Detection Of Forged Currency Notes using Machine learning algorithms

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ABSTRACT

Currency is a medium of exchange either to purchase or sell the goods and services. In today's world, With enhanced technology, counterfeit currency has become a concerning threat. Counterfeit currency leads to harm the country's economy. Severe implications are such as artificial inflation, terror funding. These concerning causes destabilize the real value of money and inflation surges over its sky. Moreover, due to terror-related activities the social-harmony gets disturbed, this can be termed as "Economic Terrorism". The proposed methodology in this paper uses Random Forest & SVM Machine Learning Algorithms to classify forged currency notes The algorithms are evaluated using metrics Accuracy, Confusion Matrix and Classification Report. The results show that SVM has outperformed Random Forest by achieving an accuracy of 99.63%.

Keywords: Counterfeit Currency, Economic Terrorism, Machine Learning, Random Forest, SVM, Accuracy, Confusion Matrix, Classification Report.

I. INTRODUCTION

Currency is a medium of exchange, each country has its own currency sanctioned by the Government. It circulates within a country either for purchasing or selling the goods. Due to the advancements in printing and scanning technology, currency counterfeiting continues to be a growing concern across nations. The forged currencies are continuously harming the world's economy that can be called as Economic Terrorism. Banks and governments work hard every day to stop fraudsters, but some are more clever than others.

In India, In the last year, the quantity of fake 500 rupee notes has climbed by 31% **[1]**according to the (NCRB) I.e. National Crime Records Bureau. In 2019, forged currency worth around ₹25.3 crore was seized. In April, 2021, fake currency worth ₹1.8 crore seized in Kochi**[2]** and ₹26 lakh was recovered in Assam**[3]**. In the year of 2020 highest ever Fake Indian Currency Notes (FICN) seized worth Rs 92.17 crore, according to National Crime Records Bureau (NCRB)**[4]**. Looking throughout the world, Mexican peso, British pound, Euros are the most counterfeited currencies in the world**[5]**.Due to this illegal practice of Forged currencies, the value of real money gets affected, Inflation grows steeply. And, the biggest menace is terror funding which destabilizes the security of a nation**[6]**.

In this paper, the primary aim is to identify the forged currency notes using the Machine Learning Algorithms, which will automatically eradicate issues such as destabilization of sanctioned currency, artificial inflation and most vital terror funding.

This paper is structured into sections which are listed below:

- Section 1 : It comprises the introduction, aim, motivation.
- Section 2 : The Literature survey or related work done is being discussed in this section.
- Section 3 : This section consists the methodology used, flow of work and the performance metrics.
- Section 4 : This section contains the obtained results.
- Section 5 : Conclusion of the paper has been discussed in this section.
- Section 6 : This section contains Acknowledgment.
- Section 7 : This section contains Imrovements & possible future scope.

II. RELATED WORK

The problem of counterfeit notes has impacted many countries and India also suffers the same. Printing the currency with forged features has now become easier with the enhanced technology. Illegally, without legal sanction of the state fake

notes are being produced and continues production of forged notes lead to the degradation of the economy of a nation**[7]**.

Fake currency has become the most important problem in market. As the technology is growing, the production of fake currency has been surged, resulting into the degradation of country's economy. In this paper**[8]**, the proposed method utilizes OpenCV for recognizing the note as fake or original.
A computer vision based approach has been proposed for Indian paper currency detection. For extracting the features of paper currency, ORB I.e. (Oriented FAST and Rotated BRIEF) and Brute-Force matcher are being used. Notes including 200 and 500 rupees are used as the dataset**[9]**. The system is developed using OpenCV, average accuracy rate is 95%.

Due to enhancement of fake currency machines, It has become a big issue nowadays. OCR(Optical Character recognition), Face Recognition and Hough transformation algorithms are the proposed methodologies in this paper. In Face Recognition model**[10]**, Mean and Standard Deviation (MSD) has been selected for building model, it achieved 93.33% accuracy.

The inflow of fake notes into the banks have been at all time high as per recent reports due to demonetization. It is very vital to detect these fake currency notes. In this paper**[11]**, Convolutional Neural Network(CNN) based model is proposed for the identification of the fake notes. Testing, training and validation accuracy is 85.6%, 98.57% and 96.55% respectively.

Principal Component Analysis (PCA) has been used in this paper for the detection of features of the currency through modeling. Moreover, a proposed algorithm has been elaborated for the recognition of the forged currency, note of Rs 2000 has been taken in consideration **[12]**.
In this paper, the proposed system is capable to differentiate between fake and real note(Indian 500 and 2000 rupee note are used) based on the image processing technique implemented using MATLAB and the accuracy achieved is 76.66% **[13]**.

It is a vital task to categorize the banknotes of different nations because of the enhancement of fake notes in today's economy. SVC I.e. (Support Vector Classifier) has been utilized in this paper, and the achieved accuracy is 93%**[14]** for the detection of fake note. Fake Currency is a threat and it impacts the growth. Making fake currency considered to be a crime. Researchers have analyzed many already been incorporated techniques to recognize the face currency to overcome this threat. For this problem there are various solutions in terms of hardware techniques. Image preprocessing, machine learning methods **[15]**.

