INDIAN CURRENCY CLASSIFICATION AND FAKE NOTE IDENTIFICATION USING DEEP LEARNING

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ABSTRACT

Currency is an unavoidable part of our day-today life. Despite the rapidly expanding utilization of master cards and additional electronic payment categories, money is considerably utilized for everyday exchanges because of its comfort. The current day monetary self-service gives birth to currency recognition, which plays a vital role in the automated banking procedure. Therefore, we propose a novel method for currency recognition that identifies Indian currency in different views on the scale. It is straightforward for a typical human being to comprehend and recognize any banknote easily, but it is undoubtedly troublesome for anyone with a visually impaired or blind individual to accomplish a similar task. Banknotes commonly have unique designs according to the denomination and can be sorted with surplus human errors in the bank. These errors lead to difficulties in evaluating and recognition. If computers or mobile apps recognize currency, it will immensely boost the precision of recognition and ameliorate people's workload efficiently. As money has a significant role in daily life for any business transactions, real-time detection and recognition of banknotes become necessary for a person, especially blind or visually impaired, or for a system that sorts the data.

This work presents an Indian Currency Prediction Analysis, proposes an optimized model to recognize the currencies effectively. The Deep Learning approach of convolutional neural network model technique has improved the effective analysis of currency recognition with improved accuracy, high speed and efficiency along with complete automatic readily procedure with no human intervention and minimal complexity. The model which we worked on essentially classifies the currency note into distinct denominations like Rs10, Rs50, Rs100, Rs500, Rs2000. The currency will be recognized and classified by using image processing techniques, deep learning techniques.

Keywords: Fake currency, deep learning, currency recognition.

1. INTRODUCTION

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. 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. The technology of currency recognition basically aims for identifying and extracting visible and invisible features of currency notes. Until now, many techniques have been proposed to identify the currency note. But the best way is to use the visible features of the note. For example, color and size. But this way is not helpful if the note is dirty or torn. If a note is dirty, its color characteristic is changed widely. So, it is important that how we extract the features of the image of the currency note and apply proper algorithm to improve accuracy to recognize the note. We apply here a simple algorithm which works properly.

The Reserve Bank is only one which has the sole authority to issue bank notes in India. Reserve Bank, like other central banks the world over, changes the design of bank notes from time to time.

Traditionally, anti-counterfeiting measures involved including fine detail with raised intaglio printing on bills which allows non-experts to easily spot forgeries. On coins, milled or marked with parallel grooves edges are used to show that none of the valuable metal has been scraped off. Reserve bank uses several techniques to detect fake currency. Manual testing of all notes in transactions is very time consuming and untidy process and there is a chance of tearing while handing notes. Therefore, Automatic methods for bank note recognition are required in many applications such as automatic selling-goods and vending machines. Extracting sufficient monetary characteristics from the currency image is essential for accuracy and robustness of the automated system. This is a challenging issue to system designers. Every year RBI (Reserve bank of India) face the counterfeit currency notes or destroyed notes. Handling of large volume of counterfeit notes imposes additional problems. Therefore, involving machines (independently or as assistance to the human experts) makes notes recognition process simpler and efficient. Counterfeit money is imitation currency produced without the legal sanction of the state or government. Producing or using counterfeit money is a form of fraud or forgery. Counterfeiting is almost as old as money itself. Plated copies have been found of Lydian coins which are thought to be among the first western coins. Before the introduction of paper money, the most prevalent method of counterfeiting involved mixing base metals with pure gold or silver. A form of counterfeiting is the production of documents by legitimate printers in response to fraudulent instructions. Counterfeit money is imitation currency produced without the legal sanction of the state or government. Producing or using this fake money is a form of fraud or forgery. Counterfeiting is as old as money itself and is sufficiently prevalent throughout history that it has been called "the world's second oldest profession. This has led to the increase of corruption in our country hindering country's growth. Common man became a scapegoat for the fake currency circulation, let us suppose that a common man went to a bank to deposit money in bank but only to see that some of the notes are fake, in this case he must take the blame. Counterfeiting, of whatever kind, may be that has been occurring ever since humans grasped the concept of valuable items, and there has been an ongoing race between certifier like (banks, for example) and counterfeiter ever since. Some of the effects that counterfeit money has on society include a reduction in the value of real money; and inflation due to more money getting circulated in the society or economy which in turn dampen our economy and growth - an unauthorized artificial increase in the money supply; a decrease in the acceptability of paper money; and losses.

