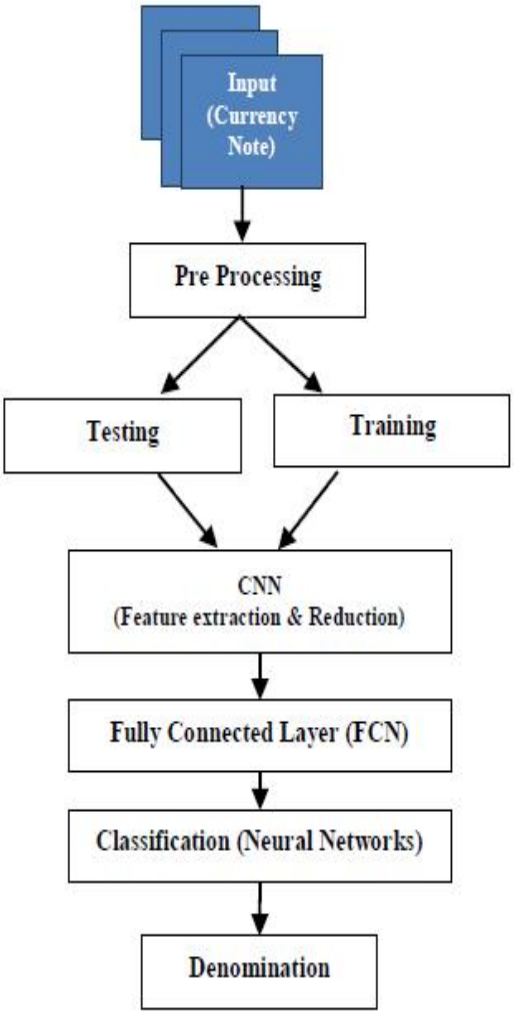

Figure 1: Block Diagram of proposed system

3.1 Dataset

Real-time creation of the fake and legitimate money databases. The evaluation takes into account the notes of 10, 20, 50, 100, 200, 500, and 2000. The images were taken using a 12-megapixel phone camera under various lighting conditions and looking in various angles. Children's bank notes are taken together with the new currency notes for appraisal and possible forgery. The samples of authentic and fake notes are depicted in Fig. 2 below.

(a) (b)

Fig. 1. Samples of (a) Real note (b) Fake note

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3.2 Preprocessing

The salt and pepper noise is there since the images were taken using a mobile device. Median filter works well to reduce salt and pepper sounds. Consequently, a median filter with a 3X3 kernel is applied to the input images.

3.3 Segmentation

Remove the backdrop from the captured image, then choose the only section with the note as a ROI. Thresholding is used during segmentation. The Otsu global thresholding method is employed in this strategy to segment the currency note.

3.4 Segmentation Classification Convolutional Neural Network (CNN)

The bank employee keeps the paper currency note on the gadget and double-checks the watermark, serial number, and other details to determine the denomination and confirm its legitimacy.

