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Currency and Fake Currency Detection using Machine Learning and Image Processing - An Application for Blind People using Android Studio

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***Abstract*— Any development in technology is made with the intention of solving the difficulties in that field. One such identified problem is blind people were unable to make out the type of currency. The proposed model efficiently identifies the type of currency. The converse of this leads to the printing and scanning of currencies and releasing them into the market, which not only affects the economy but also reduces the value for money. This further causes some conflicts and a great threat to the country. Thus, a need for efficient currency and fake currency detection methods is required. Finding fake currencies is done by any ways. The proposed work identifies the currency's originality by examining its images. The code simulated using MATLAB extracts the features of currencies. Machine learning models are used for mapping the extracted feature to its standard value, it is able to identify the fake currencies efficiently.**

Keywords—Computer vision, Machine Learning, Currency Detection, Teachable Machine, Android Studio, Image processing, Edge detection, ROI extraction.

I. INTRODUCTION

In the modern world require a methodology or a solution that works on automation system which we can be used for currency recognition. It has different applications in real world including banknote counting machines, money exchange machines, electronic banking, currency monitoring systems, assisting blind persons etc. This type of automation applications can be used to help physically challenged people like blind and visually impaired people, as they can't see anything it is difficult for them to recognize any currency. This might be used as an advantage by other people. In order to avoid this type of problems and their dependency on others, there is a requirement of a system that can help them to identify currency in any possible orientation. According to census of WHO, 28.5 crore people around the world are visually impaired. Among these, 3.9 crore of them were blind and others have low vision. Many thoughts/ideas have come across to avoid this, but in vain. Many technological systems have been adopted which are designed by analysing various features of notes currency paper. Few currencies are sensitive to light and the rest do not. While for others we need to have a stable environment and a proper background to take capture the image and the same had to check for its originality. The computational power and camera availability of current smartphones make them a suitable candidate for currency recognition. But We can't say all these methods are 100% perfect. While testing of currency many factors influence the image quality and this may lead to wrong interpretation. Hence an android can be used in this context that can help the identification of currencies. Proposed model can recognize the Indian currencies of types (10, 20, 50, 100, 500). Figure 1 shows the currency with identification marks. Another major point is the result of the currency detected is connected to a voice system that speaks out the actual result. Here mobile speakers are used so that they need not depend on other people. For this, the user had to install this application in his/her mobile phone.

Fig.1. Currency with identification marks

II. LITERATURE SURVEY AND RELATED WORK

Karthik K *et al.* [1] have proposed a paper "Recognition of Fake Currency Detection using Machine Learning" the method described detection of counterfeit currency using a deep convolution Neural Network based fake currency detection. Ketaki Bhoyar *et al.* [2] have proposed an idea of currency detection and verification by using image processing. M. Laavanya *et al.* [3] gives an idea of all possible methods to identify fake Indian currency for fraud detection. Santhiya Irulappasamy *et al* [4] proposed SSIM as a method to find the currency is real/fake. Surendra Singh Chouhan *et al* [5] has proposed a paper on "A study on Indian fake currency detection". used image processing, edge detection techniques for the fake currency identification process.

Priyanka Dhapare *et al* [6] has proposed a paper on "The detection of Counterfeit Currency using Image Processing Techniques". This paper has proposed a way to get rid of such scams by using image processing and SVM feature extraction. Niketa Gandhi *et al* [7] has proposed a paper on "Recognition and verification of Indian currency notes using digital image processing". The designed system implemented using image processing techniques focuses more on extracting denomination values. Pandian, A. Pasumpon *et al* [18] proposed convolutional neural technique in currency identification for visually impaired people. Ranganathan G *et al* [19] proposed article outlines the design of an economical robotic arm which is used to visualize the chess board and play with the opponent using visual serving system. Although many systems have been implemented, but for blind people android based technique guides them in a way to identify the currency and make them not to depend on others[15].

III. Design and Implementation

The following software's are used in proposed implementation.