In India, to reduce the funding for illegal activities, new Rs 500 and Rs 2000 note has been introduced by the Indian government. The core idea is to detect the bogus currency notes. Edge Detection techniques**[16]** are used for detecting the strip lines from the currency and HSV techniques for saturating the input image's value.

In all of those above mentioned related work, the research papers focused on an image based dataset. Moreover, the proposed methods discussed in the previous work done are chiefly focused on image of one or two notes. In this paper, this limitation is being addressed, the working methodology works on the detection of all notes of India like 10, 20,50,100,200,2000 rupees notes. The proposed methodology uses Random Forest and SVM Machine Learning algorithms to detect the fake currency notes using its features.

III. METHODOLOGY

1. ALGORITHMS USED

During this research work, two supervised machine learning classification based algorithms are utilized and examined:

A. Random Forest.

This algorithm is developed by Breiman, it is an ensemble learning based approach that can be used to solve both classification and regression based problems. Ensemble Learning, A scheme of machine learning used for boosting the accuracy by combining multiple models and then solve the same problem **[17]**. Random sampling helps in predicting more accurate and better generalized results **[18]**.

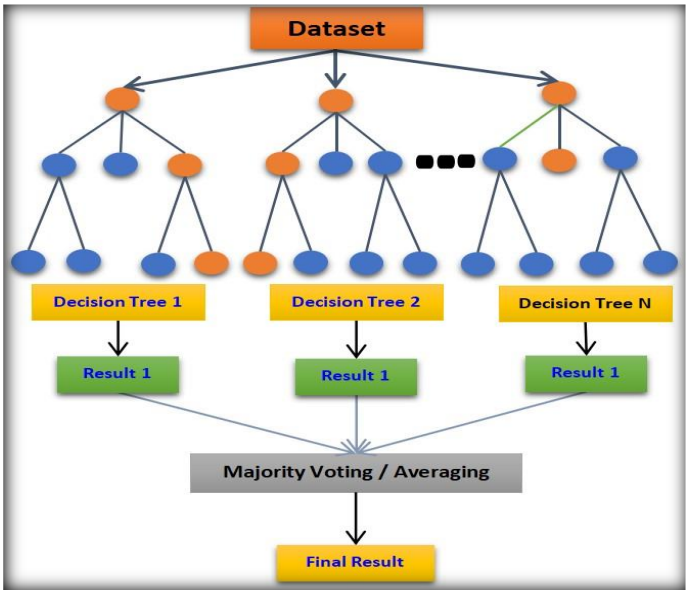

Fig. 1. Random Forest algorithm Visualization .

B. Support Vector Machine

SVM is **[19]**proposed by Vapnikt, it is one of the most well-known Supervised Machine Learning Algorithm. It is having the concept of non-linear kernels to establish decision boundary for the data I.e. that is nonlinear in nature. Mostly, for the classification problems SVM-C is used. This algorithm generates decision boundary that separates n-dimensional space into classes/groups, that distinctly classifies the data points **[20]**. Hyper plane gets created by using the extreme points/vectors. These extreme

points/vectors are known as support vector, based on which this algorithm is named as Support Vector Machine.

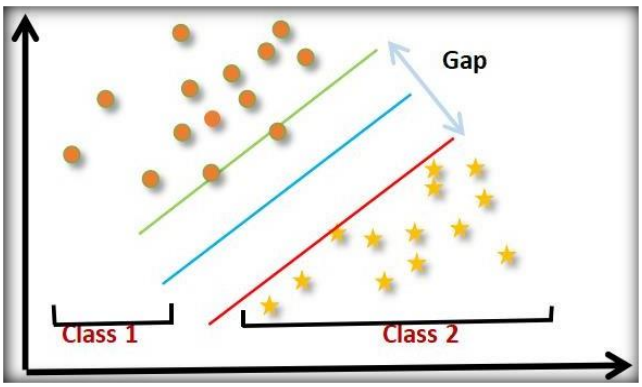

Fig. 2. Support Vector Machine algorithm Visualization.

2. DATASET

The used dataset**[21]** is a public dataset**.** The data set contains information about the features of Indian currency note with class. The features are extracted using Wavelet Transform Tool.

The total number of records are 1372 and there are 5 features present in the dataset.

TABLE I. Details about Dataset

S.NO	Features	Type	Datatype
1	*Variance*	*Independent feature*	*Numeric*
2	*Skewness*	*Independent feature*	*Numeric*
3	*Curtosis*	*Independent feature*	*Numeric*
4	*Entropy*	*Independent feature*	*Numeric*
5	*Class*	*Dependent feature*	*Boolean*

TABLE II. Dataset Division

Training	Testing
80%	20%

3. FLOW OF WORK

The flow of work is consisting of connecting blocks, having different function to perform.