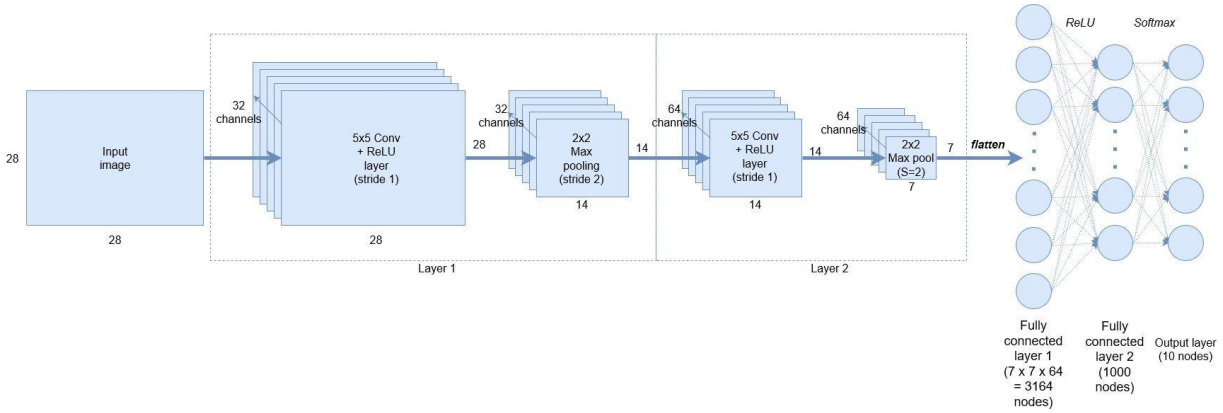

Figure 2: Architecture of CNN

It is crucial to understand the foundational concepts of CNN before starting the training process. These concepts are described here. CNNs are a particular kind of neural network that are incredibly good at categorizing and recognizing images. Large-layer feed-forward neural networks, such as CNNs, are one sort of such network.

A. Convolutional Layer (CL)

The central element of a convolutional network is the CL. The main objective of CL is to extract properties from the data it receives. In order to retain the spatial connection between pixels, convolution uses the tiny kernel of the input picture to learn information. In order to conceal the input picture, a set of teachable neurons is employed.

$$G[m,n] = (f * h)[m,n] = \sum_j \quad \sum_k \quad h[j,k] f[m-j, n-k] \ (2)$$

B. ReLU Layer

Rectified Linear Units, or ReLU, are used in non-linear processes. Pixel by pixel, all negative feature map values are changed to zero. We'll suppose that the neuron input is x and the rectifier is supplied in order to comprehend how the ReLU functions.

$$f(x) = max(0, x) \ (3)$$

C. Pooling Layer

The most pertinent data is retained while each activation map's complexity is decreased via the pooling layer. From the provided photos, a series of non-overlapping rectangles is produced. To down sample each zone, a non-linear approach is utilized, such as average or maximum. This layer, usually sandwiched between CLs, accelerates convergence and generalization while also being translation- and distortion-resistant.

D. Flatten Layer

The layer's 2D pooled feature map is transformed into a single column array, as the name suggests.

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E. Fully Connected Layer

The process is start with acquiring images. View each of the 24x24 windows closely. Give it 6000 distinct characteristics. Check the image to see if a fake currency is present. The majority of the picture is made up of the real area. Instead, pay attention to areas where a fake could be visible. As a result, we can investigate additional potential regions..

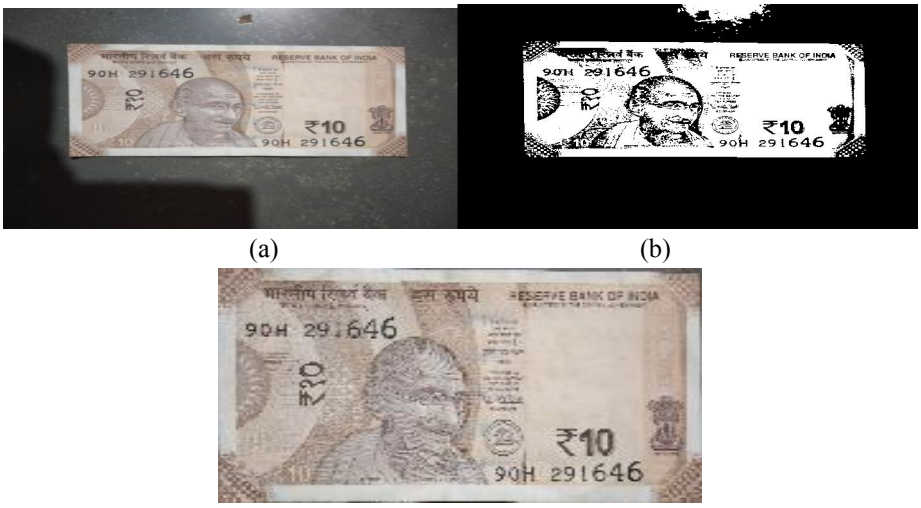
IV. RESULTS

This section discusses the proposed system's findings. The following Table I shows the database distribution for the proposed system.

