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Fake Currency Note Detection using Image Processing and Convolution Neural Network

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Abstract: ***Counterfeiting money stands for the illegal replication of original currency; hence counterfeit currency is a fake currency that has not been authorized by the government. Every year the Reserve Bank of India (RBI) faces the problem of counterfeit currency notes once filtered and circulated in the market. Commercial areas like the banks, malls, jeweler stores etc., have machine that use Ultraviolet (UV) light and other techniques to detect the authenticity of the currency. But for common people it is very difficult to detect whether the currency is fake or genuine and they may face losses especially during bank deposits and transaction. This paper proposes a system which is designed such that any person can use it easily and detect the authenticity of the currency by scanning the image of the currency note in the mobile phone. The system is developed using image processing technologies and Convolution Neural Network(CNN) classifier.***
Keywords: Counterfeit currency, Denominations, Image processing, Edge detection, Convolution neural network

I. INTRODUCTION

The overnight demonetization of Rs.1,000 and Rs.500 notes by the Indian Government introduced new notes for Rs.2,000 and Rs. 500. These new notes were claimed to have additional security features to prevent counterfeiting, however it failed to keep a check on the menace of counterfeit currency circulation in the country. With the advancement and sophistication in technology, forgers operating in fake currency, can easily overcome the security barriers. The approach presented in this paper is based upon physical appearance of the Indian currency. Image processing algorithms have been adopted to extract the features such as security thread, intaglio printing (RBI logo) and identification mark, which have been adopted as security features of Indian currency. Hence, we propose a more user friendly and portable solution to this problem in form of a mobile app coupled with cloud storage.

II. LITERATURE SURVEY

In [1], the authors suggested processing images using a CNN-based model. The model received an input image that was scaled down to 80 × 80 pixels. For training the unique CNN model, a self-constructed dataset of 40,000 photos (20,000 images each of Rs. 500 and Rs. 2,000 and 10,000 each of false and actual types) was employed. Convolution was the first component of the architecture, followed by fully connected layers. Based on retrieved elements like Mahatma Gandhi's watermark, angular bleed lines, etc., the photos were divided into false and true categories. 85.6% testing accuracy was attained.

The authors of [2] recommended using a transfer learning model. As a model for the prediction of counterfeit, VGG16 was suggested. Data was prepared by maintaining a real-time and Deep convolutional neural networks' local features were modelled in [11] to enhance fine-grained picture classification. The GoogLeNet base model, which had the best performance [12], was employed. However, the DCNN was not employed as a classifier, simply as a feature extractor. Then, a multi-class linear SVM was learned using the features. Similar to [13], a linear SVM carried out the final classification after DCNNs had been trained to extract features. The classification of the general pre-trained features in [14] was done using a very randomised forest.

III. PROPOSED SYSTEM

In the proposed system, the image of currency notes captured by the digital camera. The working of our proposed system is as follows: Firstly, we capture the image of the currency note by digital camera or scanner under the ultraviolet light. Then the RGB image is converted into the grayscale image. Then the whole grayscale image is passed through the process called Edge detection. Edge detection is a process in which identification of points in a digital image with discontinuities, simply to say, sharp changes in the image brightness. This image is further processed, and edges of gray scale images are detected. Image segmentation is the process of dividing an image into multiple parts by cropping it. Then the currency note features are cropped and segmented and these features are extracted. The intensity of each extracted feature is calculated and if the intensity is greater than the average value the currency note is said to be real otherwise it is said to be fake.

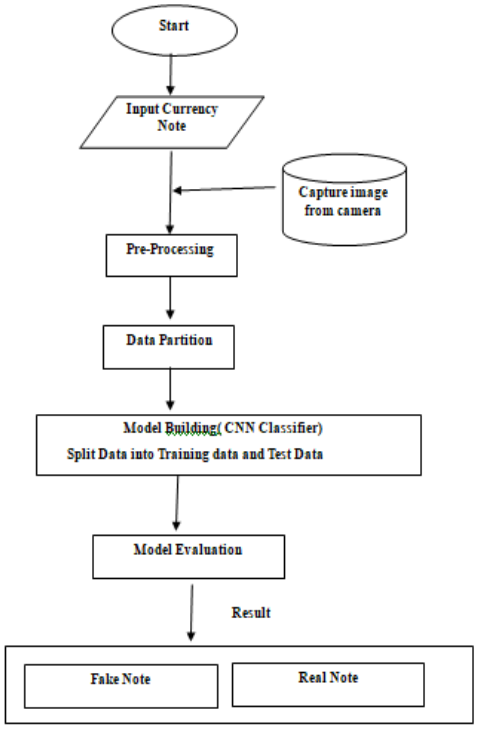

Fig.1 Proposed Methodology

A. Data Collection

The database of fake and real currency is created in real time. The currency notes of 200, 500 and 2000 are considered for the evaluation. The images are captured using phone camera of resolution 12 MP in different light condition and in different directions. The new currency notes of fake and real are taken for evaluation. Some features about how to detect a fake Indian currency note are given below:

1) Identification mark: A symbol with intaglio prints which can be felt by touch, helps the visually impaired to identify the denomination. In 2000 denominations the identification mark is a circle.
2) Security thread: It is visible as a continuous line from behind when held up against light.
3) Latent image: It is a vertical band on front side of denomination at right hand side.
4) Watermark: The portrait of Mahatma Gandhi, the multidirectional lines and on electrolyte mark showing the denominational numeral appear in this section.
5) Number Panel is a special, unique and distinct font is used. The spaces between the numbers are evenly distributed.
6) Micro lettering feature appears between the vertical band and Mahatma Gandhi portrait. It always contains the word „RBI‟ in Rs.5 and Rs.10. The notes of Rs.20 and above also contain the denominational value of the notes in micro letter.

Fig.2 Indian currency Rupees 2000

B. Pre-Processing

The main goal of the pre-processing to enhance the visual appearance of images and improve the manipulation of datasets. Pre-processing of image are those operations that are normally required prior to the main data analysis and extraction of information. Image pre-processing can significantly increase the reliability of an optical inspection. Several filter operations which intensify or reduce certain image details enable an easier or faster evaluation.

C. Training Using CNN

CNN's are a category of Neural Networks that have proven very effective in areas such as image recognition and classification. CNN's are a type of feed-forward neural network made up of many layers. CNN's consist of filters or kernels or neurons that have learnable weights or parameters and biases. They are capable of learning filters that extract useful information from pixel values embedded in the image thus providing accurate classification results. Typically, a CNN consists of different types of layers namely, convolution, pooling, flatten and fully connected. A convolution layer, as the name suggests, performs convolution operation of the filters on different parts of the image thus extracting notable features. This is usually followed by a pooling layer which facilitates dimensionality reduction. Several such sets of convolution and pooling layers are followed by flattening and fully connected layers which use the derived feature vectors for the purpose of classification. This paper proposes two novel CNN architectures for classifying currency notes of Rs. 500 and Rs. 2000 each. The architecture of a ConvNet is analogous to that of the connectivity pattern of Neurons in the Human Brain and was inspired by the organization of the Visual Cortex. Individual neurons respond to stimuli only in a restricted region of the visual field known as the Receptive Field. A collection of such fields overlap to cover the entire visual area.Fig.3 Pixel Conversion

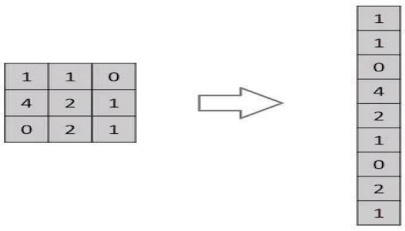

Fig.3 Pixel Conversion

A ConvNet is able to successfully capture the Spatial and Temporal dependencies in an image through the application of relevant filters. The architecture performs a better fitting to the image dataset due to the reduction in the number of parameters involved and the reusability of weights. In other words, the network can be trained to understand the sophistication of the image better.

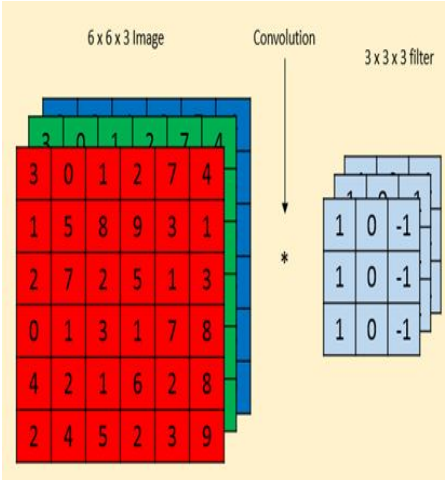

Fig.4 Convolution Layer

The role of ConvNet is to reduce the images into a form that is easier to process, without losing features that are critical for getting a good prediction. This is important when we are to design an architecture that is not only good at learning features but also scalable to massive datasets.