2. LITERATURE SURVEY

Bhatia et al. proposed a method for fake currency recognition using K-Nearest Neighbours followed by image processing. KNN has a high accuracy for small data sets making it desirable to be used for the computer vision task. In this, the banknote authentication dataset has been created with the high computational and mathematical strategies, which give the correct data and information regarding the entities and features related to the currency. Data processing and data Extraction is performed by implementing machine learning algorithms and image processing to acquire the result and accuracy.

Laavanya et al. proposed the detection of counterfeit currency using a deep convolution neural network. This framework identified the fake currency by examining the currency images. The transfer learned convolutional neural network is trained with two thousand, five hundred, two hundred and fifty Indian currency note data sets to learn the feature map of the currencies. Once the feature map is learnt the network is ready for identifying the fake currency in real time. The proposed approach efficiently identified the forgery currencies of 2000, 500, 200, and 50 with less time consumption.

Upadhyaya et al. presented various fake currency detection techniques proposed by various researchers. The review highlighted the methodology implemented on characteristics feature with

success rate of each method to detect counterfeited currency. Moreover, the study included the analysis of widely acceptable statistical classification technique for currency authentication. The comparative analysis of Logistic Regression and Linear Discriminant Analysis (LDA) was performed to realize the better model for currency authentication. It has been found that classification Model using Logistic regression shows better accuracy of 99% then LDA. The study will benefit the reader in identifying most feasible technique to be implemented based on the accuracy rate.

Yadav et al. identified the authenticity of the currency notes by using various machine learning algorithms and to compare which of these algorithms is best suited for the same. The machine learning algorithms classify the currency notes since features extracted from images. The dataset was taken from UCI Machine Learning Repository.

Zhang et al. used Single Shot MultiBox Detector (SSD) model based on deep learning as the framework, employ Convolutional Neural Network (CNN) model to extract the features of paper currency, so that this work can more accurately recognize the denomination of the currency, both front and back. The main contribution is through using CNN and SSD, the average accuracy of currency recognition is up to 96.6%.

Jadhav et al. studied bank note of various countries by extracting its features in depth and analysis it uses deep learning. This system recommended a deep learning-based algorithm to detect Forged bank note through general scanners that can be used by persons to prevent personal monetary damages caused by fake bank note.

Potluri et al. used the Convolution Neural Networks for detecting Fake Currency note. This proposed Mobilenetv2-FCD is trained to detect the Indian Fake currency Notes. The proposed network detects fake notes with 85% accuracy. The network can be trained for any nation's currency and can be used accordingly.

Yadav et al. applied the six supervised machine learning algorithms on dataset available on UCI machine learning repository for detection of Bank currency authentication. To implement this this framework have applied Support Vector machine, Random Forest, Logistic Regression, Naïve Bayes, Decision Tree, K- Nearest Neighbor by considering three train test ratio 80:20, 70:30 and 60:40 and measured their performance on the basis various quantitative analysis parameter like Precision, Accuracy, Recall, MCC, F1-Score and others. And some of SML algorithm are giving 100 % accuracy for train test ratio.

Bhavsar et al. used the deep learning technique, detection model trained with dataset and tested it with different Indian currency with good accuracy.

