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Detection of Fake Indian Currency Notes using Deep Learning

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Abstract: A normal human being can easily see and distinguish any banknote, however doing the same job is extremely difficult for someone who is visually challenged or blind. Because money plays such an essential part in our everyday lives and is required for any commercial transaction, real-time detection and recognition of banknotes is a must for anyone who is blind or visually impaired. The mobilenet based CNN model-based Indian currency detection and identification system is presented for this purpose, and it is quick and accurate. To make the system more resilient, pictures of various denominations and situations were collected first, and then these images were supplemented with various geometric and image modifications. These augmented pictures are then manually tagged, and training and validation image sets are created from them. Later, the trained model's performance was assessed on a real-time scenario as well as a test dataset. The suggested mobile net model-based technique exhibits detection accuracy of 91.33% according to the test results. This standalone system operates in real-time.
Keywords: Transfer learning, Machine learning, Currency recognition, Currency detection, Image Augmentation

I. INTRODUCTION

Rapid technological advancements can assist the banking industry in modernising; this necessitates the use of automatic counterfeit money detection in automated teller machines and automatic goods merchant machines [1]. A "Cash Sorting Machine" is available to bank employees to assist them in identifying different types of currency. Sorting devices for cash are precise and efficient. The average individual, on the other hand, must keep several different features of money notes in mind to recognise counterfeit currency notes. The Reserve Bank of India, on the other hand, focuses on the features and anti-counterfeiting labelling of monetary forms. Even still, no one can be certain that manual detection of genuine cash is 100 percent accurate.

Before demonetization, the three most common denomination currency notes were Rs 100, Rs 500, and Rs 1,000; following demonetization, the three most common denominations were Rs 2000, 500, and 200, except for Rs 100 [2]. Characteristics of the various denominations are contained in [1-5], as indicated in figure 1.

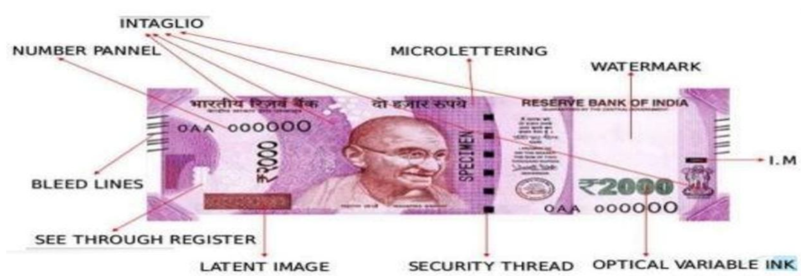

Figure 1. Specimen Copy of Rs 2000 Currency note [5]

Artificial Intelligence (AI) is being used in a variety of sectors, including game development, health care financing, and so on. Artificial intelligence-based deep neural networks [7] may be used to detect counterfeit money notes, identify their serial numbers [6], and identify and extract characteristics from them.

A dataset of 2000, 500, 200, 100, 50, and 10 Indian currency notes was created using a One Plus 6T with a 64MP rear camera. A mobile net CNN model is used to identify counterfeit money notes. The outcomes of a mobile net-based CNN-based model are examined in this study in terms of training and testing accuracy.

The outcomes of a transfer learning CNN-based model are examined in this study in terms of training and testing accuracy. The following are the main contributions of the planned work:

1) Mobile net and vgg16 models have been created to detect counterfeit money with great accuracy.
2) A web-based and mobile phone application to detect counterfeit money has been created.

II. RELATED WORK

Transfer learning has been one of the most common approaches for solving computing and prediction problems when the dataset is trained across neural networks in recent years. The speed and precision of these models differ. In [8], the framework Single Shot MultiBox Detector (SSD) was used to extract characteristics of money in order to recognise the cash in three denominations. There was no difference in the dataset after the augmentation since the backdrop of the training and tested pictures in the dataset was the same.

The folded banknotes in [9] are the subject of CNN-based study, and all of the bills are of the same denomination. [9] created a computer vision-based approach for automatic banknote recognition for the benefit of visually challenged individuals, where SURF characteristics were employed for recognition. This research is conducted using US banknotes with a distinct image of the person on the banknote, making it simpler to distinguish between those with the identical front note characteristics as those in India.

[10] presents a unique banknote image processing method based on the Free-From-Deformation (FFD) model, which can aid in the processing of low-quality banknotes and minimise the false rejection rate. [11] describes a new architecture for a banknote identification and verification system based on neural networks for categorization and verification. A method for recognising paper cash that uses a sequential deep neural network and data augmentation to increase accuracy has been presented [12].

