ANALYSIS AND EVALUATION OF DEEP NEURAL NETWORS FOR A VISION BASED CURRENCY NOTES RECOGNISING SYSTEM WITH VARIOUS ML TECHNIQUES

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ABSTRACT—

Outwardly disabled individuals confronted an issue in distinguishing and perceiving the various sorts of banknotes because of certain reasons. This difficult causes researchers to notice present a robotized banknote recognition framework that can be separated into a dream based framework and a sensor-based framework. The fundamental point of this investigation is to have a more profound examination of the impact of region and orientation on the exhibition of Machine Learning and Deep Learning individually utilizing Malaysian Ringgit banknotes (RS 500,RS 2000) In this task, two tests directed on two kinds of banknote picture: diverse region and orientations caught by utilizing handphone camera in a controlled situation. Highlight extraction of the RGB esteems called RB, RG, and GB from banknote picture with the distinctive region were utilized to the machine learning order calculations, for example, k-Nearest Neighbors (kNN) and Decision Tree Classifier (DTC), Support Vector Machine (SVM), and Bayesian Classifier (BC) for perceiving each class of banknote. Banknote picture with various orientation was straightforwardly taken care of to AlexNet, a pre-prepared model of Convolutional Neural Network (CNN), the most mainstream picture handling structure of Deep Learning Neural Network. Ten times cross-approval was utilized to choose the improved CNN, DTC, SVM, and BC which depended on the littlest cross-approval misfortune. From that point forward, the presentation of kNN, DTC, SVM, BC, and AlexNet model was introduced in a disarray lattice. Both CNN and DTC accomplished 99.7% exactness yet both SVM and BC perform better by prevailing to accomplish 100% precision. It additionally can be presumed that AlexNet can possibly perform incredible in testing new information if just the information had recently been prepared with comparable orientation. Orientation offers impact to the presentation of the AlexNet model.

Keywords—*Banknote Recognition, Region, Orientation, Machine Learning, AlexNet*

I.   INTRODUCTION

The identification of fake banknotes is significant in numerous applications, for example, banking, great merchants, and great tellers. Banknote fake location is a cycle of recognizing in-certified monetary standards. The development of falsified cash is turning into an incredible danger to worldwide by affecting every nation's economy completely [1]. The creation of monetary standards around the globe has dispatched a worldwide test to stop money forging. Despite the fact that the banknotes are fused with a few security highlights, yet because of immense upgrade in printing media makes straightforwardness to make fake banknotes. In this manner, recognizing fake banknotes is a fundamental requirement for nation to secure its economy.

On November 8, 2016, the Indian government reported the demonetization of all Rs. 500 and Rs. 1,000 banknotes. It additionally reported that it would give Rs. 500 and Rs. 2,000 new notes in return for demonetized notes [2]. The Indian Government accepted this demonstration would shadow economy and decrease the utilization of unlawful and fake money to finance criminal behavior and psychological oppression. Yet, the average folks turned into the real casualties of fake banknotes misrepresentation. Fig. 1 and Fig.2 shows Fig.2: Statistics of Demonization-wise Detected Counterfeit Banknotes [13]

Every Indian cash note has explicit security includes that are followed for all the banknotes. With the assistance security includes, the location of authentic banknote is conceivable. In this paper, the proposed method removes the security highlights from the picture of the banknote and distinguishes its validity utilizing Machine Learning strategies. As of right now, there are different procedures that have been executed to identify the fake banknotes; yet tragically a considerable lot of these are exceptionally perplexing just as require equipment support. There are scarcely any fake money location methods actualized by numerous specialists in the field of Image Processing [3] just as Machine Learning [4]. A portion of these are executed utilizing picture planning strategies yet are not exact. To defeat the restrictions of the effectively actualized methods, in this paper, we propose a productive and financially savvy fake money discovery through a Mobile application that utilizations Machine Learning procedure Support Vector Machine [8] to verify the banknotes.

The proposed framework follows the means including Image Acquisition, Region of Interest trimming from Image, Feature Extraction and Machine Learning Technique to anticipate whether the info picture of banknote is genuine or fake. Machine learning is a capacity of PC frameworks to freely discover answers for issues by perceiving designs from information.