Babu et al. proposed a system for currency recognition system and the detection of fake Indian currency banknotes using image processing techniques. It is hard for people to perceive monetary forms from various nations. The point is to help individuals with taking care of this issue. In any case, money acknowledgement frameworks that are considering picture investigation are entirely not adequate. This framework depends on picture handling and makes the procedure programmed and vigorous. The aim to assist those folks that are not ready to recognize which country's currency note was. This framework use banknotes which are currency, may differ the size, texture, color.

3. PROPOSED SYSTEM

In this project we are designing custom CNN algorithm to classify Indian currency. The Deep Learning approach of convolutional neural network model technique has improved the effective analysis of currency recognition with improved accuracy, high speed and efficiency along with

complete automatic readily procedure with no human intervention and minimal complexity. The model which we worked on essentially classifies the currency note into distinct denominations like Rs10, Rs50, Rs100, Rs500, Rs2000. The currency will be recognized and classified by using image processing techniques, deep learning techniques.

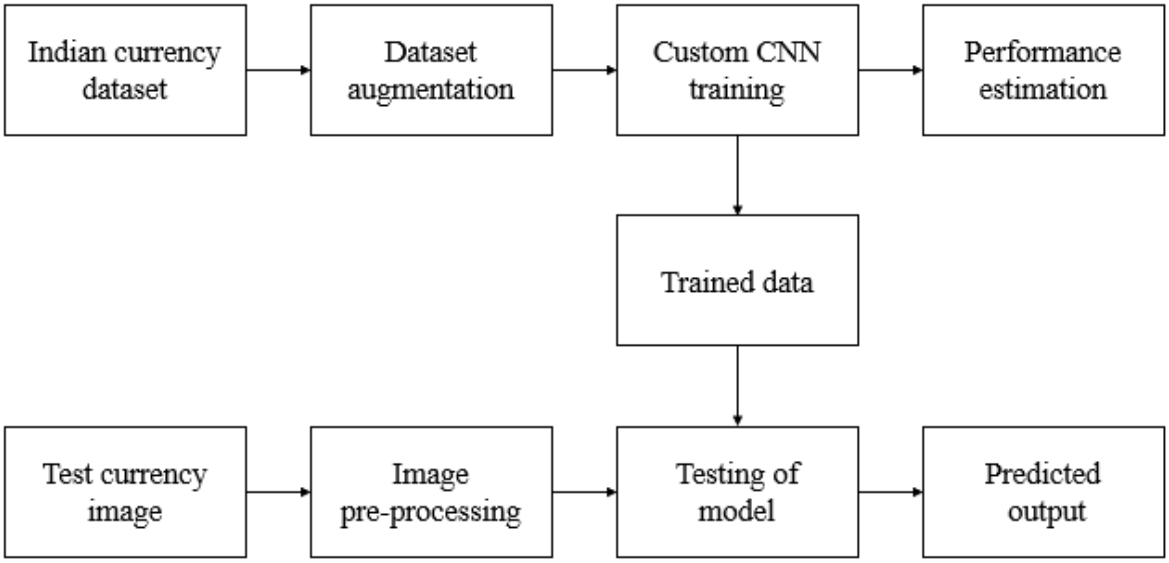


Fig. 1: Block diagram of proposed system.

3.1 Pre-processing

Data pre-processing is a process of preparing the raw data and making it suitable for a machine learning model. It is the first and crucial step while creating a machine learning model.

When creating a project, it is not always a case that we come across the clean and formatted data. And while doing any operation with data, it is mandatory to clean it and put in a formatted way. So, for this, we use data pre-processing task.

Why do we need Data Pre-processing?

A real-world data generally contains noises, missing values, and maybe in an unusable format which cannot be directly used for machine learning models. Data pre-processing is required tasks for cleaning the data and making it suitable for a machine learning model which also increases the accuracy and efficiency of a machine learning model.