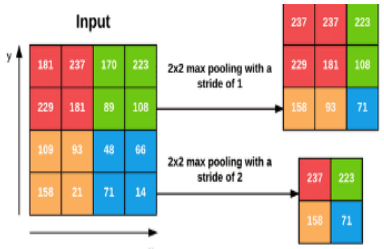

Fig.5 Pooling Layer

Layer (type)	Output Shape	Param #
input_1 (InputLayer)	[(None, 224, 224, 3)]	0
block1_conv1 (Conv2D)	(None, 224, 224, 64)	1792
block1_conv2 (Conv2D)	(None, 224, 224, 64)	36928
block1_pool (MaxPooling2D)	(None, 112, 112, 64)	0
block2_conv1 (Conv2D)	(None, 112, 112, 128)	73856
block2_conv2 (Conv2D)	(None, 112, 112, 128)	147584
block2_pool (MaxPooling2D)	(None, 56, 56, 128)	0
block3_conv1 (Conv2D)	(None, 56, 56, 256)	295168
block3_conv2 (Conv2D)	(None, 56, 56, 256)	590080
block3_conv3 (Conv2D)	(None, 56, 56, 256)	590080
block3_pool (MaxPooling2D)	(None, 28, 28, 256)	0
block4_conv1 (Conv2D)	(None, 28, 28, 512)	1180160
block4_conv2 (Conv2D)	(None, 28, 28, 512)	2359808
block4_conv3 (Conv2D)	(None, 28, 28, 512)	2359808

Fig.6 Process of Convolution Neural Network

D. Classification

Figures 7, 8 are screenshots from the android application showing the output of classification of a real and fake note respectively.

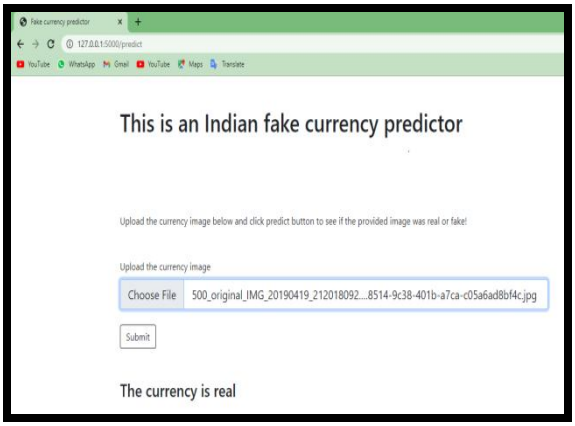

Fig.7 Prediction of real currency

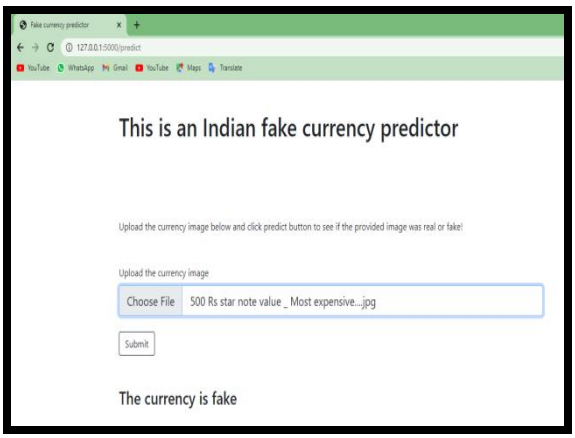

Fig.8 Prediction of fake currency

IV. RESULT AND DISCUSSION

In this paper, we have demonstrated how digital image processing and CNN techniques can be used for identifying counterfeit currency. The performance of the proposed method is evaluated based on the Average Sensitivity, Specificity, and Accuracy rate. The evaluation has been done for various types of real and counterfeit currencies. For the evaluation of our deep learning model, Figures 6 is the process of convolution neural network.. A testing accuracy of 99% is obtained on this CNN model.

V. CONCLUSION

In this paper, a system has been developed using CNN classifier to successfully identify counterfeit currency. The task at hand is to create a model which can efficiently identify a counterfeit note with good accuracy. This was achieved in this paper using a custom-built CNN model for classification of Rs.10, Rs.20, Rs.50, Rs.100, Rs.200, Rs. 500 and Rs.2000 Indian currency notes. Furthermore, we developed a complete system in the form of an android application to support our CNN model which can be readily used by the common people.