The same dataset is exposed to both the algorithms, the best model has been taken out based on the performance metrics.

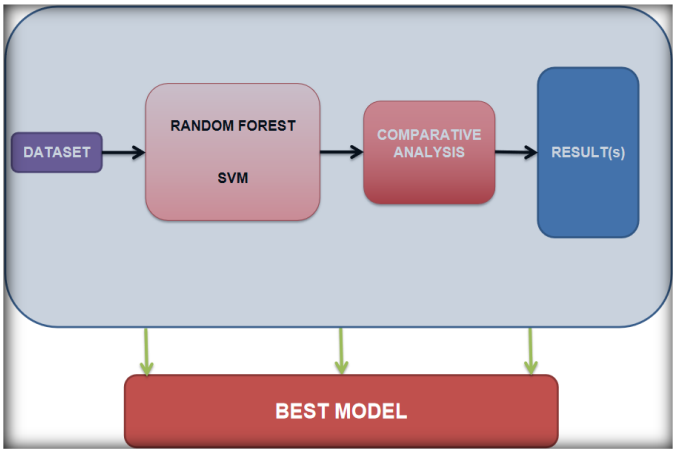

Fig.3. Flow of work

4. PERFORMANCE METRICS

A. Accuracy :

$$\frac{(TP+TN)}{(TP+TN+FP+FN)} \quad (1)$$

B. Confusion Matrix

		Actual Values		
		Positive	*Negative*	
Predicted Values	*Positive*	TP	FP	Precision
	Negative	FN	TN	
		Sensitivity	*Specificity*	*Accuracy*

Fig 4: "Structure of Confusion Matrix"

C. Classification Report

i. **Precision :**

$$\frac{TP}{(TP + FP)} \quad (2)$$

ii. **Recall**:

$$\frac{TP}{(TP + FN)} \quad (3)$$

iii. **F1 score** :

$$\frac{2*(Precision * Recall)}{(Recall+Precision)} \quad (4)$$

IV. RESULT

The obtained results are shown in this section. The above mentioned performance metrics used for evaluating the performance. SVM achieved 99.6% accuracy outscoring Random Forest.

i. Accuracy

TABLE III. Accuracy of Random-Forest & SVN

Random Forest	SVM
98.54 %	99.63 %

ii. Confusion Matrix

TABLE IV. Random-Forest Confusion Matrix

		Actual Values		
		Positive	**Negative**	
Predicted Values	**Positive**	***155***	***2***	***Precision = 98.7***
	Negative	***2***	***116***	
		Sensitivity= 98.7	***Specificity= 98.3***	***Accuracy = 98.5***

TABLE V. SVM Confusion Matrix

		Actual Values		
		Positive	**Negative**	
Predicted Values	**Positive**	***156***	***1***	***Precision = 99.3***
	Negative	***0***	***118***	
		Sensitivity= 100	***Specificity= 99.1***	***Accuracy = 99.6***

iii. Classification Report

TABLE VI. Random Forest Classification Report

	Precision	**Recall**	**F1-score**	**Support**
0	0.99	0.99	0.99	157
1	0.98	0.98	0.98	118
Accuracy			0.99	275
Macroavg	0.99	0.99	0.99	275
Weighted-avg	0.99	0.99	0.99	275

TABLE VII. SVM Classification Report

	Precision	**Recall**	**F1-score**	**Support**
0	1.00	0.99	1.00	157
1	0.99	1.00	1.00	118
Accuracy			1.00	275
Macroavg	1.00	1.00	1.00	275
Weighted-avg	1.00	1.00	1.00	275

V. CONCLUSION

Currency is legally sanctioned by the government, which we use it in our daily routine as a medium of exchange either for selling or purchasing the goods and services. Due to enhanced technology, the creation and circulation of forged currency notes have been increased, leading to artificial inflation and deflation of the real value of money. Moreover, it is used for terror-financing, which results into disturbance in a society. To overcome such adverse effects of Forged currency, Random Forest and SVM (Supervised)Machine Learning Algorithms are used to detect the fake currency notes based using its features. The performance metrics to evaluate Random Forest and SVM are Accuracy, Confusion Metrics and Classification Report. The results show that SVM outscored Random Forest by achieving an accuracy of 99.63% .

VI. ACKNOWLEDGMENT

A special thanks to our Faculty Dr. Vivek Sharma who bestowed us the golden opportunity to demonstrate our expertise through the wonderful Forged Currency Notes Detection Project, which has enabled and motivated us to do a lot of research. As a result, we have learnt many new things, we all are very grateful to him.

VII. IMPROVEMENTS & FUTURE SCOPE

In this paper, we have used the machine learning algorithms. The large & complex dataset can improve our proposed methodology and make it more robust and hence provide us better results. Our Future Scope is to incorporate Deep Learning based models which can provide better solutions to complex dataset which are non linear in nature, that will make the fake currency detection system more robust and effective.

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