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Bank Note Recognition using Vision-Based System

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***Abstract*— According to the latest estimations by the World Organization from their research, it is known that there is a large population across the world who are not gifted with perfect vision, recently estimated as 2.2 billion. And along with blindness comes around many challenges like walking, accessing the current technology, socializing, identifying basic things such as medicine, reading, cooking, and many more. And one of the most challenging things a visually impaired person can face is recognizing currency notes. The motive of the research is to evaluate the performance of the ground-breaking technologies, i.e., Artificial intelligence and Machine learning in recognizing different kinds of banknotes but also provide the voice assistance to the system. Previous studies include the images of the banknote directly fed to AlexNet and, the currency note picture with various orientations and taken in different environments are fed into the machine learning classification using one of the algorithms such as K-Nearest Neighbours (KNN).**

***Index Terms*—Currency recognition, visually impaired people, vision-based system, random forest classifier, python**

I. INTRODUCTION

For a normal person with correct eyesight visualizing and identifying banknote is task of not much importance because their brain is capable of absorbing and processing the information. They can recognize with minimum to no effort, but unfortunately for the visually impaired, that is not the case. Because of their weakness, they get cheated and exploited. Sometimes, elderly people with perfectly functioning pair eye cannot tell the kind of banknote they are holding. Even though there are distinguishable features like the size of the banknotes that tell their differences apart, visually impaired people and elderly people are victimised by this issue. Nowadays banknotes are detected using a sensor-based or camera. Although this sounds interesting, it has proven over the years that it may have less accuracy than vision-based systems. Not only visually challenged people but also many others all over the world can use the system in accomplishing their day-to-day tasks with much security and ease. One such technology is Convolutional Neural Networks; which is a subpart of Deep Learning Neural Networks. These Convolutional Neural Networks are used in image processing to achieve results of better accuracy. Image processing is not the only application of CNN, it is also used in many areas in today's research field such as the world of medicine, which made miracles in the detection of cancer, security, and surveillance like home security, license plate detection used in near traffic systems.

II. LITERATURE SURVEY

This is a literature survey conducted by exploring and studying different resources and textbooks. In general, the

