WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Deep Learning Based Indian Currency Recognition for Visually Impaired People

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1. Introduction

Over the course of the previous decade, a great number of different structures and approaches to medical treatment have been established. These upgrades are being made with the goals of lowering the cost of medical diagnostics and providing the healthcare industry with technology that makes it possible for folks to handle things more readily than ever before without the direct supervision of an expert. [1]-[10] Nevertheless, people with disabilities were not the main focus of the majority of these advances. Nevertheless, there is an immediate need for technology that may support and aid in their day-to-day lives, improve their living circumstances, and eventually lead to greater levels of independence. The inability to see clearly stands out as the most serious of these impairments. According to the MOHFW India Report, blindness affects 0.36% of the population overall across all age groups; however, blindness affects 1.99% of the population overall among those who are beyond the age of 50. These individuals face a variety of challenges on a day-to-day basis, most notably when it comes to topics pertaining to money and other concerns associated with money. The term "currency denomination" refers to a certain amount of money, often for coins or paper notes. It may also refer to the physical form of the money.

Since the abandonment of the barter system, the currency has been a part of daily life. The term "currency" refers to any type of money that is used or circulated as a medium of trade, most notably circulating banknotes and coins[1]-[4]. Every country in the world has its currency, with its denomination that indicates its monetary worth. [5]Other currencies include the Rupee, the Euro, the Pound Sterling, the Dollar, the Japanese Yen, and the Dirham. Visually impaired persons have a tough time exchanging money because they are unable to distinguish between different denominations of currency. Following demonetization, new currency notes are released in India; each note is unique in terms of design, size, and color. The sizes of the 500- and 2000-rupee notes differ significantly, although the sizes of the 10, 20, 50, 100, and 200-rupee notes are nearly equal. As a result, it has become extremely difficult for the blind and visually handicapped to identify or recognize these currencies.

Due to continual usage, tactile markings on the surface of banknotes disappear or fade, making it difficult for those with visual impairments to correctly detect and identify banknotes using touch [1].The solution to this kind of problem can be found in the field of digital image recognition, which encompasses a wide range of tasks. [9]Here, patterns and distinguishing characteristics are sought after, extracted, and the outcomes are contrasted with real digital banknote images

The most significant contribution that the banknote detection and recognition system that was suggested makes is that it makes it simpler to utilize the practical standalone system, which will assist with the identification of banknotes in real time. This is the most important contribution that the system makes. Both pictures taken from the Kaggle dataset and pictures taken by the user themselves were utilized in the generation of the Challenging self-built dataset. This was done so that the dataset could be used for the Challenging self-built competition. After that, both the photographs and the labels that correspond with them are entered into the image categorization model. Each label is the name of a specific concept or class that the model will learn to recognize as more information is given into it. This information will be fed into the model. Teachable Machine is then used in order to put the model through its paces in terms of both training and testing.

After training and validating the model on a large dataset of images. The newly constructed model is put into action by means of the Android Application, which is utilized to carry out the implementation. The Android Application is created in Android Studio by using the Java libraries and the Application Programming Interface (API) that is provided by Java and the Android Studio.

The remaining sections of the paper are structured as follows: Section I provides background on Indian Currency Recognition for the Visually Impaired; Section II discusses relevant literature; Proposed Methodology used to implement the project is listed in Section III to explain the methodology, various figures are used to explain the model workflow; and conclsuion is discussed in Section IV.

2. Literature Review

Meharu et. al. [1] proposed the development of a neural-network based on Convolutional Neural Network, a model that employs pre-trained models to assist vision-impaired individuals in reading the real-time inscriptions of Ethiopian currency banknotes. Indeed, if the model's input photographs contain Birr notes that are incomplete, excessively damaged, or creased, the model's attempt to honor Ethiopian currency bills will be deemed unsuccessful. This investigation employs both a single-stage and a two-stage discovery strategy. After receiving a frame from a live videotape, the discovery system tries to assign a value of 1 BIR, 5 BIR, 10 BIR, 50 BIR, or 100 BIR to the incoming image.

Rahman Sarker, et. al. [2] has proposed a real-time currency discovery system for the blind in Bangladesh. Using image processing algorithms, the proposed method aids visually impaired individuals in effectively completing bill payments. This research resulted in the development of a system capable of recognizing Bangladeshi banknotes with their colorful angles and scales. The device can also detect crumpled, deteriorated, or weathered currency. The author praised traditional Bangladeshi paper banknotes by employing the widely-used sphere-grounded point descriptor.

V, C, et. al. [3] have proposed a system for rooting the parcels of Indian paper currency, which will be salutary in delivering sight to the visually bloodied. This approach is better at handling partial check and standpoint changes and works well for getting fresh class-specific data. Transfer literacy evaluation also demonstrates its effectiveness in dealing with visual gyration, dimension, and lighting changes. The thing of this design is to produce a stoner-friendly, real-time, simple-to-use, and accessible operation. This design will profit visually hindered persons by giving them vision.