Table 1: Dataset Distribution

	Training	Testing
Real	1600	400
Fake	1600	402

Segmenting the currency note is the project's first phase. Thresholding method is used throughout the segmentation process. The background information is eliminated, and the area of interest is divided up. The segmentation's findings are depicted in Fig. 5.



(a) (b)

(c)

Figure 3: Segmentation Results (a) Input Image (b) Segmented Image (c) Output Image

Using qualitative and quantitative analysis, the proposed fake cash recognition system's outcomes are assessed.

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Fig. 2. Qualitative analysis of Real currency notes

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Figure 4: Qualitative analysis of fake currency notes

Using an accuracy parameter, the quantitative analysis of the this system is computed. The phony cash identification system's accuracy is listed as

$$Accuracy = \frac{No\ of\ sample\ correctly\ detected}{Total\ no\ of\ samples} \quad (4)$$

The Performance analysis of the fake currency recognition is as shown in graphical analysis.

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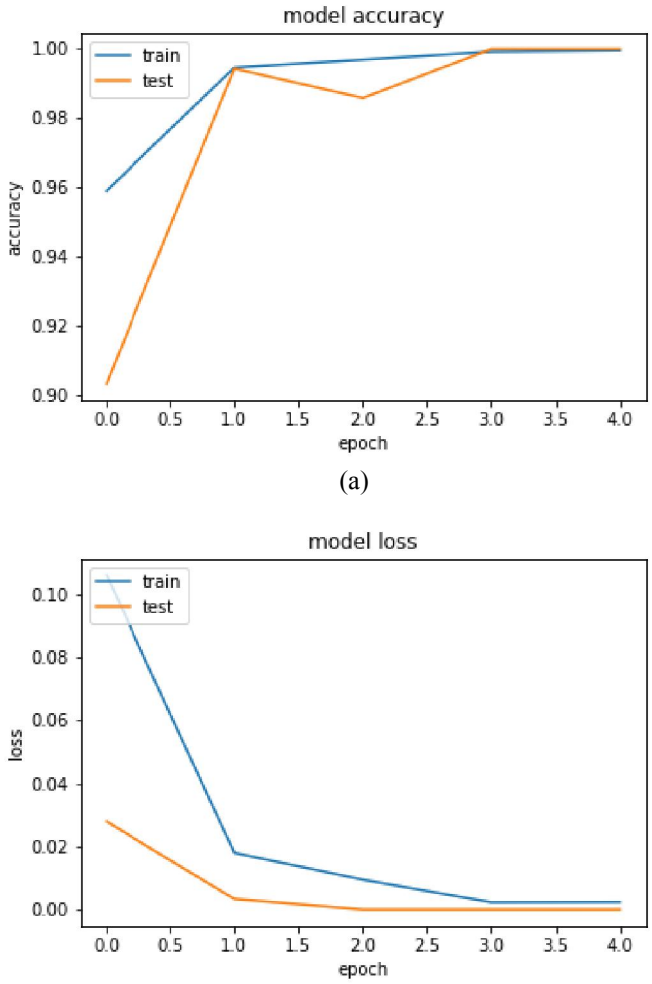

(a)

(b)

Figure 5: Quantitative analysis of proposed system (a) Accuracy (b) Loss

With a loss of 0.0557 and 0.0593, the CNN algorithm obtained training and validation accuracy of 98.50% and 98.19%, respectively.

V. CONCLUSION

In this research, the image processing technique will be used to identify fraudulent Indian rupee notes. The affordable system will be this one. The system will function with Indian currency in the denominations of 10, 20, 50, 100, 500, and 2000. Additionally, the technology offers reliable and accurate findings. It will take little time to identify a bogus note. In this system, input is provided through a camera, and output is shown on a PC. CNN algorithms are utilized in this system to train and test the phony money. The suggested system's qualitative and quantitative analyses demonstrate that the CNN algorithm outperforms a good one. The CNN algorithm has a loss of 0.0557 and 0.0593, and training and validation accuracy of 98.50% and 98.19%, respectively.

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