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detection can be done by either using a sensor-based system or a vision-based system (camera). Using a sensor-based system results in less accuracy because it involves sensors and many electrical components. So, the vision-based system is used because it is the most used medium.
Gowri Sanjay Tele et al. (2018) state that a fake currency misses many features that a genuine one has such as latent image, watermark ID, and security thread. The work developed a method for extricating properties and the general traits of the currency notes. This can get complicated as it extracts both detectable and undetectable features. This detection can be done by using Image Processing [1].
Navya Krishna G et al. has used Convolutional Neural Networks [2,3,4]. The system developed checks whether the currency note is genuine or not. Image recognition depends on Deep Learning. This model has better performance than the previous model which makes use of Image Processing [5].
N. A. J. Sufri et al. used the algorithms: k-Nearest Neighbors (kNN), Decision Tree Classifier (DTC), Support Vector Machine (SVM), Bayesian Classifier (BC), and AlexNet. But SVM and BC have achieved greater accuracy than kNN and DTC. [6].
Iyad Abu Doush et al. state that colours are used to describe an object, without colour features many objects cannot be matched correctly. SIFT algorithm compares and classifies many objects. The results show that number of features recognized in colour SIFT are significantly larger than compared to grey scale SIFT [7,8].
Gustavo Adrian Ruiz Sanchez et al. state that their model has achieved 98% accuracy on smartphone videos. In this they have used foreground segmentation algorithm. This detects notes present only in a video. To minimize reasonable threshold this study, chooses 0.6 threshold. Fast Library for Appropriate Nearest Neighbors (FLANN) is used to match high dimensional vectors. The result was 10% false negative rate [9].
Yueqiu Ren has proposed Banknote Recognition in real-time using ANN. Euclidian distance- based MDC and BPNN classifiers are used to classify banknote to specific category. The dimensionality is reduced by PCA and LDA. The image in the form of RGB is converted to HSV mode in MATLAB. F-measure is used for classification [10].
Professor Chetan More, Monu Kumar, Raushan Singh, Rupesh Chandra have published a paper “Fake Currency Detection using Basic Python Programming and Web Framework”. The research was done and published in the year of 2020. In this research a popular web framework called as Flask is used (flask is a web framework of the programming language python) [11].
Vivek Sharan and Amandeep Kaur have proposed “Detection of Counterfeit Indian Currency note using Image Processing” in the year of 2019. There are many features that separate the counterfeit from the genuine notes and among them, they have considered mainly three distinguishable features: latent image, denomination (rupee symbol on the banknote), and the RBI symbol. These three features are used to develop an algorithm to detect counterfeit banknotes [12].
Akash S Patil in the year of 2019 has published a paper “Indian Paper Currency Detection”. In this paper he detailed a new algorithm to improve the accuracy and the speed in the recognition and classification process. OpenCV library of computer functions is used for identification and classification of the notes (a library of python programming NumPy is also used) [13].
Archana M R, Prajwal S K, Kalpitha C P, Pratiksha N have published a paper “Identification of Fake Notes and Denomination Process” in the year of 2018. Their intention was to reduce the human power used for the classification by automating the process. The system they developed can be made into two parts: the first part is the note recognition, and the second part is the conversion system [14].
Sungwook along with their team aimed at developing an algorithm which not only recognizes their country’s currency but also many other currencies. The concepts that were used to develop the model are segmentation of the image, equalization, and they have also extracted region of interest. The algorithm developed using local binary approach has an accuracy of 92% [15].
S. Atchaya, G. Kaviarasi, K. Harini and B. Swathi have published a paper “Fake Currency Detection using Image Processing” in the year 2017. Using MATLAB (image processing) they have developed a technique called Performance matrix for the purpose of detection of counterfeit currency. Various features like fluorescence, watermarks, and optically variable ink are used for the detection [16].

III. IMPLEMENTATION

The data flow diagram in the Fig 1 depicts the user first loads the dataset from the files and the image pre-processing is done by feature extraction, which is extracting the important features in a currency note such as latent image, watermark id, fluorescence, micro lettering, and many more. After the feature extraction, we then apply the random forest classification. One of the image processing algorithms used is SIFT, where color is the feature that is used to describe the object in an image. Then the output is given as one of the seven kinds of denominations.

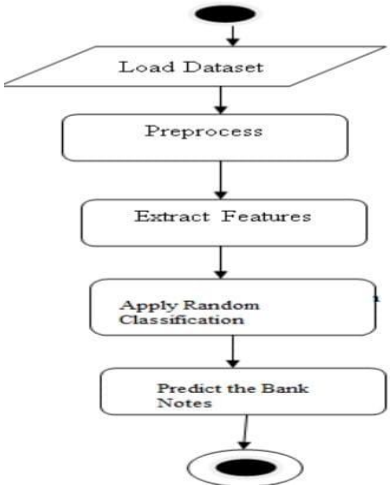

Fig 1. Data flow diagram

IV. METHODOLOGY

In this chapter we will explain about methods we used in this work. First step is to collect the data, we took 150 pictures for the seven denominations of Indian notes, a common thread to be observed in these pictures is that the background surface must be plain. Next, we load the dataset, each image is then pre-processed by extracting different features such as HuMoments and then histogram of the image is plotted. The features are then concatenated together to form a single feature vector. After the preprocessing, the random forest classifier is initialised with 200 estimators and multithreading is enabled. The progress of the estimators is constantly recorded, a dictionary is created with all the hyper parameters then a grid search is performed on these hyper parameters to find the best set of parameters. The classifier is then made to fit on the training data and a confusion matrix is created. The system then predicts the notes.

