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FAKE CURRENCY NOTE DETECTION USING SPRINT ALGORITHM

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.Abstract:*The advancement of color printing technology has increased the rate of fake currency note printing and duplicating the notes on a very large scale. Few years back, the printing could be done in a print house, but now anyone can print a currency note with maximum accuracy using a simple laser printer. To mitigate this problem, we introduce a Fake Currency Note Detection System using Machine Learning. Fake Currency Detection is a task of binary classification such as Sprint algorithm in machine learning. Enough data on real and fake banknotes can be used train a model that can classify the new banknotes as real or fake. The result will predict whether the currency note is fake or not. Fake Currency Detection is a real problem for both individuals and businesses. Counterfeiters are constantly finding new methods and techniques to produce counterfeit banknotes, which are essentially indistinguishable from real money. Currency counterfeiting is always been a challenging term for financial system of any country. The problem of counterfeiting majorly affects the economical as well as financial growth of a country; the race is going on between the counterfeiters and the banks. To resolve the issue various researchers came across with variety of techniques and proposed solutions mostly focused on Machine learning and Image processing areas.*

Keywords:*Fake Currency Note,Machine Learning, Image Processing, Binary Classification, Sprint, Counterfeiting.*

I. INTRODUCTION

Malpractice is always a serious challenge that resulted in a serious problem in society. The automation in technology creates a more copied currency that is entirely spread, resulting in reducing the economic growth of the country. The note detection is compulsory, and also necessary to be very consistent and reliable. The paper currency identification depends upon a number of steps, including edge detection, feature extraction, image segmentation, grayscale conversion, and comparison of images. This paper alsoconsists of a literature survey consisting of different methodologies for detection. The review to detect malpractice concludes that whenever we apply some efficient preprocessing and feature extraction techniques, it helps in improving the algorithm as well as the detection system. Machine Learning techniques help in building tools that is required and necessary for the research work, and we can make computer learning design, implementation, and methods to have a difference between fake and genuine currency. It is going to utilize pattern recognition and image processing learning and analyzing methods for distinguishing features. The paper is performed using anaconda, an integrated development environment of python and then training is done on the datasets to identify the currency, it provides an advanced features of data analysis as well as an excellent visualization.

Machine Learning techniques help in building applications that support in detection of currency, through automated system and algorithm. Machine Learning is going to use pattern recognition and image processing for analyzing the real characteristics. The aim of this work is to create a paradigm which can be supervised with the help of related set theory so that it can be further beneficial in detecting feigned datasets with a very few categorizing bugs. Therefore another name referred as categorizing model grouped as data, consisting

of attributes and labelsfor the bills referring as fake or genuine. Moreover it identifies decision boundaries which seperate samples of two classes.

First, take out data from images that rooted out from an original and copied banknote. In regard to digitization, use camera for printing in terms of inspection. The size of all images have 300x 300 pixels, this is because of the distance concerning lens and grayscale pictures having targeted some dots per inch to achieve. Properties and characteristics are explored and taken out from images in support of transformation concerning wavelet. Some methodologies that came from wavelet transformation are variance, skewness, kurtosis, entropy of pictures and class relevant to currency. Among these some are continuous in showing the features of a banknote and some ie. the last one actually the real sign of the banknote, indicates 1 as original and 0 for duplicate. The set theory has 1100 samples, 600 samples for feigned notes, remaining 500 copies for original currency. This work basically aims at observing images taken as input that anonymously based on properties taken out after wavelet transformation and also on the problem based on machine learning. Therefore the processes are continuing with transformation of images. We check their feasibility by testing the data set in respect of set theory, which will be visible but not mentioned in the model, for achieving accuracy. Set of data is given, by using their properties we able to design supervised learning model and using that we classify whether the currency is fake or real. For the values that are not mentioned in the data set, we can search them by applying properties and methodologies. As some of the properties are continuous in nature, normalization is applied to make the data set in the scope of 0 to 1. We cannot neglect any properties having outliers or falsify.