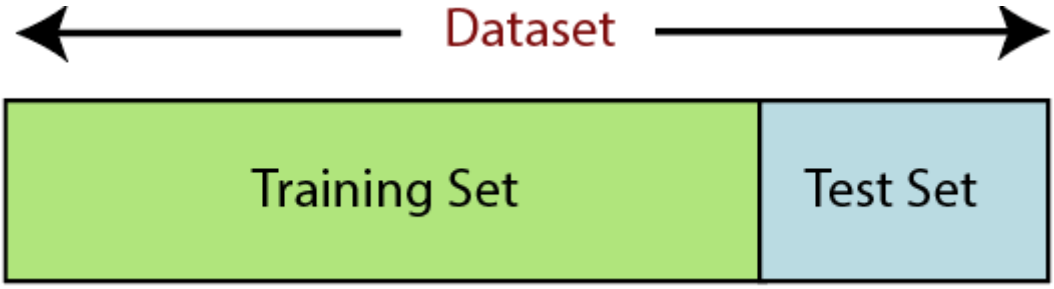
- Getting the dataset
- Importing libraries
- Importing datasets
- Finding Missing Data
- Encoding Categorical Data
- Splitting dataset into training and test set
- Feature scaling

3.1.1 Splitting the Dataset into the Training set and Test set

In machine learning data pre-processing, we divide our dataset into a training set and test set. This is one of the crucial steps of data pre-processing as by doing this, we can enhance the performance of our machine learning model.

Supposeif we have given training to our machine learning model by a dataset and we test it by a completely different dataset. Then, it will create difficulties for our model to understand the correlations between the models.

If we train our model very well and its training accuracy is also very high, but we provide a new dataset to it, then it will decrease the performance. So we always try to make a machine learning model which performs well with the training set and also with the test dataset. Here, we can define these datasets as:



Training Set: A subset of dataset to train the machine learning model, and we already know the output.

Test set: A subset of dataset to test the machine learning model, and by using the test set, model predicts the output.

3.2 Custom CNN

According to the facts, training and testing of any deep neural network or transfer learning involves in allowing every source data via a succession of convolution layers by, rectified linear unit (ReLU), max pooling, fully connected layer and utilize SoftMax layer with classification layer to categorize the objects with probabilistic values ranging from $[0,1]$. Convolution layer as is the primary layer to extract the features from a source image and maintains the relationship between pixels by learning the features of image by employing tiny blocks of source data. It's a mathematical function which considers two inputs like source image $I(x, y, d)$ where x and y denotes the spatial coordinates i.e., number of rows and columns. d is denoted as dimension of an image (here $d = 3$, since the source image is RGB) and a filter or kernel with similar size of input image and can be denoted as $F(k_x, k_y, d)$.