Due to heavy computation, the suggested job was designed to address small data problems and was unable to perform real-time processing. [13] describes a support vector machine-based currency identification system for Ethiopian banknotes that accurately detected the front section of the money. On the backside of the bills, it was not trained.

Deep convolutional neural networks are used to classify Turkish lira banknotes, which are constructed and trained using the DenseNet-121 architecture[14]. [15] uses image processing methods to examine the front and back sides of Myanmar currency (kyats) in three denominations. Zernike moments were utilised for feature extraction, and classification was done with the k-nearest neighbour algorithm. [16] also uses a neural network to tackle these kind of problems for visually challenged people. Their findings imply that further major research on cognition frameworks and brain processes might lead to more significant results in these types of challenges. [17] describes a portable device enabling blind individuals to identify and recognise Euro currencies. The modified Viola-Jones algorithms [18] and the Speed Up Robust Features (SURF) [19] algorithms are used to detect banknotes.

[1], [3] demonstrated how to extract features such as identification marks, numeral watermarks, floral designs, micro-lettering, and security thread from images using the sober operator, which worked well with less computation time, and they also demonstrated how to extract hidden features from the latent image. To categorise and validate Indian currencies, Sahana, Murthy, and colleagues used image processing methods for extracting different features from different denominations of Indian currency (10, 20, 50, 100, 500, 2000) depending on size, conspicuous colour, identifying markings, and so on. [2]

III.METHODOLOGY

Figure 3 shows how the suggested three-layered CNN model works flawlessly to detect counterfeit Indian money denominations (10, 50, 100, 200, 500, and 2000). Method edge detection, picture segmentation, filtering, and other features are included in the suggested system. Currency features are fed into the model to make the system more trustworthy. The model is given Indian currency notes as an input data set in Deep Convnet. As illustrated in Figure 4, the model is programmed using Deep CNN methods and includes a user-friendly Web interface for uploading the image. Original or phoney money notes are displayed in the results. The flow of the proposed CNN model is depicted in Figure 2, and the key phases are as follows:

A. Take a picture with your camera or upload a picture from your hard drive; the image format might be JPEG or PNG.
B. Data pre-processing, picture smoothing, and noise removal
C. Pattern matching, segmentation, and edge detection.
D. Print the outcome (Fake or Original)

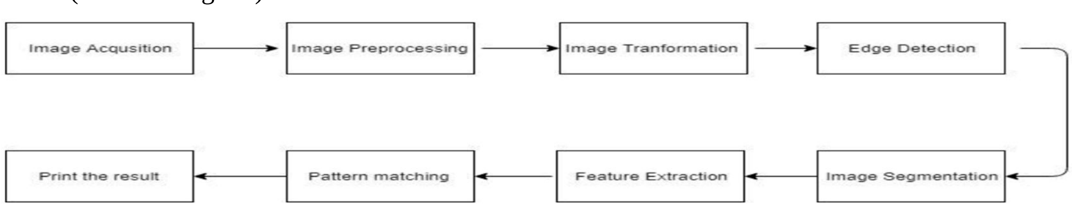

Figure 2. The proposed transfer learning CNN model flow diagram

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The Convolution Neural Network (CNN) improves picture resolution and aids in the resolution improvement of an older text [20]. We used Deep CNN with three Convolution layers to train the suggested model to recognise counterfeit Indian rupee notes, as illustrated in figure 3. To categorise the note, we utilise two fully linked layers to determine the likelihood that it is a fake or original.