V. RESULTS

The GUI developed is shown in the Fig 1 where the user can browse the system to select dataset and note for classification, there is also a clear button next to the select dataset button to clear the old dataset and browse a new dataset. At the bottom of the application there are several buttons including preprocess, parameter tuning, model training, prediction, classification, live and quit. Preprocess, parameter tuning and model training can be used to train the model in case there is new dataset that has been added. Prediction is used to classify a single banknote and voice output is provided. Classification can be used to classify both single note and multiple notes as well shown in the Fig 2, 3 and Fig 4 respectively. The live button can be used to open the camera and quit button closes the application. The current accuracy for the system is around 96% and we aim to improve the accuracy by further training the model.

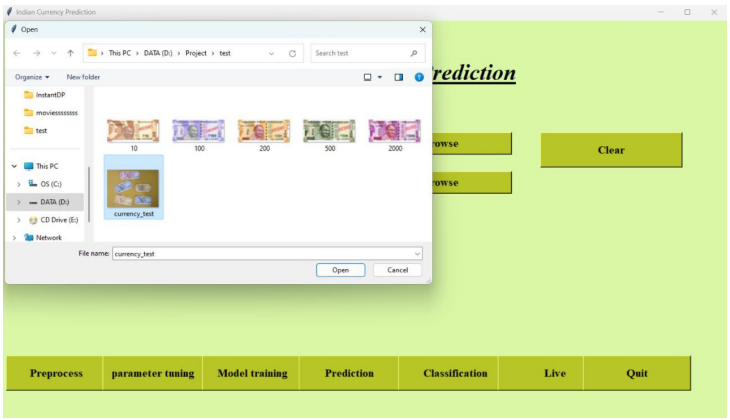

Fig 2. The GUI Indian Currency Prediction is opened and browsing the dataset

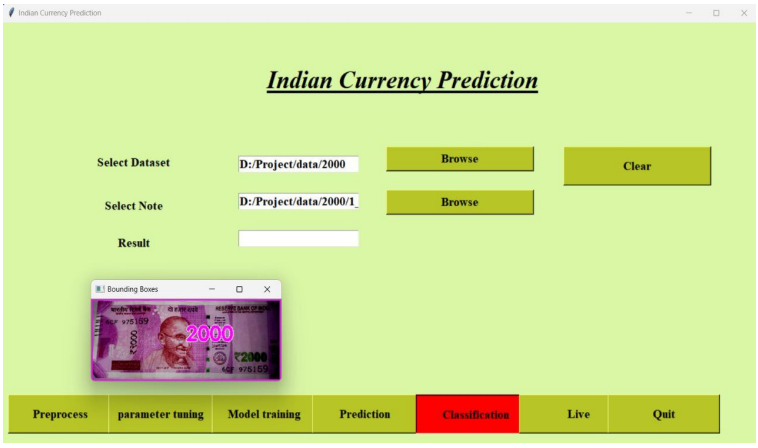

Fig 3. 2000 Rupees banknote is classified as 2000

Fig 4. Multi-note classification is enabled

VI. Conclusion

We aim to develop a system which is vision-based that can help not only visually impaired people and elderly people but also any person with imperfect eyesight to identify Indian banknotes. We aim to develop a system which is highly accurate and fast in recognizing Indian banknotes. And we also aim to make the system user-friendly by providing voice assistance to the system, which will make it more convenient for visually impaired people to use. The algorithm that has been proposed is automatic and hence it doesn't need human intervention. This system can be used by people for their day-to-day activities. We aim to provide progressive and efficient results. This system has other applications such as currency exchange machines and electronic banking.

Future Work

Future research can be focused on including banknotes with different backgrounds and not a just plain background. A more efficient and user-friendly product can be developed with more accuracy. As there are many types of visual impairments, different solutions can be developed for each type. With more dimensions and different backgrounds, the application needs to be trained.

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