II. LITERATURE REVIEW

Literature research is the most important step in the software development process. Before creating a tool, it is important to determine the time factor, profitability, and company strengths. With these in place, the next 10 steps are to decide which operating systems and languages you can use to develop your tools. Once programmers start building tools, they need a lot of external support. This support can come from experienced programmers, books, or websites. The above evaluations will be considered in the development of the proposed system before building the system.

Vipin Kumar Jain [2020] have proposed a paper Recognition of Fake currency detection done by image processing technique. This paper based on Fake Currency Identification by Android Mobile Phone Using Digital Image Processing.

S. S. Veling, Miss. Janhavi P. Sawal, Miss. Siddhi [2021] have proposed a paper Fake Indian Currency Recognition System byusing MATLAB proposed work is to propose a currency note recognition system under hyperspectral imaging mode with different lights under different wavelengths and the comparison of features by using image processing algorithms.

"Currency Recognition and Fake Note Detection"by Ms. Renuka Nagpure, Shreya Sheety, Trupti Ghotkar,(2019),
This project proposed that identification of fake note is done for blind through image processing using segmentation. it extracts various features of currency notes with the help of MATLAB software. This enhances simplicity and high performance speed.

“Automatic Indian New Fake Currency Detection Technique” by MayadeviA.Gaikwad, Vaijinath V. etal(2017),
Detection of fake note is possible using deep learning using SVM and FNN (Feed Forward Neural Network),FNN also uses for verification. It

uses max pool operation ,suppose ,the image it extracted ,then that image would go through augmentation process and then annotation, these enable database creation ,then we input image through real time through transfer learning by alex-network, after that it will go for feature extraction where there the comparison is isdone between real time and database features.

"Fake Currency Detection using Image Processing" by Mrs.MonaliPatiland Prof. JayantAdhikari (2019),
This project is implemented for duplicacy of currency is a vulnerable threat on economy and it is now a common phenomenon due to advanced technology and laser printer, to get rid of this, some methods are processed. Detection of currency is possible through register, watermarking, optically variable ink, security thread, fluorescence, latent image andidentification mark. This is really beneficial for banking sector.

Abburu et al. (2017) proposed a system for automated currency recognition using image processing techniques for accurately identifying both the country of origin and the denomination of a given banknote. However, they do not discriminate between a fake and a real currency note. However, the DeepMoney solution proposed here does not use image processing and differs in many ways.

Ross et al. (2016) have proposed a database for detecting counterfeit items using digital fingerprint records which can be used for detecting counterfeit currency note. It takes an image of the authentication region and creates a digital fingerprint of the object. It uses signal processing techniques, such as, FFT of the image to create the digital fingerprint to extract features which are used to compare the fake and real objects.

"Survey of Currency Recognition System Using Image Processing" by Amol A. Shirsath S. D. Bharkad, (2013)
They made an android based application for blind people for detection of fake currency; he also proposed denominations for impaired people. This system mainly termed as android based currency recognization system.

"**Identification of Fake Currency" by Mohammad H Alyshayeji(2013)**
In this paper, they used bit –plane slicing technique with the help of edge detector algorithm for identification of currency. In which,for roman coins, spatially local coding method is used. Along with that it also uses traditional rigid spatial structure model such as spatial pyramid.

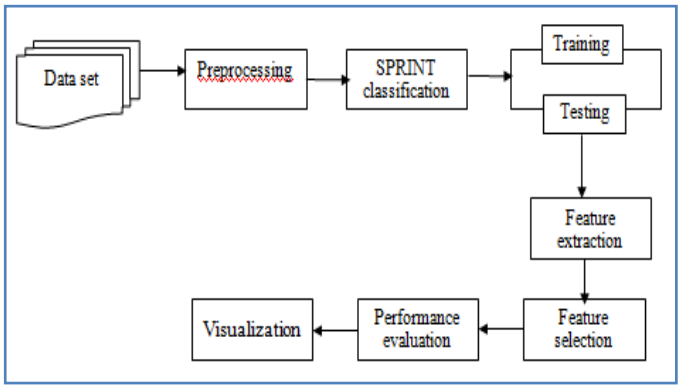
III. METHODOLOGY

The proposed system consists of the benefits of the existing system and removes its disadvantages. This system focuses on the improvement and implementation of the fake currency detection application. The scope of the project is to provide techniques and methods that appear suitable while you access the image of the currency you want.