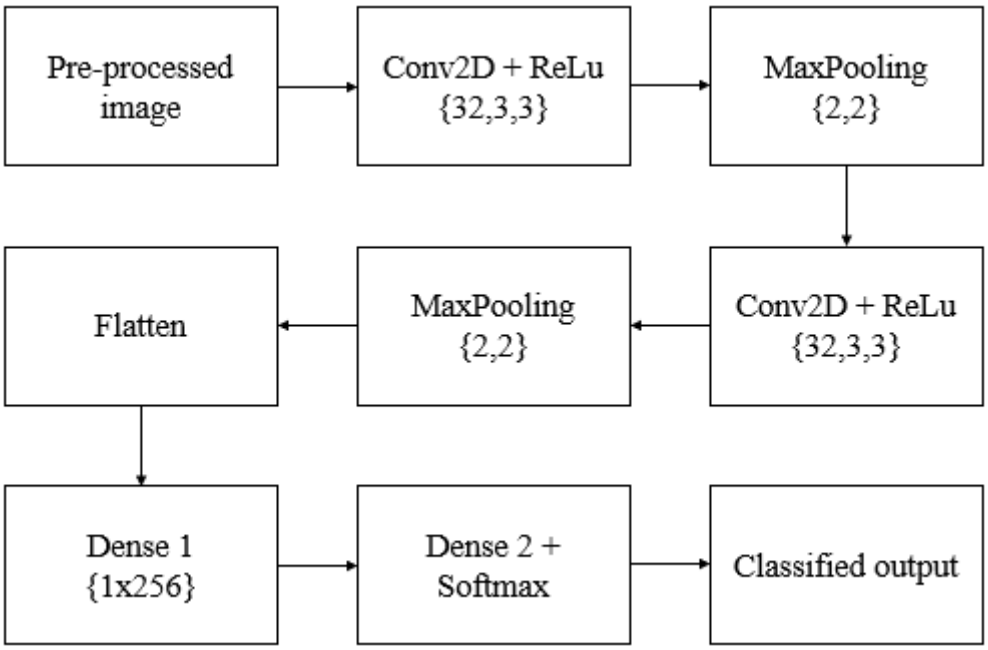


Fig. 2: CNN architecture.

The output obtained from convolution process of input image and filter has a size of $C\left((x-k_x+1),\left(y-k_y+1\right),1\right)$, which is referred as feature map. Let us assume an input image with a size of 5×5 and the filter having the size of 3×3. The feature map of input image is obtained by multiplying the input image values with the filter values.

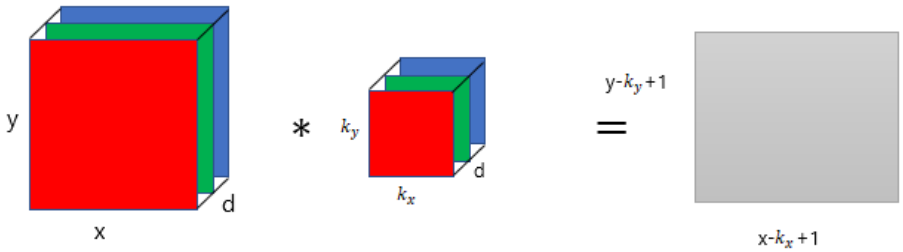


Fig. 3: Representation of convolution layer process.

1	1	1	0	0
0	0	1	1	1
1	1	0	0	1
0	0	0	1	1
1	1	1	0	0

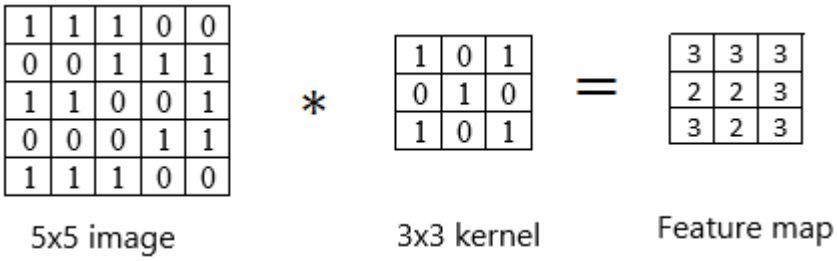
5x5 image

*

1	0	1
0	1	0
1	0	1

3x3 kernel

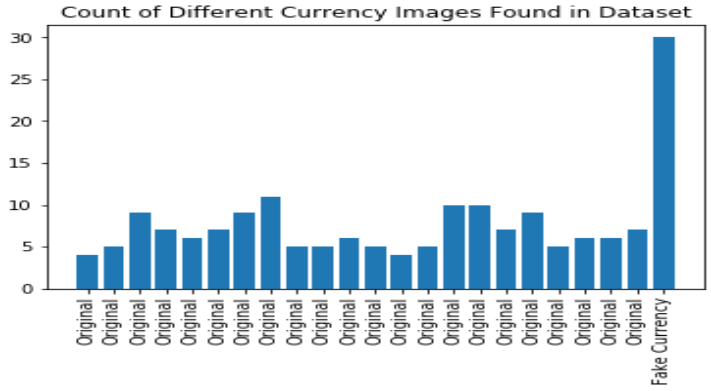
(a)