VI. ACKNOWLEDGMENT

Dr. S. Sahaya Tamil Selvi is an Associate Professor and Head in department of Computer Science, St. Joseph's College for Women, Tirupur with over 22 years of experience. With area of interest in Artificial Intelligence and Digital Image Processing, she has published 8 research articles in various reputed national and international journals and has presented 10 research papers in national and international Conferences and Seminars. She has published a book named "A Comprehensive Handbook of C++, Java and Python". She is an Editorial Board Member for various national /international journals.

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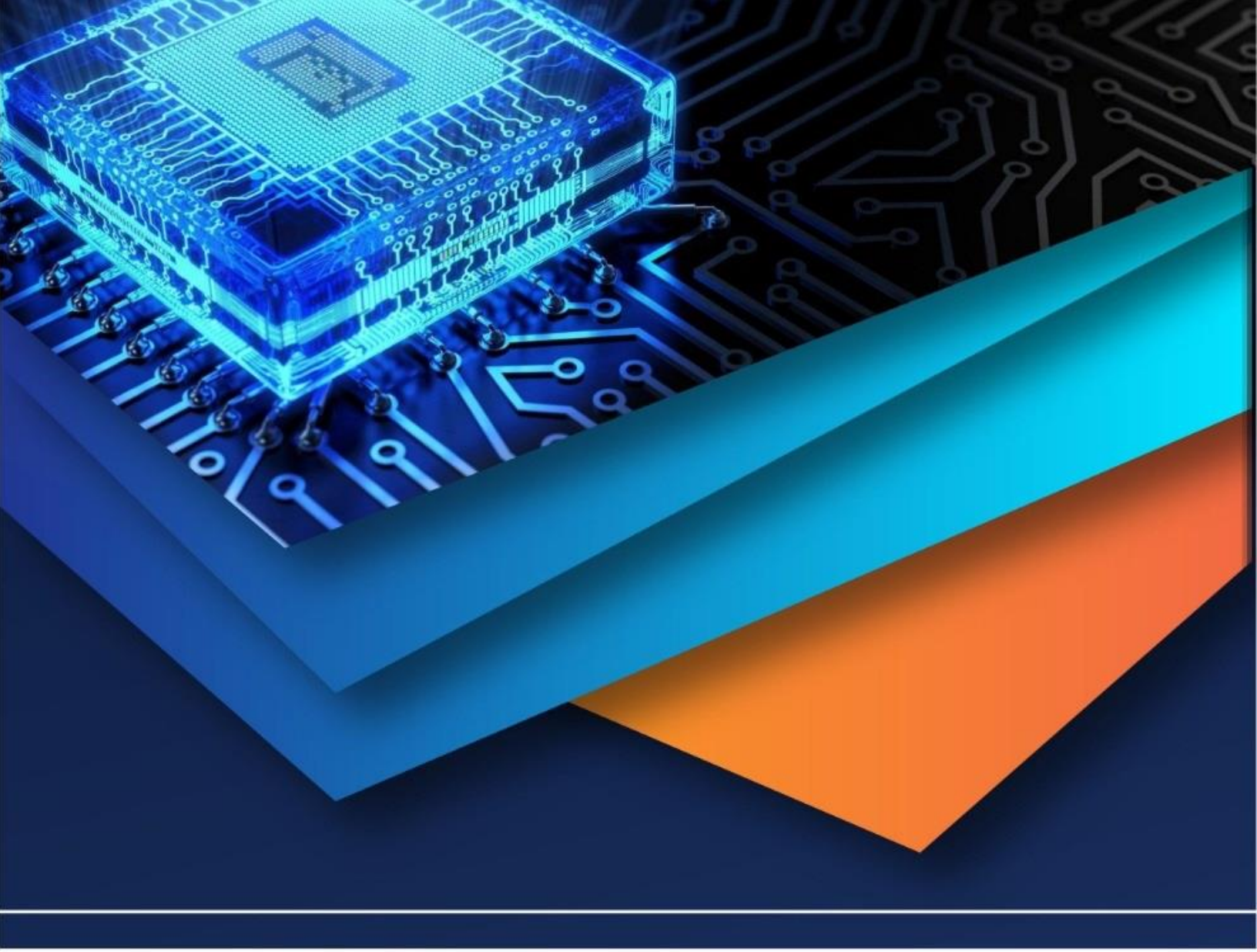

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