In the proposed system, We work on 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.

The characteristics used to authenticate currency notes are Security Thread, Serial Number, Latent image, Watermark, Identification Mark. The results are displayed on web UI which shows the extracted features of currency notes. The real currency note extracted features displays at least 70 percent intensity, it is seen that the 500-2000 note displays intensity less than 75 percent for some features hence it is considered as fake note.



Block diagram of proposed system

Data preprocessing

Data preprocessing is converting raw data into useful information that a machine learning model can use. It is the initial and most important step in developing a machine-learning model. We need access to clean, well-formatted data while developing a machine learning project. Additionally, data must always be cleaned and formatted before being used in any activity. Hence data preprocessing is considered a vital task.

SPRINT CLASSIFICATION ALGORITHM

The histogram and attribute table are the two data structures proposed in the enhanced SPRINT method. The three components of the property sheet are data indexing, attribute value, and class identification. In the memory section, the hard disc, instead of recorded data, contains the attribute list only. The attribute table was divided with node expansion, and each relevant child node was linked. To describe the attribute node distribution types, Histogram is linked with the nodes. In the class distribution, as per the numerical properties' nodes are linked with two histograms such as Cabove and Cbelow. The former can identify the sample type, which deals with distribution.

Additionally, it specifies the distribution pattern for untreated samples and two samples' values when considered together with updates. In the discrete distribution class, the Histogram's attribute is expressed by one node only. The minimum description length idea is applied to SPRINT pruning for achieving efficient performance.

Feature extraction is the mechanism used to minimize the amount of resources required for executing data preprocessing with minimum loss of relevant information. Additionally, feature extraction can help analysis by reducing the duplicated data. The machine's efforts to generate variable features and the minimization of the data optimize the learning and generalization stages of the machine learning process.

Description of SPRINT Algorithm. The SPRINT algorithm has no limit to the number of input records and its processing speed is considerable. This algorithm creates a list of attributes and a corresponding statistics table for each attribute of the sample data in the initialization phase. Elements in the list of attributes are known as attribute records, which consisted of labels, attribute values, and classes. Statistics tables are used to describe the class distribution of a property, and the C above and C below two lines, respectively, describe the class distribution of processed samples and untreated samples.

Steps of the original SPRINT algorithm are as follows:

Maketree (node s)

{

If (node 𝑠 meets the termination conditions)

{ Put node 𝑠 into the queue, labeled as a root node; Return; }

For (for each attribute 𝐴) {

Update histogram in real time; Calculate and evaluate the index of segmentation for each candidate segmentation points, and find the best segmentation point;

Find out the best segmentation for node 𝑠 from the best segmentation for each attribute.

Based on it make two part𝑆1, 𝑆2;

Maketree (𝑆1);

Maketree (𝑆2);

}

}

IV. RESULTS AND DISCUSSION

Data Collection

The dataset contains these four input characteristics:

- The variance of the image transformed into wavelets
- The asymmetry of the image transformed into wavelets
- Kurtosis of the image transformed into wavelets
- Image entropy

Data pre-processing

Now we need to balance our data, the easiest way to do this is to randomly drop a number of instances of the overrepresented target function. This is called random undersampling. Otherwise, we could also create new synthetic data for the under-represented target class. This is called oversampling. For now, let's start by randomly deleting 152 observations of actual banknotes.

Data Exploration

Now let's start exploring the dataset. First, I'll check the data types and if there are any missing values in the data:

We, therefore, have no missing values in the data. We can now draw a pair diagram to get an overview of the relationship between all the entities. I will also colour the observations: blue for genuine banknotes and orange for counterfeit banknotes:

- The distribution of both variance and skewness appears to be quite different for the two target characteristics, while kurtosis and entropy appear to be more similar.
- There are clear linear and nonlinear trends in the input features.
- Some characteristics seem to be correlated.
- Some features seem to separate genuine and fake banknotes quite well.

The dataset is fairly balanced, but for the binary classification task, we need to balance it perfectly. So let's start preprocessing the data by doing just that.