Machine Learning Techniques are fundamentally isolated into Supervised Learning and Unsupervised Learning [5]. It totally relies upon the sort of Data assortment that which kind of method should be executed for acceptable outcomes. Managed learning happens when the framework is given info and yield factors and needs to figure out how they are planned together. Regulated learning is as the name demonstrates the presence of a chief. A directed learning calculation gains from named preparing information, and assists with anticipating results for unexpected information. Regulated learning method falls fundamentally into relapse and grouping. Relapse is executed when the yield variable/class mark is nonstop numeric, and grouping is actualized when the yield variable/class name is discrete and non-numeric or having classifications. Solo learning procedure is unlike regulated learning where the information contains values for input variable yet having no comparing yield variable. As such, solo learning isn't related with the oversight. Solo learning further arranges into bunching calculation and affiliation calculations [4].

The Indian money has security highlights which considered as information highlights to the ML calculation alongside the mark related with that highlights whether the banknote is fake or genuine. Every nation's money notes are related with security highlights by help of which the SVM figure out how to characterize the info picture. The security highlights are then separated from the picture and are changed over to vectors to continue them for preparing the Support Vector Classifier.

II.   LITERATURE SURVEY

The work in Paper [1] centers around the building up a framework which can work kind of a bionic eyeglass that is portable stage which incorporates visual identification and recognition capacities. Dataset pictures of banknotes were taken by versatile camera, significant shapes are removed from pictures utilizing versatile thresholding and morphological shape channels. So as to plan a dependable and vigorous banknote recognition calculation framework had the objective to decide article or set of visual items that are anything but difficult to identify and sufficiently assorted to work as a premise of further recognition. The framework is prepared to utilize numerous highlights for arrangement of banknotes and subjects effectively get the chance to comprehend the best approach to utilize framework certainly. Common reasons for mistakes were happened when executing the framework like covering the region of enthusiasm with at least one fingers, can mess up recognition.

Alongside the Identification of Banknotes it's important to identify the fake banknotes too , paper [2] proposes a framework which will perceive fake notes as well as somewhat noticeable, collapsed, wrinkled or perhaps worn by use. This task utilizes Computer vision framework for perceiving numerous banknotes with various view, scales and condition having variable light powers. It utilized Computer Vision(OpenCV) for accelerating the cycle then by decreasing commotion and CLAHE for expanding

contrast, Recognition measure done by Scale Invariant Feature Transform(SIFT), accelerated Robust Features (SURF), Features from Accelerated Segment Test(FAST), Oriented FAST and Rotated BRIEF (ORB), Binary Robust Invariant Scalable Key focuses (BRISK).This framework accomplished better shape assessment. Drawback of framework is that for test pictures during which the vast majority of the banknotes regions were blocked, the nearby inliers proportion performed better. This occurred because of nearby coordinating of patches maintains a strategic distance from the evacuation of consequences of recognizable proof that have low inliers proportion.

The Paper [3] proposed a particular way to deal with survey the model which will utilize include discovery and perceive Indian Currency notes. The principle highlights of Indian cash are concentrated quickly all together that manufactured framework will be beneficial for the outwardly impeded individuals to identify specific element of specific note. For focal numerals, an obvious word jargon and preparing a classifier created by twofold Support Vector Machine (SVM) classifiers. The proposed framework identifies the image via preparing a course object identifier in MATLAB and along these lines the HOG descriptor utilized for perceiving the Ashoka Pillar symbol on money where CIE LAB Color Space model has been worked for shading investigation of the banknotes. The delta-E separation among preparing and testing of information to characterize the cash and format coordinating for recognition of distinguishing proof mark, the two gives end in 100% precision. Notwithstanding, picture histogram for shading and Markov chain for surface examination yielding a fairly lower precision as different banknotes could have comparable hues and surfaces, accordingly diminishing the effectiveness.

A model included Optical Character recognition (OCR), Face Recognition and Hough change calculation is given recently in 2019 by Adiba Zarin, Jia Uddin. The highlights of Bangladeshi notes, for example, microprinting, water-mark, and bright lines are separated and tried for authentic notes. The test consequences of the given model picked up the accomplishment to get the exactness as high as 93.33% which makes it reasonable for organization on a portable application. Besides, the got outcomes are contrasted and the yield from singular calculation of OCR, Face Recognition and Hough change, to show that the proposed calculation gives the most noteworthy exactness [10].

III.   PROPOSED APPROACH

The fake banknote location is required in numerous applications, for example, Banking, Selling Goods. Manual checking of notes and distinguishing deceitfulness is a very tedious task. In this way, the Indian Counterfeit banknote recognition framework distinguishes the fake banknote of India dependent on specific security highlights with assistance of which the framework can choose whether the Banknote is real or not.