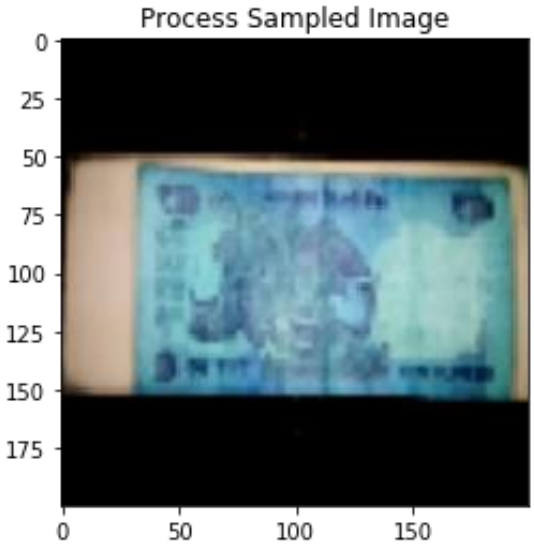


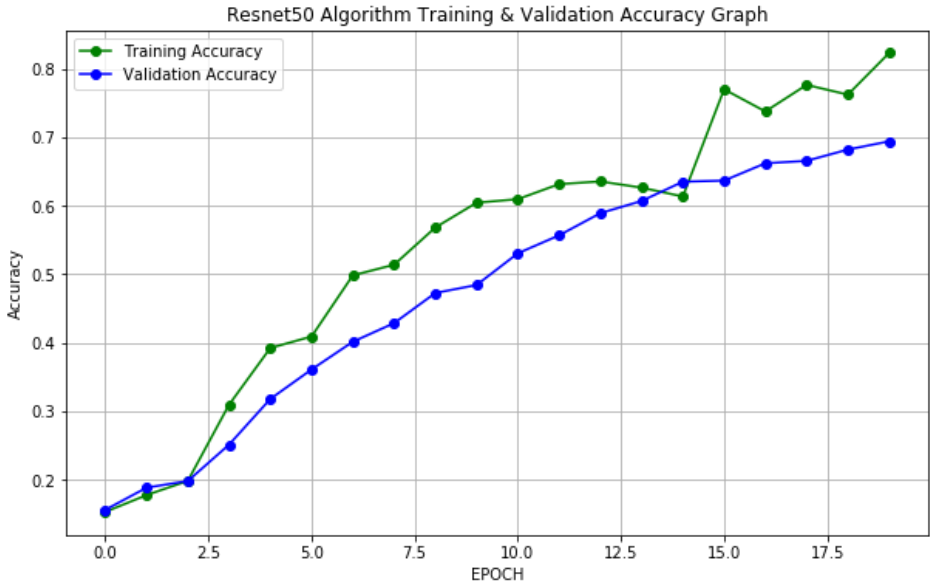
(b)

Fig. 4: Example of convolution layer process (a) an image with size $\mathbf{5 \times 5}$ is convolving with $\mathbf{3 \times 3}$ kernel (b) Convolved feature map.