Data analysis

Data analysis is a process of inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, and is used in different business, science, and social science domains. In today's business world, data analysis plays a role in making decisions more scientific and helping businesses operate more effectively.

Data Visualization

Data visualization is the graphical representation of information and data. By using visual elements like charts, graphs, and maps, data visualization tools

provide an accessible way to see and understand trends, outliers, and patterns in data.

Algorithm implementation

The SPRINT algorithm has no limit to the number of input records and its processing speed is considerable. This algorithm creates a list of attributes and a corresponding statistics table for each attribute of the sample data in the initialization phase. Elements in the list of attributes are known as attribute records, which consisted of labels, attribute values, and classes. Statistics tables are used to describe the class distribution of a property, and the C above and C below two lines, respectively, describe the class distribution of processed samples and untreated samples.

Steps of the original SPRINT algorithm are as follows:

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If (node s meets the termination conditions) {
Put node s into the queue, labeled as a root node;
Return;
}
For (for each attribute A) {
Update histogram in real time;
Calculate and evaluate the index of segmentation for each candidate segmentation
points, and find the best segmentation point;
Find out the best segmentation for node s from the best segmentation for each
attribute. Based on it make two part S1, S2;
Maketree (S1);
Maketree (S2);
}
}
```

The termination condition of the algorithm has three kinds of cases. (1) No attribute can be used as testing attribute. (2) If all the training samples in the decision tree belong to the same class, the node is used as a leaf node and labeled by this class. (3) The number of training samples is less than the user-defined threshold.

Segmentation of Attributes

The traditional SPRINT algorithm uses *Gini* index [5] to search for the best segmentation attribute, which provides the minimum *Gini* index representing the largest information gain.

For a dataset D containing N classes, Gini is defined as

$$\mathrm{Gini}(D) = 1 - \sum_{j=1}^{N} p_j * p_j. \quad (1)$$

pj the frequency of class J in D. If a partition divides the dataset D into two subsets D1 and D2 , |D1| and |D2| represent the number of records in subsets D1 and D2, respectively. After the segmentation, the *Gini* value is

$$\mathrm{Gini}(S) = \frac{|D_1|}{|D|}\mathrm{Gini}(D_1) + \frac{|D_2|}{|D|}\mathrm{Gini}(D_2). \quad (2)$$

A segmentation of attribute values providing the least *Gini* value is chosen as the best segmentation [9].

