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Fake Currency Detection Using Image Processing and Machine Learning

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***Abstract*—The development of colour printing technology has accelerated the production of counterfeit currency notes and their mass duplication. A simple laser printer may now be used by anyone to print currency notes with the highest level of accuracy. A few years ago, printing could only be done in a print shop. As a result, the problem of phoney notes being used in place of real ones has greatly escalated. India has sadly always struggled with issues like corruption and black money, and it also has a significant issue with counterfeit currency notes. This prompts the development of a technology that more quickly and effectively detects fraudulent money notes. The suggested strategy offers a**

method for examining Indian currency notes. Machine learning and image processing principles are used to verify cash notes. As a machine learning approach for categorization in this case, we employ KNN. A new data point is classified using the K-Nearest Neighbours (KNN) method, which stores all of the existing data and does so based on similarity. This means that using the KNN algorithm, fresh data can be quickly and accurately categorised into appropriate categories. The distance metric most frequently employed is the Euclidean distance. Then, among its k Nearest Neighbours (where k is an integer), it allocates the point to the class.The current technology combines machine learning and image processing to determine if Indian cash is fake or not when it is inserted into a PC device. Therefore, we made the decision to turn the current system into an Android application in order to identify bogus Indian currency quickly, accurately, and efficiently.

***Index Terms*—Counterfeit money, image acquisition, segmentation, edge detection, feature extraction, image processing, machine learning**.

I. INTRODUCTION

Today, all nations must contend with the complex and growing problem of currency counterfeiting. Since the creation of money, there has been a global A challenge has been launched to stop monetary fraud. Several security elements have been added to banknotes to prevent counterfeiting, however with the development of printing media technology, it has become simple to produce fake paper currency. Therefore, finding phoney banknotes is a growing concern for nations looking to safeguard both their economies and their citizens trust in their money. Currency recognition has become a significant and important issue as the dissemination of counterfeit notes grows every day[1]. The advancement of automated systems is important for automatic money recognition and other recognition techniques, and it has been growing in importance in the modern economy. For the automation of numerous sector offices, including transaction machines, ticket booths, for mall shopping, banknote exchange services, and others, a well-organized paper currency

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recognition system is essential. Various methods have been devised to identify fake currency[2]. One of them uses chemical analysis to determine the fineness of the paper used in a non-visual manner. The second strategy relies on manual inspection. Manually reviewing these notes is a laborious process that takes a lot of time and effort. Therefore, we require an automated system for detecting fake money that offers high accuracy and speedy findings[3]. This dataset for banknote authentication was developed using advanced computational and mathematical techniques, providing accurate data and information about the entities and properties associated with the currency [4].Along with image processing we can use machine learning or deep learning algorithms for the classification of currencies. We can use various machine learning algorithms such as Support Vector Machine (SVM), Gradient Boosting Classifier(GBC),K Nearest Neighbor (KNN)[5], Random forest etc and also use deep learning algorithms such as Convolutional Neural Networks(CNN), Artificial Neural Networks(ANN),Single Short Multi Box Detector(SSD) etc[6]

This fake currency detection application suggests utilising the K-Nearest Neighbours machine learning algorithm to identify phoney Indian currency notes of 10, 20, 50, 100, 200, 500, and 2000. KNN is a desirable candidate for application in the computer vision job because of its high accuracy for tiny data sets. The fake and authentic Indian currency notes of 10, 20, 50, 100, 200, 500, and 2000 made up this data set. Machine learning algorithms are used to do data processing and data extraction. By running machine learning code in PyCharm and application code in Android Studio Eel, the KNN model is finally turned into an Android application. The application for detecting fraudulent currencies was then built after it had been integrated.

II. RELATED WORK

These days, the rate of counterfeit note manufacture and distribution is rising as a result of advances in colour printing technology. This is a critical issue that affects practically all of the nations. Because it jeopardises the real economy's security, it has an impact on the economy. Such fake money fuels malevolent intentions, typically involving terrorist actions[7]. Data processing and data Extraction is performed by implementing machine learning algorithms and image processing to acquire the final result and accuracy[8].