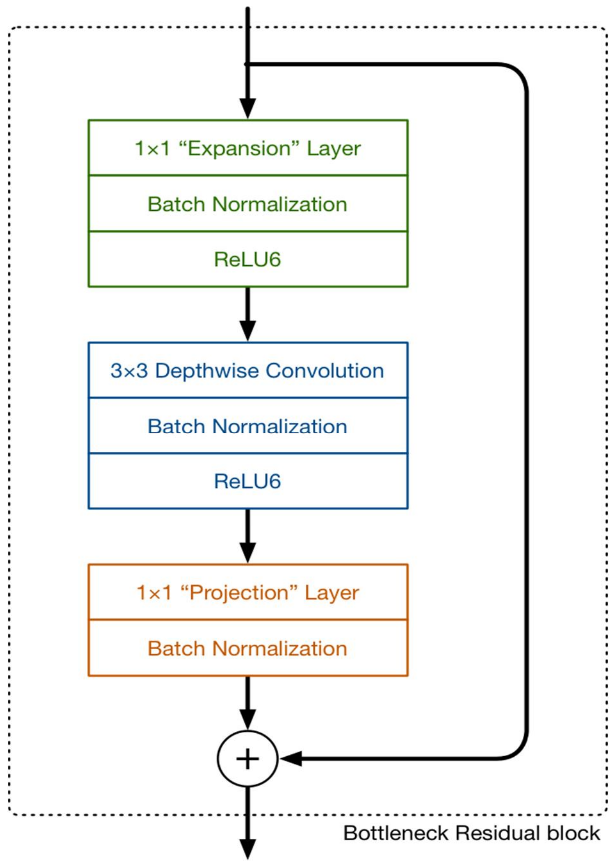

Figure 3: Architecture of the CNN transfer learning model

IV. EXPERIMENTS AND ANALYSIS

The results of the model are shown in the table below; the model's success rate in recognising authentic or fraudulent Indian rupee notes is 91 percent. The suggested model failed to detect authentic cash notes with more stains in one out of ten situations. We can improve the success rate by increasing the data set size and capturing more pictures.

The hyper parameters of the CNN model trained are as follows – Epochs 100, Batch size 16, Learning rate .0001. Figure 4 shows the accuracy and loss of the proposed CNN model

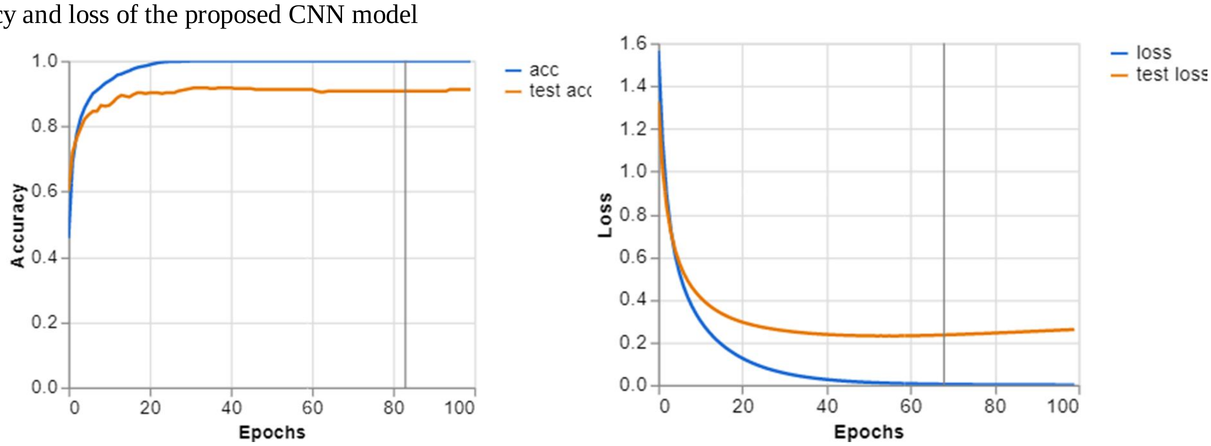

Figure 4: Accuracy and loss of the proposed CNN model

Table I
Performance Analysis Of The Experimental System

Denomination of the banknote	Results		
	No. of test images	Correctly detected images	Accuracy (%)
2000	100	98	98
500	100	89	89
200	100	94	94
100	100	87	87
50	100	95	95
10	100	85	85
Average Detection Accuracy			91.33

V. CONCLUSION AND FUTURE WORK

In this study, a standalone and real-time banknote or money detection and recognition system based on the mobilenet transfer learning model is suggested. As a separate class, the model is trained with various pictures of different denominations of bills of different values. The Banknotes Dataset is created under a variety of circumstances, including crowded backgrounds, rotation, occlusion, illumination intensity, scale, and so on. To avoid overfitting, data augmentation is used, resulting in a rise in the number of pictures with a broad diversity, which helps to make the detection and identification system more robust and accurate. Annotation is done for all pictures that are included in the dataset once they have been properly augmented. Following that, the dataset is divided into two parts: training and validation. The model is then taught with the help of pictures and associated resistive annotation files using transfer learning. The entire system is self-contained and does not require access to the internet to function.