For discrete attributes and continuous attributes, the SPRINT algorithm uses different processing methods.

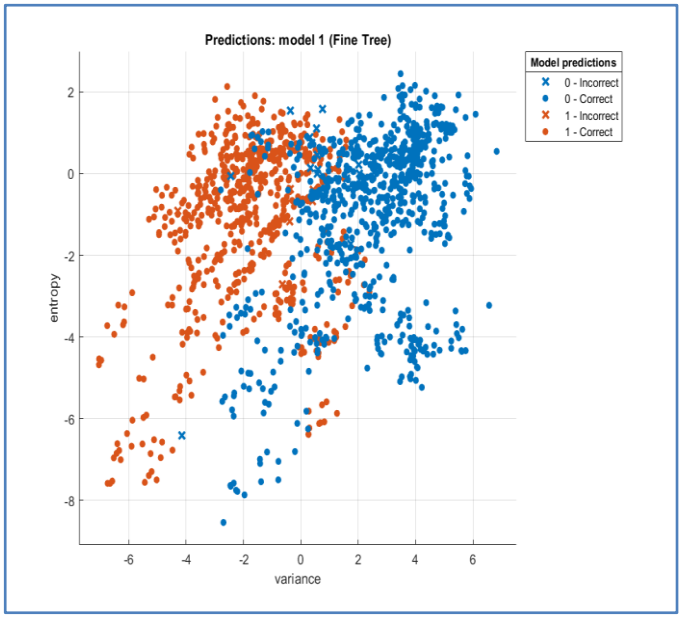
In order to find discrete attribute segmentation point [7], we assume that the number of a certain attribute's values is n , which should be divided into two parts. All attribute values are considered as possible partition, and then the corresponding *Gini* value is obtained. There are 2n kinds of possible partitioning ways in total. We need to calculate the *Gini* value for each partitioning way using exhaustive method and then can obtain the best segmentation.

For the solution of finding the continuous attribute's partitioning point, the split can only occur between two values. First the values of the continuous attribute should be sorted and the candidate segmentation points are intermediate points between two values.

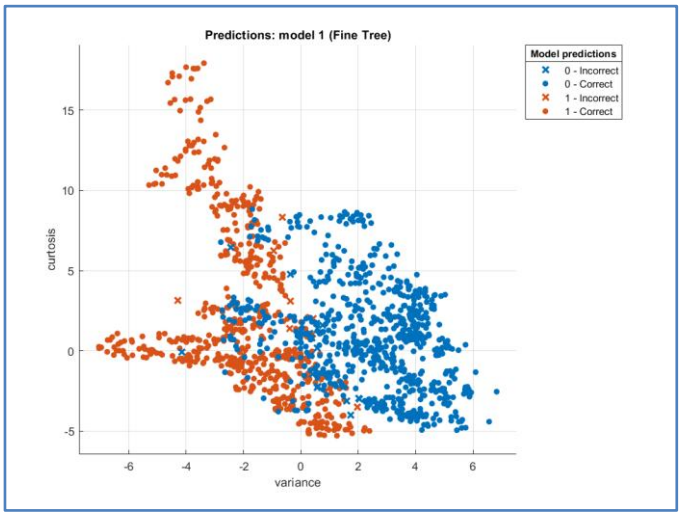
After a scan of sorted values, the statistics table should be updated when a record is read. The statistics table contains all the information needed to calculate the *Gini* index. Then we should calculate the *Gini* index to find the segmentation point with the minimum *Gini* value.

Although the traditional method can find the best segmentation point, it is necessary to traverse all of the segmentation in discrete attributes [8], which makes this algorithm have high time complexity. For the segmentation of continuous attributes, dividing them into two consecutive parts in most cases can not reflect the distribution of attribute values.