Fig.3: Rs. 500 Banknote Image

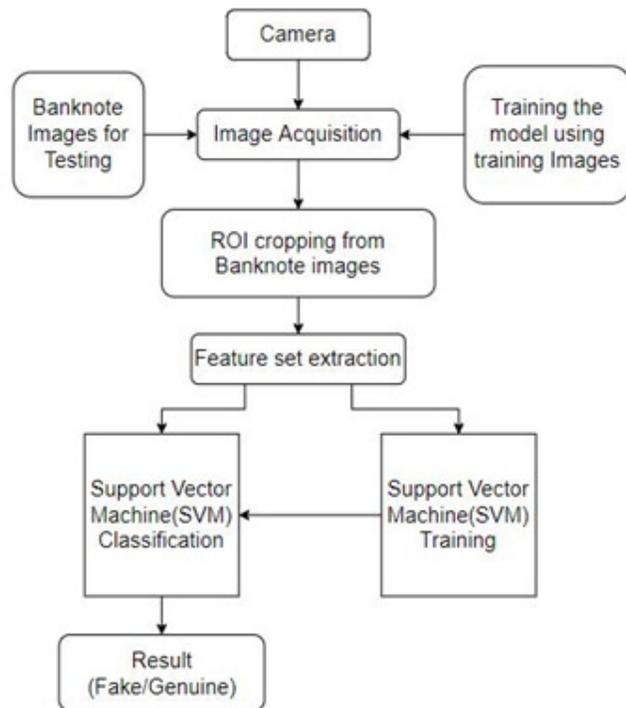from image, feature set extraction and performs classification. The methodology is depicted in Fig. 2.

Fig. 2 security features embodied in an Indian banknote.

Fig.3. Rs. 2000 Banknote Image

Name of Security Feature	Description
Latent Image	Latent image showing the respective denominational value in numeral. The latent image is visible only when the note is held horizontally at eye level.
Devanagari Script	This feature represents the denomination number of the banknote written in Devanagari script.
Security Thread	Security thread has a plain, non-readable fully embedded security thread.
R.B.I. Logo	Reserve Bank of India Logo
Denominational Number	This feature represents the denomination number of the banknote.
Identification Mark	This feature is in different shapes for various denominations i.e. Rs. 20 have in Vertical Rectangle, Rs.50 in Square, Rs. 100 in Triangle and Rs. 500 in Circle.

TABLE I Security Features [12]

Security includes that are related with the banknotes are utilized as ascribes to prepare the Support Vector Machine. The framework workflow includes Image Acquisition, ROI trimming

Following are the subtleties of each stage:

1)   Image Acquisition: Image obtaining is a cycle of catching pictures of the banknote by utilizing an advanced camera or scanner in various conditions to preprocess and upgrade quality for additional preparing procedures. As it were, this is where the preparation information is procured so as to prepare SVM for having a superior arrangement of fake banknotes.

2)   ROI Cropping: Region of Interest editing from the picture cycle includes trimming out the security highlights from the Banknote picture. The trimmed pictures will additionally be considered as highlight independently. A lot of highlights at that point will be passed onto the Machine Learning calculation to make the forecast.

3)   Feature Set Extraction: Feature Set extraction is a significant advance in the development of example groupings, pointed toward removing pertinent data that describes each class of a specific cash. In this cycle, security highlights are removed from ROI edited pictures and afterward changed over into include vectors. These component vectors are utilized by the classifier to perceive input units and target yield units. Indian banknote pictures have numerous highlights that can be utilized to speak to banknote pictures.

4)   Training Support Vector Machine: Training is the cycle where the Support Vector Machine learns the example of the banknote's highlights. The separated component vectors are utilized to train the framework. The preparation cycle includes learning the examples of the preparation banknotes and afterward the result of Training is a Support vector classifier. The Support Vector classifier has the capacity to identify the falsifying of the cash. Preparing information is as significant as the core of the human body. Great nature of preparing information guarantees the better classifier.

5)   Classification Using Support Vector Machine: Once gathering highlight vectors of the banknote, it is important to perceive the example of the banknotes on the base of these removed highlights, which ought to be prepared by a fruitful classifier for the banknote recognition framework. Here proposed framework is going to utilize one of the most natural classifiers which had been utilized for various application as of late supposed support vector machine. By the preparation utilizing preprocessed Banknote pictures, the classifier can distinguish the fakeness of banknotes. In a working situation, the banknote picture is caught by means of a portable camera or scanner and in the wake of experiencing the Image preprocessing and highlight extraction stage the money note is certifiable or misrepresentation is recognized utilizing the pre-prepared SVM classifier.