There are several ways to capture a banknote, train a model, and evaluate the likelihood that an image is fake. The ideal settings for image capture are white backgrounds and good lighting.Picture capture of a money note with a modest digital camera or scanner under UV light.Image segmentation is the process of dividing an image into different segments to facilitate and improve analysis.One method for processing images is edge detection. It is utilised to determine an object's borders within a picture. algorithms like Sobel, Prewitts, Canny, Roberts, and the fuzzy logic technique, etc. Here, the clever algorithm of edge detection is utilised.One method for processing images is edge detection. It is utilised to determine an object's borders within a picture.Algorithms like Sobel, Prewitts, Canny, Roberts, and the fuzzy logic technique, etc. Here, the clever algorithm of edge detection is utilised.The hardest and most crucial part is feature extraction. The effectiveness of our algorithms will depend on how quickly we can process the notes' security characteristics.Various features of the currency is extracted and comparison is perform between test and original data images[9].

Apart from image processing we can also use machine learning and deep learning algorithms to increase the accuracy and efficiency of the fake currency system.Using an industrial camera, high-quality photographs of both legitimate and fake cash were gathered to create the data set.The data set is augmented to increase the data sets.After investigating the data set, it was discovered that the data needed to be scaled in order to prevent the model from favouring one particular attribute over another. In order to do this, it has been determined to limit each feature's range between 0 and 1.After normalization various machine learning and deep learning algorithms can be used for the classification of the currencies[10].

The Nearest Neighbors in K It is a supervised algorithm for lazily learning. It is said to as lazy because there is no dedicated training phase.and uses all of the data for both classification and training. Predictive classification problems are where it is most frequently employed.The algorithm categorises a given data point by examining its nearest neighbour and giving each one a weight based on the distance between them. The closer data points are given more weight when the distance is Euclidian, Manhattan, etc. There are a few benefits, such as the ease of implementation, flexibility in terms of feature kinds, and ease of handling many classes[11].

A supervised machine learning approach called the Support Vector Classifier is mostly utilised for challenges with classification and regression. Each point in this procedure is plotted in an n-dimensional plane with its value serving as the sample's data point. The classification is then carried out by identifying the hyper-plane that divides the classification into the best subsets. This approach has a number of benefits, including good performance for non-linear decision limits, economical memory utilisation, and versatility[11].

Gradient Boosting Classifier: This ensemble of under performing learners contributes to the creation of an extremely accurate predictive model. Algorithms that produce models with accuracy that is only marginally superior to response selection at random called poor learners[12].

Convolutional neural networks, also known as CNNs or ConvNets, are a type of artificial neural network that is well renowned for having exceptional strength in the area of recognising proof as well as picture order. Convolutional layer, max pooling layer, relu, and fully connected layer are the four main processes in convolutional neural networks[12].

A large frame paradigm for object detection is the Single Shot Multi Box Detector (SSD). From feature maps on various

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layers, it generates bounding boxes from which the output of these bounding boxes is produced. Depending on the classifier, it will create several bounding boxes, from which we can infer the nature of the item. Although it is faster than ResNets and Faster R-CNN, it is also employed in real-time detection. However, SSD assures both the accuracy and the speed of the detection process[13].

Decision Tree uses a cascade of classifiers, the result of one classifier serves as the input for a subsequent classifier. This procedure aids in sorting out the different classes of currency notes. Each classifier assigns a classification to the input set based on a few security criteria. These classifiers are independently trained before being linked together in a cascade. A preprocessing step involves calculating the percentage of histogram bins. To represent as a percentage of pixels with a specific id, the value of each bin is multiplied by 100 and divided by the total number of pixels[13].

Logistic Regression[LR] is an SML model that's widely or frequently employed for categorization. For classes that can be separated linearly, the LR model performs excellently and even makes implementation simple. Particularly, it is most frequently utilised in manufacturing. Since LR is a linear model, it is often used for binary classification; however, by applying the OvR approach, it is possible to classify many classes[13].

Random Forest[RF] is a classifier made up of a variety of decision trees, according to RF. To build the sub classifier, subdatasets are randomly chosen from the main dataset. After that, they are concatenated to make the RF classifier. Each sub-classifier makes a forecast for a class, after which voting is done, the class with the most votes becomes the model's prediction[13].