MATLAB: It is a programming and numeric computational platform used to analyze data, develop algorithms, and create models.

Teachable-Machine: It is an AI based tool that is quick enough to train or expertise a model to solve real-life problems / to manage real-life situation.

Android Studio: It is an IDE where one can create an android application based on the knowledge of some programming language, based on IntelliJ IDEA.

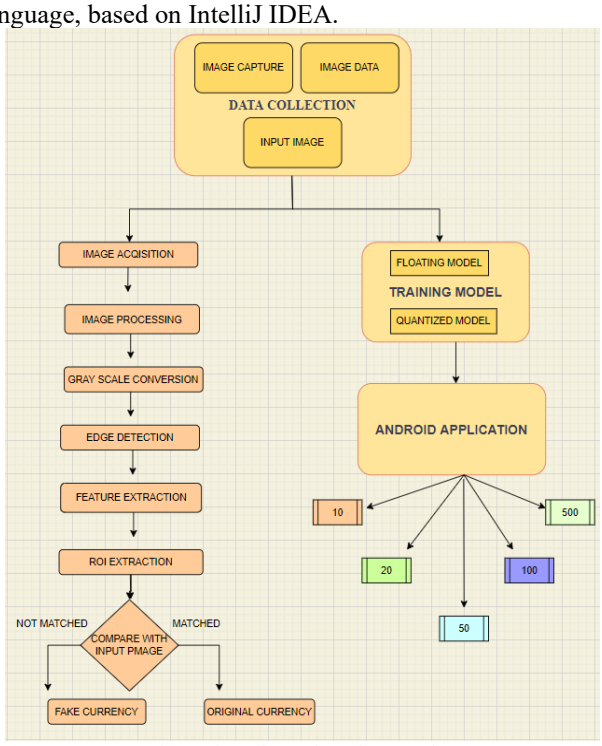

Fig.2. Flow chart of Implementation

Figure 2 shows the model design and flowchart of implementation. It gives the detailed view of working model of Currency detection as well as to check its originality. various methods which one can adopt to identify a currency and to check its originality. Although many methods have been discussed in the past to identify a fake currency, but only those methods which are speed and accurate in currency's originality are adopted.

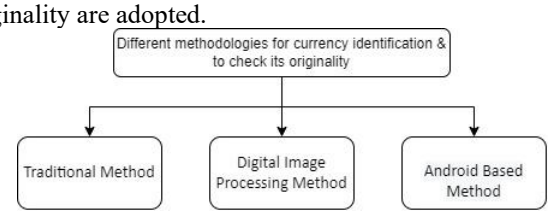

Fig.3. Implementation Methods

Figure 3 shows the different implementation methodologies adopted to identify the currency type and its originality[11][12][13].

A. Traditional Method-The very first proposed method is the traditional method where a common man employs the below mentioned features like Security thread, Serial Image, Latent Image, Watermark, Identification mark, Fluorescence, optically variable ink, Micro lettering, Intaglio printing etc. in identifying fake currencies. All of these features can be clearly identified by an ordinary person. This method would not assure 100% accuracy. Hence, we move on to scientific and mathematical based technique. In our current model, we had used MATLAB for simulation purpose.

B.Digital Image Processing Method- The proposed system works on the image of currency notes captured by a digital camera. The very first step involved is inputting an image done either by scanning or by capturing through a camera with good resolution. The captures / scanned image is a R-G-B (color) image which will be converted to a grayscale image for ease in feature extraction[8][9][14]. Now only those regions of the currency which we are interested to analyze (ROI – Region of Interest) will be cropped and segmented. From each segmented slice features like intensity are calculated. If the standard conditions are satisfied, then the currency note is considered as original otherwise fake[10].

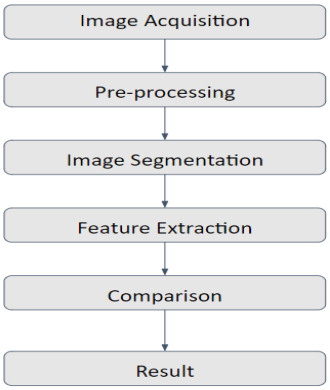

Fig.4.Steps of currency detection

Figure 4 shows the different steps involved in currency's originality detection using digital image processing method.