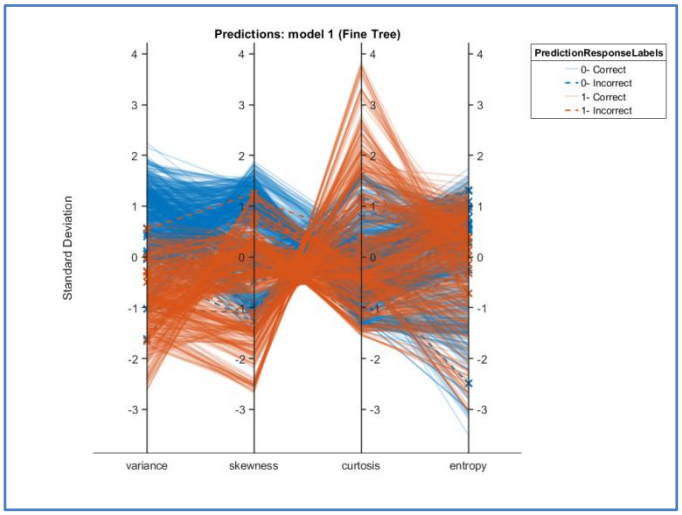
V. EXPRERIMENT RESULTS



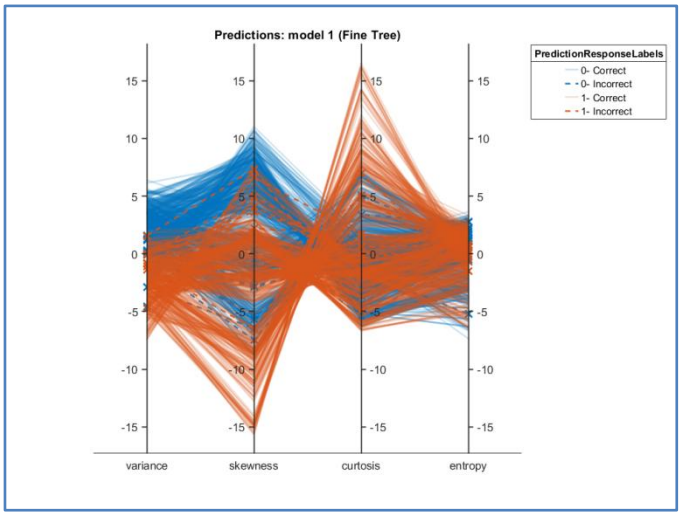
Prediction (Skewness)



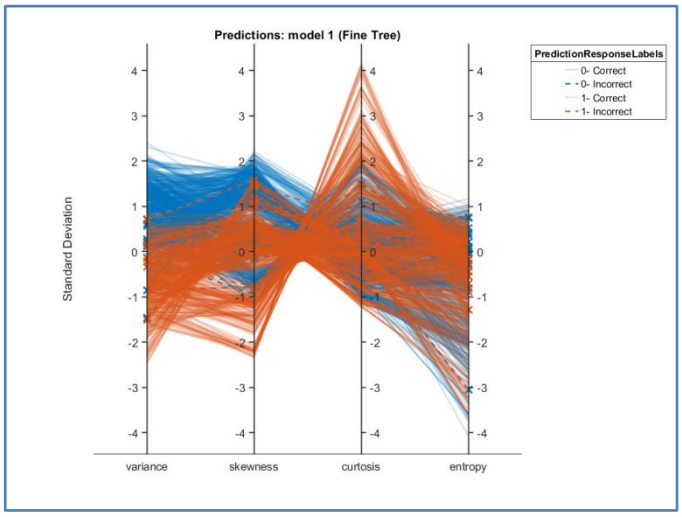
Prediction (curtosis)



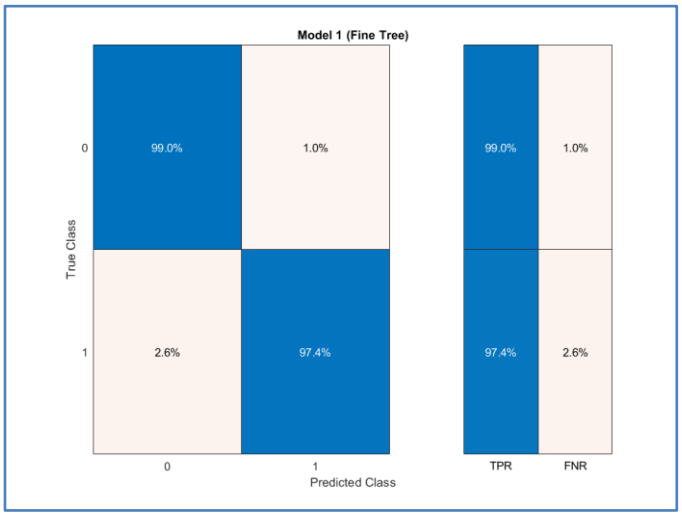
Standard Deviation



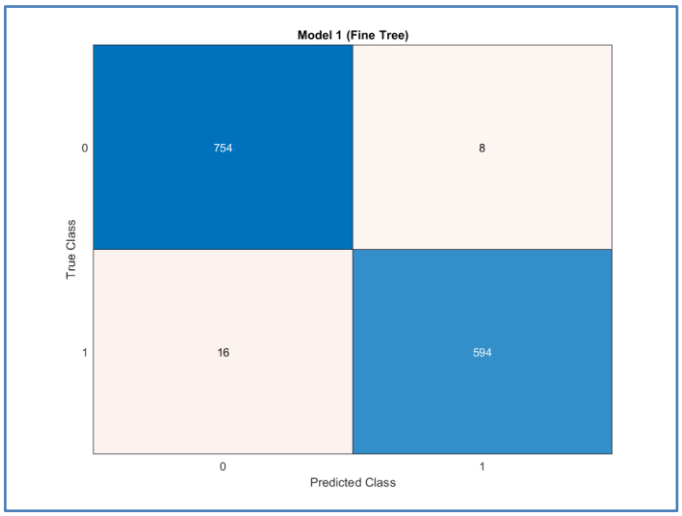
Statandar deviation2



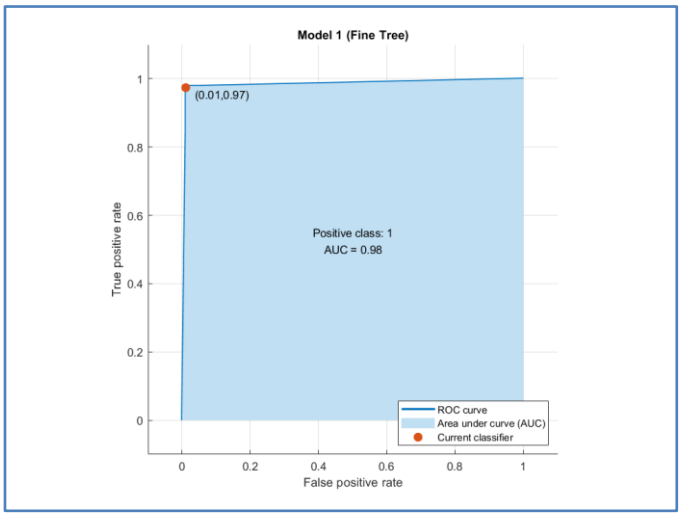
Standard Deviation3



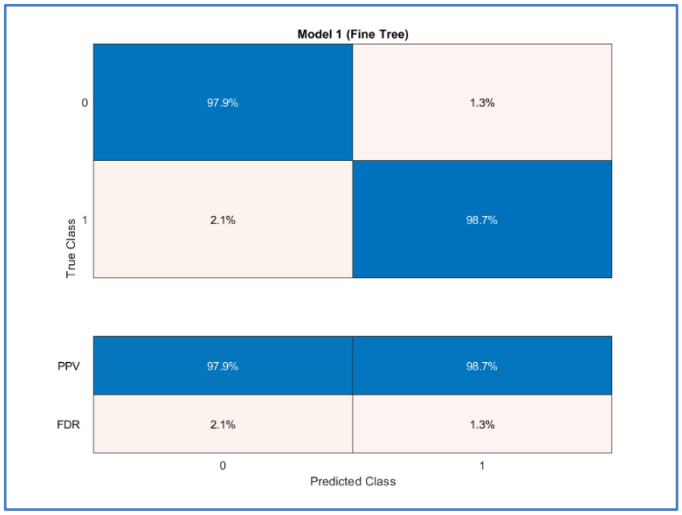
Confusion Matrix3



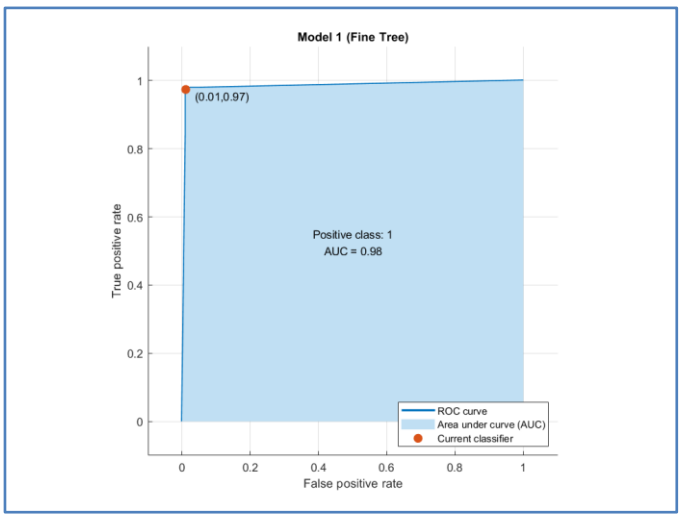
Confusion Matrix1



True Postive Rate (Diagram1)



Confusion Matrix2



True Positive Rate (Diagram2)

VI. CONCLUSION

Fake currency notes are increasing day by day, in order to overcome this we proposes a very helpful and efficient system to detect the fake currency. In this paper our model is performing the fake currency detection. The detection accuracy is most accurate since the currency characteristics features are learned through layer by layer. The recognition and fake currency detection can also be extended by considering the patterns of currency surface as features for improving the detection accuracy. At the end of this process user can now make the difference between the real and a fake currency note and can get the equivalent value in different currencies.

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