The framework cycle begins with picture procurement utilizing a camera or scanner. Simultaneously, the framework expects us to choose the group. In view of the chose group, a specific classifier invokes. As there are three classifiers in the framework. One of the classifiers is for Rs.100, the classifier for Rs.200, and another classifier for Rs.2000 banknote. The framework can be utilized for a fake banknotes recognition by providing related preparing banknote pictures. So that the framework can be utilized for bogus money discovery for any nation, given the SVM is prepared according to the ideal prerequisites. In preparing and testing the dataset, all pictures of the banknote are certified, and just the presently utilized Indian banknotes. All monetary standards utilized incorporate collapsed, old, torn, and new brands, yet do exclude past monetary standards as these notes are viewed as fake for the present.

IV.   IMPLEMENTATON AND RESULTS

We plan to distinguish the fake banknote with the assistance of security includes that are installed onto the banknote itself. In our work, we have picked three highlights that will be utilized to test the fakeness. These highlights are utilized as contributions to prepare the SVM for arrangement. Picture securing is performed utilizing a versatile camera. The individual highlights are then removed by the utilization of ROI editing and the individual element is then considered as an autonomous vector. Our primary concern is to extricate the examples that are engraved upon banknotes the cycle follows by ROI editing. Additionally, computerized picture enrollment is utilized to isolate the note divide from the background. When the security highlights are separated into the list of capabilities vector, every vector is treated as an individual element so as to prepare the machine learning model. We focus to streamline the exactness and interpretability of the classifiers, and we look at the exhibition of the proposed Support vector classifier with different Machine Learning ordering calculations.

The goal of the Support Vector Machine classifier is to locate the ideal hyperplane which directly isolates the information focuses in two segments by boosting the edge. Additionally, SVM is utilized to discover the isolating hyperplane ideally so the arrangement mistake is limited for the given test tests. A SVM achieves the ideal hyperplane which straightly characterizes (isolates) the bigger bit of the preparation information focuses while boosting the good ways from the hyperplane. Twice this separation is known as the edge.

There are 30 banknotes in our dataset. Among 30 banknotes, 15 notes are certifiable and 15 notes are fake. We have utilized the hold-out technique for assessment and utilized 80% information to prepare the classifier. That is, to prepare the classifier there are 12 certified notes and 12 fake notes. The yield of the classifier can either be 1 for an authentic banknote or 0 for a fake banknote. As we have thought about preparing the classifier with the assistance of 3 highlights, which are Latent picture, Security string, RBI logo. The proposed framework creates roughly 80% precision up until this point. This is a direct result of the little information size and furthermore pictures are taken with a normal goal camera.

Fig. 4 and Table II speaks to Accuracy (in %) of classifiers, for example, Logistic Regression, K-Nearest Neighbors, Random Forest, and Support Vector Machine and Performance assessment framework for example Disarray lattice for Rs. 500 note utilizing Support Vector Machine. The disarray network is introduced to grandstand class-wise discoveries.
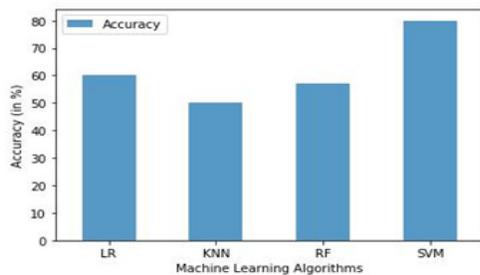

Fig. 4 Accuracy (in %) of various classifiers

		Predicted Class	
		Fake	Genuine
Actual Class	Fake	9	2
	Genuine	4	9

TABLE II: Confusion Matrix using Proposed Approach

CONCLUSION

In a decision, a dream based mechanized calculation that can perceive and arrange the INDIAN RUPEE banknote utilizing machine learning and profound learning model was all around created. Both SVM and BC give a superior and static presentation in arranging information base with 3 unexpected regions in comparison to kNN and DTC. Alex.Net can't perform well in testing the new information base with various orientation yet give incredible 100% exactness with a data set of comparable orientation. From this calculation, the outwardly hindered individuals ready to improve their personal satisfaction by decreasing the reliance on others particularly during grocry exercises.

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