Image Acquisition- It is the process of capturing an image from a hardware-based source like scanner. The image captured is completely a raw image which has to be processed in the further steps.

Pre-processing-Image pre-processing is done to strengthen or intensify some of the features of image for future analysis and processing. 1. Noise Removal: Noise from the image is eliminated using median filter. Median filter strengthens the brightness of the image, then the obtained smooth image is stored.2. Aspect Ratio: Another pre-processing adopted was Aspect Ratio which is defined as the ratio of the width of the note to the height of the note, which is standardized as (66mm

X 166mm) 3. Gray-Scale Conversion: The image is then converted to grayscale image is usually sufficient to distinguish edges as the adjacent segments are compared with each other. 4. Image Binarization (image thresholding): It is the process of taking a grayscale image and converting it to black-and-white to reduce the information contained within the image shade range.

Image Segmentation- It is a method in which a digital binary image is broken down into various subgroups called Image segments which helps in ease extraction of features in further steps. Here we have employed a Global Threshold based segmentation i.e., based on the threshold value on pixel intensity of edge detected image. A Global threshold-based segmentation is a segmentation technique where in which we employ a binary image i.e., the image with only two intensity levels (0 & 1). Here the background image is assigned with intensity 0, hence gives a black outlook, while the image is assigned with intensity level 1, hence have a white outlook.

Feature Extraction-Feature extraction is the process of extracting the features like pixel intensity/ spacial or texture attributes or any other parameter from the region of interest (ROI) as a compact vector component. It uses an object-based that gathers the data of above-mentioned features.

Comparison-The features extracted from the input currency images enables us to differentiate fake notes from the real ones. To compare the performance, we have segmented the image and then we compare the two images and store the difference. Based on the pixel intensity difference obtained from each slice, the currency can be considered as a fake currency if it does not meet the standards, Otherwise the currency is a real one.

C.Android Based Currency Detection-The proposed system works on the real-time image of currency note taken from the camera activity of an application created to detect the currency. The algorithm flow can be observed at 3 different which is applied here is as follows: 1. *Collection of Data* 2. *Teaching the machine* 3. *Application Creation*

Collection-of-Data-Here the images of different denominations of the currency notes are taken either directly through the camera from the mobile or by showing the currency to the webcam. The images of the currency to be taken in all different denominations. Images of the currency denominations to be taken from all sides. Proposed work, teachable machine/images are used. The collected data to be classified and the same to be uploaded on different classes i.e., different denominations. As we increase the number of samples / images, the accuracy of the algorithm or our system increases, thus we will end up with higher efficiency.

Teaching / Training the model-Here in this phase , we had opted for the option called “Teach Model” as shown in the figure with default setting of Epochs, Batch Rate & Learning rate. Upon doing this, all the images of each class will be learned by the machine and accordingly the teachable machine provides tensorflow.js, TensorFlow & TensorFlow lite files (Floating / Quantized type as in figure 5), which we will be using in Android studio in creating an application of interest. In the process of teaching the model, the epochs, Batch size & the learning rate is to be set a s per figure 5(a) and once the model training is done, we need to export floating as well as the quantized files under TensorFlow Lite. The same are using integrating with the application software in android studio.

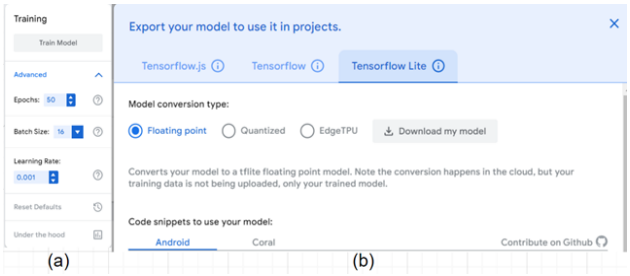

Fig.5. Model training and import files

Android Application development

Here in project model, we will be creating an application that could effectively identify the currency. For this, we are using Android Studio[16]. We had got an application based repository in GitHub Depository.As an additive we had used an online voice recorder, we had recorded the mp3 files for sounding of different currencies which we had used in our model[17].