4. RESULTS AND DISCUSSION






Resnet50 Algorithm Training & Validation Accuracy Graph
Training Accuracy
Validation Accuracy
Accuracy
EPOCH
0.2
0.3
0.4
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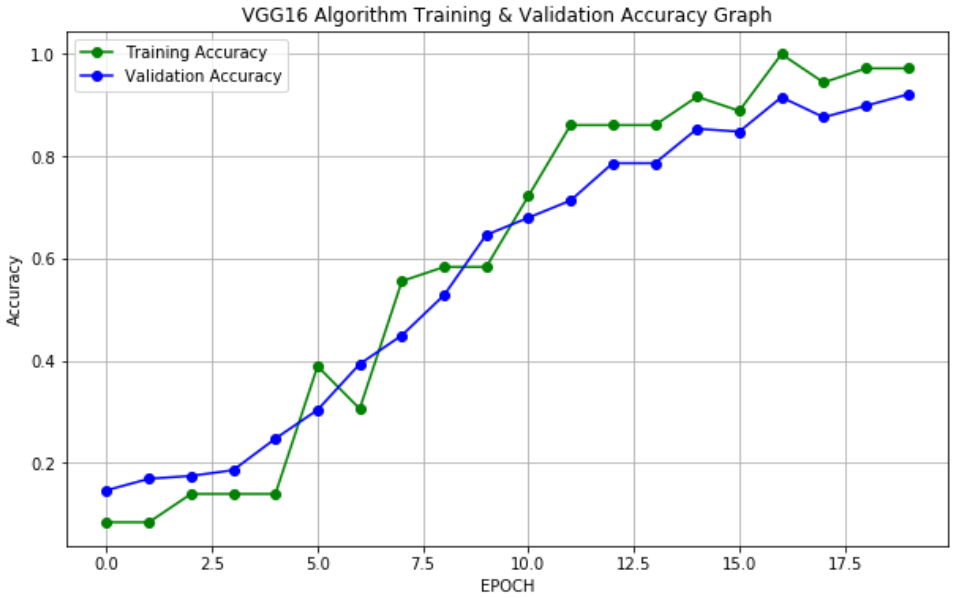
7.5
10.0
12.5
15.0
17.5


VGG16 Algorithm Training & Validation Accuracy Graph
Training Accuracy
Validation Accuracy
Accuracy
EPOCH
0.2
0.4
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1.0
0.0
2.5
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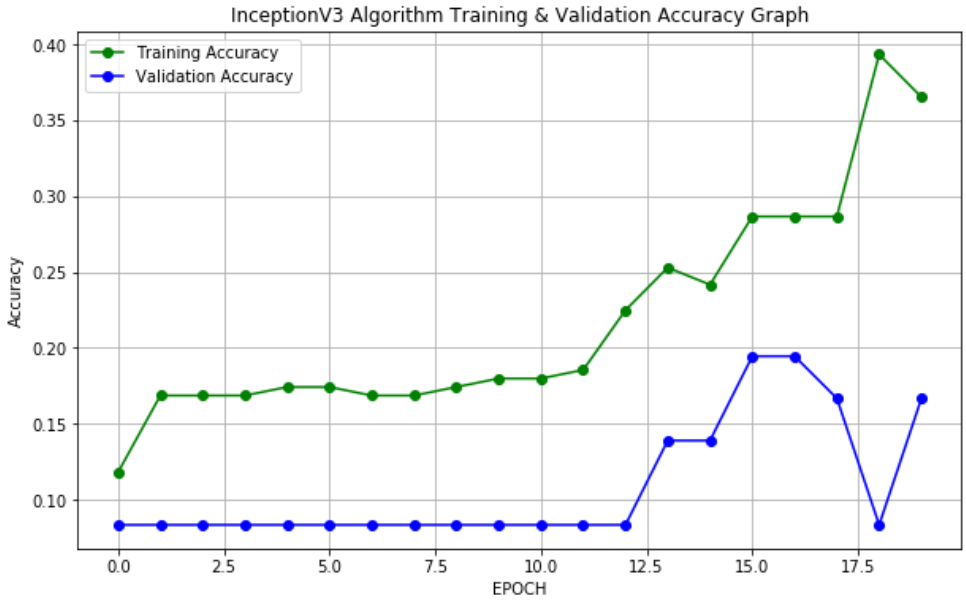
7.5
10.0
12.5
15.0
17.5