After training has reached the point where the learning rate saturates, the learned model files are utilised in a real-time banknote detection and recognition system with a live video stream. Any visually impaired or blind person may recognise banknotes with the aid of this method, which will benefit them in their daily life. On the dataset, the suggested method achieved an average detection rate of 91.33 percent, and it is robust enough to recognise banknotes even in instances of partial occlusions and wrinkled or ripped money notes. Future work on this system will concentrate on improving the suggested method and expanding the training dataset by include additional banknotes from other nations. Additionally, work will be done to build an interactive interface with a variety of features such as automated counting of banknotes, money summation, and a UV beam that will aid in the detection of counterfeit notes.

VI. ACKNOWLEDGEMENT

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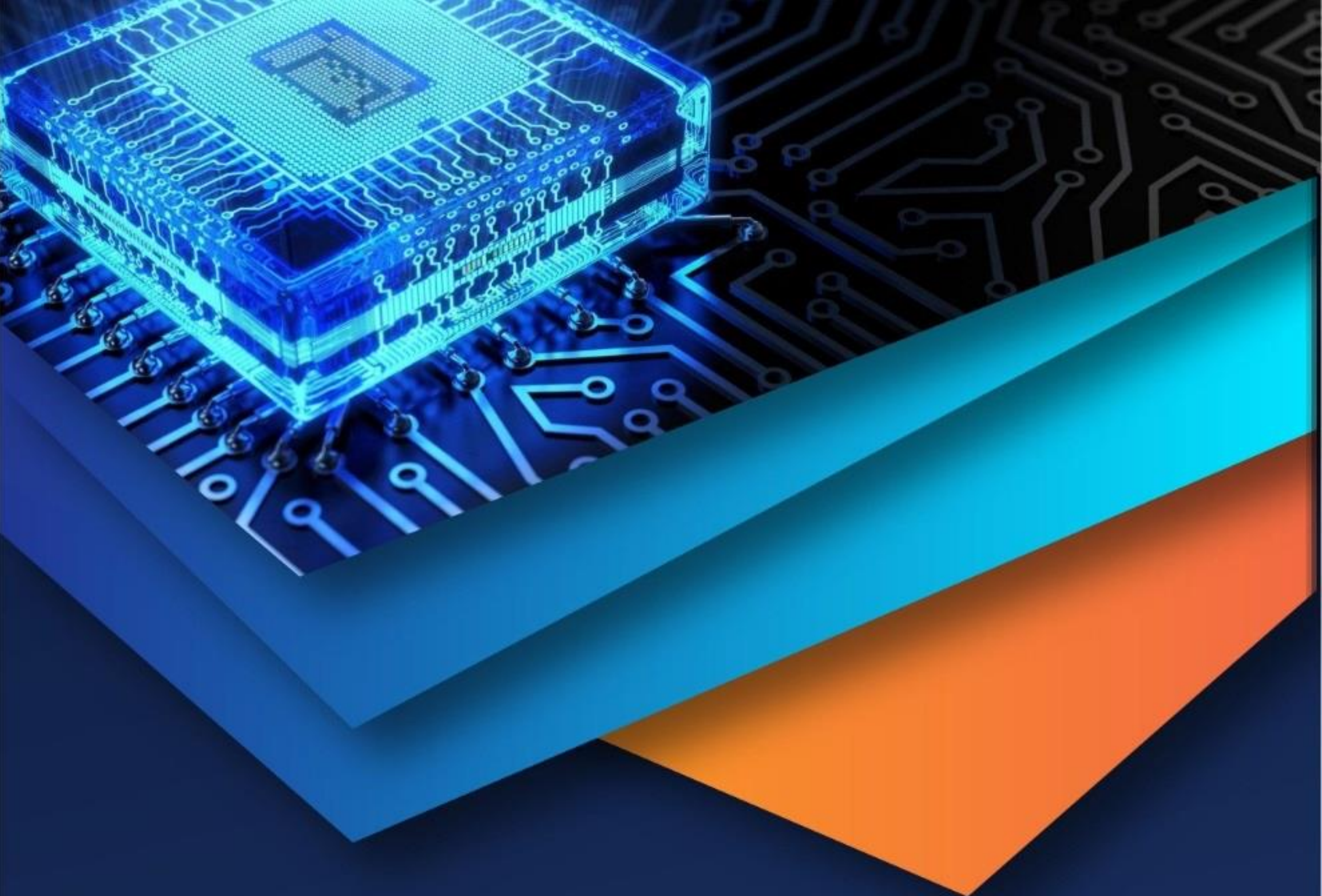

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