Naive Bayes[NB] is a classifier where class labels are given to the problem instances that are represented as feature values vector and where finite sets are used to derive the class label n generally for training of such classifiers there is not a particular algorithm, even having a bunch of algorithms working on common principle i.e., NB assumes that each feature has an independent value means not having relation with some other feature for a given class variable. Particularly for probabilitybased models, NB works quite effectively, and supervised learning models can be taught very successfully[13].

Artificial Neural Networks(ANN) has three separate sets of neural network classifiers that are applied to each feature group. Each neural network has three layers: an input layer (layer 1), a hidden layer with many nodes, and an output layer (layer 3). Depending on the quantity of features in each feature group, such as ink work, printing, or artwork, the input layer has input nodes. Since one hidden layer yields the highest accuracy, a multi-perceptron model is not used. In order to train the sigmoid activation function is used[14]

III. PROPOSED SYSTEM

This projects aims a fake currency detection android application, which can identify fake and real Indian currency note of 10,20,50,100,200,500 and 2000.

The first step is data collection, which is collecting the fake and real Indian currency notes of 10,20,50,100,200,500 and 2000 to train the model.

The data pre processing is the second step which is the technique used to convert raw data into clean data. Data quality assessment, data cleaning, data resolution are performed. Hence, images are resized and reshaped.

In model building prediction algorithm is applied to the model to predict the output and according to the accuracy we can decide whether the model is required or not. Here the models was build based on two algorithms CNN and KNN. CNN had accuracy of 68 and KNN had accuracy of 90 percentage. Hence KNN model was selected as the final model. It is a lazy learning supervised algorithm. The reason it is called lazy is because it doesn't have a specialized training phase and uses all the data for training while classification. It is mostly used for classification predictive problems. The way

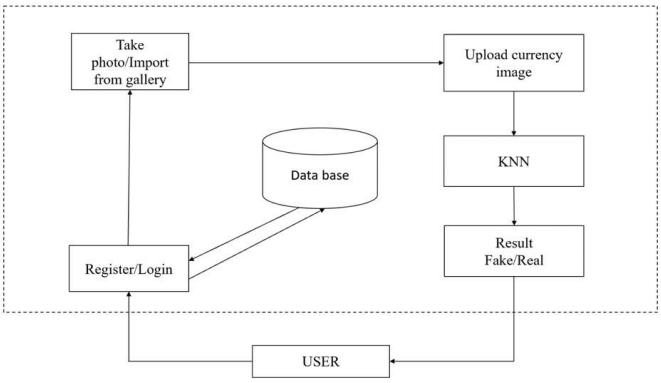

Fig. 1. Architecture of fake currency detection system

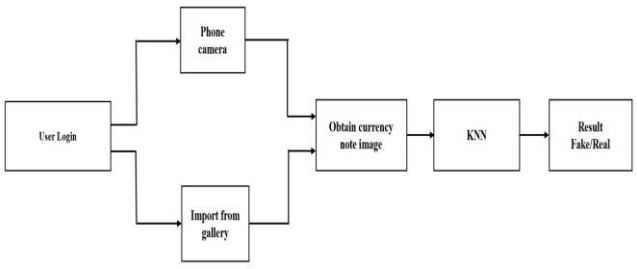

Fig. 2. Block diagram of fake currency detection system

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the algorithm works is that it classifies a given data point by looking at its closest neighbour and assigns a weight to them based on the distance.

At last the model is converted into an android application by building the KNN model and machine learning code was run in pycharm and application code was run in android studio eel. Then it was integrated and run and application was build.

Figure 1 represent the architecture of fake currency detection system and figure 2 represent block diagram of fake currency detection system.

IV. RESULT AND DISCUSSION

The performance of various state of the art models for fake currency detection system and classification is discussed in here. The following figures show the accuracy and loss of the proposed model. We have 70 percentage of training set and 30 percentage of validation set among dataset. We train the model using the training data and check its performance on both the training and validation sets (evaluation metric is accuracy). Figure 3 shows the training and validation accuracy of CNN model.

As you can see in the diagram, the accuracy increases rapidly in the first first epoch, indicating that the network is learning fast. But at from epoch 5 there is a difference between the train and validation accuracy.