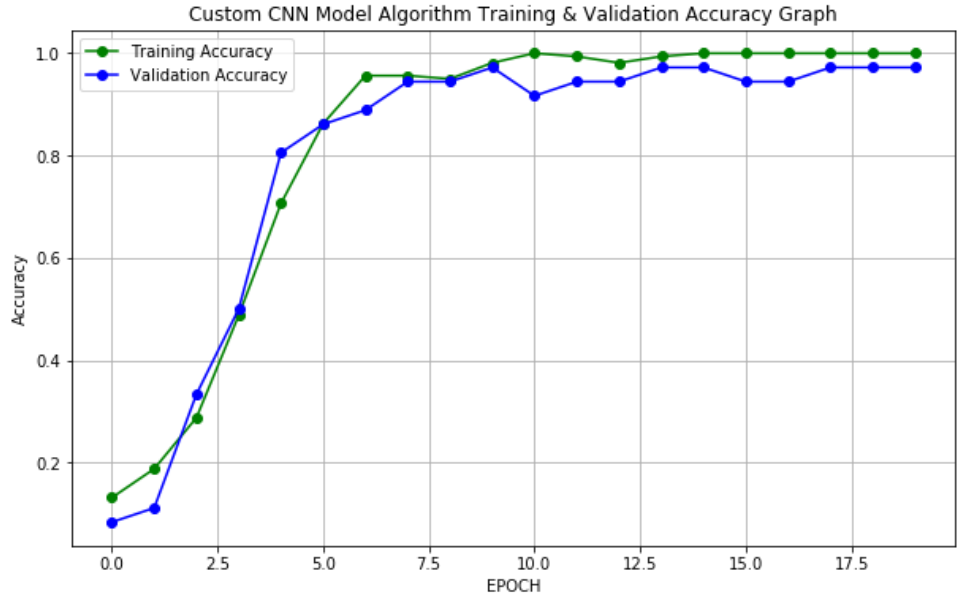
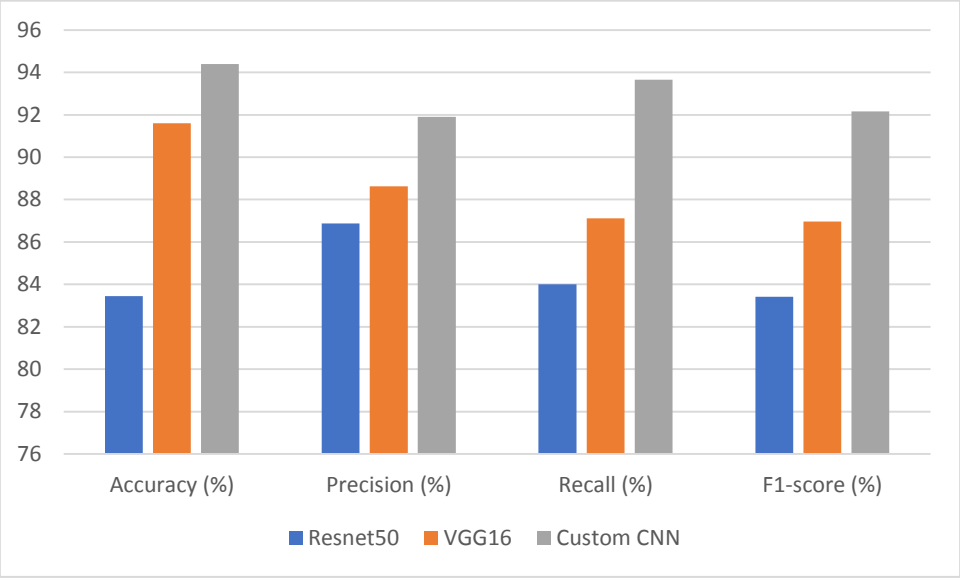


Table 1. Performance comparison of existing and proposed classification models

Algorithm	Accuracy (%)	Precision (%)	Recall (%)	F1-score (%)
Resnet50	83.44	86.87	84	83.42
VGG16	91.6	88.63	87.12	86.96
Custom CNN	94.4	91.9	93.65	92.16



5. CONCLUSION

In this study, we have proposed a system for fake Indian currency note classification. Our proposed system can detect the fake currency with high accuracy. The custom CNN system for currency counterfeit detection has its limitations. It can only detect the security features from the front image of the currency note. In future work, we aim to include the flip side features for counterfeit detection in the future.

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