Fig.6. Data collection, model training and application development

Figure 6 shows the data collection of various classes includes 10,20,50,100,500. Training the model in Teachable Machine and building an application using Android Studio. The application software used in detecting the currency type capable of detecting currency type effectively which uses the concept of image recognition, and model produces as audio output expressive the currency type. This is done by means of audio mp3 files downloaded using the online voice recorder and the same are used in the application design.

Fig 7: Region of Interest [ROI] recognition.

Figure 7 shows the ROI recognition code where the different identifiable regions of the currency are extracted and are compared with standard values.

```
mp = MediaPlayer.create(this, R.raw.hun);
mp1 = MediaPlayer.create(this, R.raw.ten);
mp2 = MediaPlayer.create(this, R.raw.Fhun);
mp3 = MediaPlayer.create(this, R.raw.Twenty);
mp4 = MediaPlayer.create(this, R.raw.fifty);
```

Fig.8. Media player source files

Figure 8 shows the different media-player source files accessing which are downloaded from online voice recorder are used enabling the audio output once the currency is detected among the selected denominations.

IV. Simulation Results And Analysis

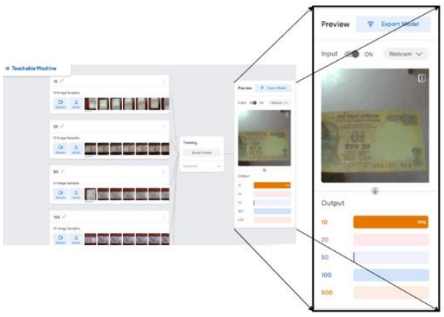

Fig.9. Teachable machine output

Figure 9 shows the Intermediate output on Teachable Machine – Currency Type Detection Here for a real-time currency of Rupees 10, the model gives an accuracy of 99%.

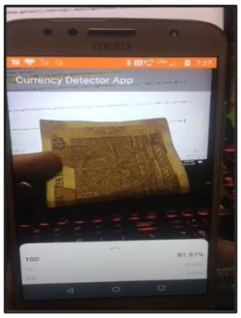

Fig.10. Currency detection App

Figure 10 shows the currency detection application. Application taking 10 rupees as an input image and output results with voice as well as percentage of output 81.57%.

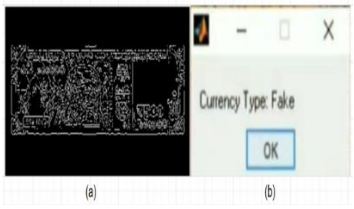

Fig.11. Currency's originality detection

Figure 11. shows the currency's originality detection with edge detection and feature extraction output floating window. Let the result of the experiment be considered at two different stages, one yields in detecting currency type and the other in determining its originality. The image acquisition is a common step for both above mentioned stages, then it has two diversions' i.e., android based currency type detection & other the MATLAB based currency originality detection. Fig 9 and 10 corresponds to the currency type detection. Fig 11 gives the output of currency's originality detection. If the accuracy level is less than 95%, then it indicates that we collect and had to feed it to the teachable machine. By doing this able to get a higher accurate design model.

V. Conclusion

Currency and fake currency detection is proposed for Indian paper currency system. Using this model, blind people can use this application to identify the currency effectively & efficiently. Obtained results shows that with an efficiency of 95% and above. Also, the currencies are classified into different denominations with more than 90% efficiency. Based on the intensities of the sliced section of ROI extracted image which when compared to the standard intensities of the currency notes, identified the currency's originality. The proposed model has low processing time and is cost effective. Hence it is very reliable for real-time applications.

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