It has been found that the CNN model only gives an accuracy of 60 percentage, so a new model using KNN was build. Figure 4 shows the testing accuracy of the KNN model.

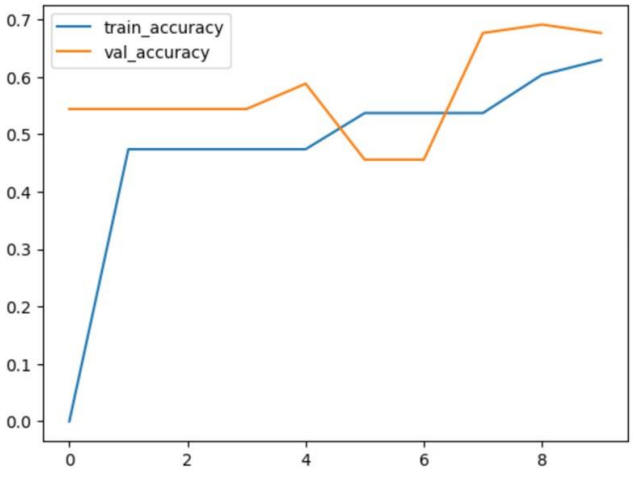

Fig. 3. Training loss and testing loss of CNN model

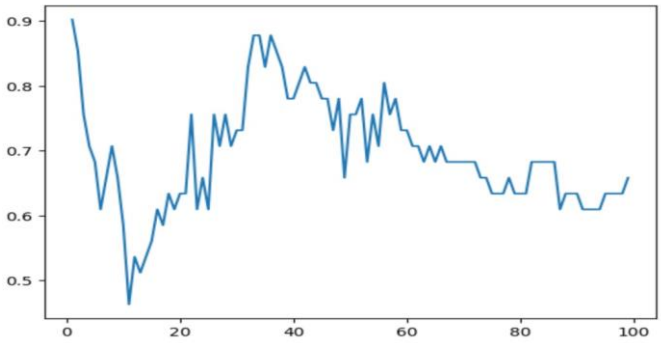

Fig. 4. Testing accuracy of the KNN model

As you can see in the diagram the KNN model gives an maximum accuracy of 90 percentage.

V. CONCLUSION AND FUTURE SCOPE

In this century where the majority of people are aware of technology and how it works, many of them indulge in unlawful activities. One of such activities is the production of fake currency which is practiced to deceive people. In this proposal, it is focused on this illegitimate practice and try to bring forward a solution for it. According to a survey, the maximum number of cases of counterfeit in India still relate to fake currency, there were 132 cases of counterfeit currency in 2018, which shot up 37 percent to 181 in 2019. In Order to stop this fraudulent activity, our system is proposed, which is a fake currency detection application which uses KNN machine learning techniques to recognize whether the currency is fake or not. Firstly data collection is performed by collecting the fake and real Indian currency notes of 10,20,50,100,200,500 and 2000 to train the model. Secondly the data pre processing is performed to convert raw data into clean data. Thirdly the models was build based on two algorithms CNN and KNN. Fourthly in testing module the model is tested after training the images from dataset where CNN had accuracy of 68 percentage and KNN had accuracy of 90 percentage and KNN is selected as the final model for the fake currency detection application. Finally the model is converted into an android application by running machine learning code in pycharm and application code in android studio eel. Then it was integrated and fake currency detection application was build. The machine Learning algorithm used is K Nearest Neighbor (KNN) which has high accuracy of 90 percentage. Hence the system will be more efficient, reliable and the result will be having high accuracy. So the fake currency detection application will be more helpful for the user to identify the currency is fake or not. By implementing this system we can reduce the spread of fake currencies.

In this fake currency detection application only Indian currency notes can be recognized whether it is fake or not, in future the application can be updated to recognize other foreign

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currency notes whether they are fake or not. Now this application is limited to android operating system, in future it can also be available in ios. Advertisements can be shown in this application for users. In future we can also focus on faster and more accurate fake currency identification with the use of modern image processing algorithms The accuracy of the application can be increased even more by using any other machine learning or deep learning algorithms. We can include tracking of device's location through which the currency is scanned and maintaining the same in the database. In future we can include a module for currency conversion.

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