Reddy, et. al. [4] proposes an idea for helping people who are blind or visually impaired locate items using a model that is based on the identification of images taken from a database of things. The foundation of the approach is the hypothesis that people who have been bled in some way exhibit distinctive visual traits. The results of the photo identification are sent to the user in the form of audio feedback from the system. The MobileNet armature and the Single Shot Sensor (SSD) frame have been combined in this model in order to give a system for the finding of things that is quick, efficient, and capable of a deep level of literacy. This method plays a role in the realization of a large number of discoveries in a single setting.

Rajendran, et. al. [5] proposed a study that investigates the use of Convolutional Neural Networks (CNNs) for societal enterprises, as well as the exhibition and evaluation of several CNN models. This research estimated the Alexnet, Googlenet, and Vgg16 models. In terms of compiling and evaluating specific data sets, every model was modified. This study revealed the operation of conception transfer literacy for bill recognition. The paper discusses the use of Convolutional Neural Networks (CNNs) to solve societal problems and investigates the presentation and evaluation of color CNN models.

Joshi, R.C. et. al. [6] proposes a real-time finding and identification of bills by using the YOLO- v3 CNN model- based bill discovery and recognition system, which is both quick and accurate. The YOLO- v3 model serves as the foundation for the system that is proposed in this work to identify and recognize bills or cash in real time and independently. The most important contribution that might be made by the proposed bills discovery and recognition system would be to simplify the usage of a convenient standalone device that could assist drug addicts in related bills in a real-time script.

Jadhav, R. et. al. [7] study is Currency Recognition Using Machine Learning. This study proposes an image processing-based method for identifying currency. This method relies on the three characteristics of hue, size, and texture, which are used for recognition. Numerous nations' currencies can be identified using the methodology presented in this paper. For purposes of implementation, only Indian paper currency is taken into account. Using this method, it is easier to scrutinize currencies anywhere, at any time, and CNN is utilized to carry out the procedure. The primary objective is to aid the visually impaired by providing them with a simple mobile application. The proposed system is expandable to detect coins and identify fraudulent currency.

Shraddha et.al. [8] proposed an investigation for Indian Currency Detection for the Blind using VGG-16. This study indicates that despite the prevalent use of credit cards and other electronic payment methods, the use of currency has not decreased due to the ease and convenience of using cash for everyday transactions. Those with ocular impairments who are unable to differentiate between the various currency bills face a formidable obstacle as a result of this exchange of money. This is due to the absence of a braille signature and the uniform texture of all currency notes. This study aims to develop a vision-based framework for detecting and identifying Indian banknotes. The VGG16 model, which can extract detailed features from currency notes, was selected for this study. The proposed system can aid in the classification of currency notes more effectively and even aid impaired individuals in identifying currency notes that have become deteriorated from repeated use. According to the most recent surveys, there are 165 visually impaired individuals for every 100,000 individuals. Eighty-two percent of the population is believed to have visual impairments, while 18 percent have weak vision. Convolutional neural networks, the deep learning technique, and the VGG-16 model are utilized in this endeavor to assist blind individuals in recognizing paper currency. This endeavor is primarily comprised of four elements: input, data, deep learning, train and test, and classification. This undertaking will benefit from the use of VGG16, which will enhance accuracy considerably (CNN model architecture). VGG16 provides more precise results than the current model because it is capable of extracting deeper features, according to the findings.

Pokala, R., et. al. [9] proposed research would use image processing to help impaired individuals recognize Indian currency. According to the study, visually impaired individuals may have difficulty distinguishing between distinct currency denominations. Various Indian coins are engraved with distinctive symbols, but impaired individuals have difficulty deciphering them. In this endeavor, the characteristics of each of the currency's reference photographs are contrasted. The numeric component of the currency is retrieved and compared if the difference is less than the predetermined threshold. Using open-source hardware (the Raspberry Pi) and software (Python), the primary goal of this paper is to develop a real-time paper currency identification and audio output system for the visually impaired. In this investigation, the ORB image processing technique was utilized, and the average processing

time was 9 seconds. This study concludes that the identification of currency for individuals with visual impairments, a significant problem in contemporary society, has been resolved.

3. Proposed Methodology

Prediction of Currency Denomination is difficult owing to the numerous variables involved. The dataset must be preprocessed, and the essential features must be combined into a single feature. After that, we will need to use the appropriate deep learning algorithm for picture categorization and identification of the denomination of the cash. The following are the steps that were taken in order to develop the Currency Denomination Identifier Application:

a. Data Collection and preprocessing

Data gathering and Pre-processing are the first steps in our method. We compiled this picture collection by scouring the web for open-source resources like Kaggle and Mendeley Data. The data includes information about the note, such as how much it is worth. Within the dataset, each currency note has its own class, which is divided into seven categories. A single dataset of labeled currency notes is used for each class. We will pre-process the data after it has been gathered to remove any incomplete or unnecessary information. We will also employ feature engineering to extract significant traits from the data. This procedure includes converting data into a more usable format for analysis.

b. Training the model

The second phase of our methodology involves "training" the model by instructing it to make decisions based on the information that has been gathered and analyzed. During this stage of the process, the data is partitioned into distinct classes according to the designation of the class name. In order to train the models, we will first separate the data into training datasets and testing datasets. The ratio of the training dataset to the testing dataset is 85:15, which indicates that 85% of the data is used for training and 15% is used for testing. The models are going to be educated by making use of the training dataset, and then the performance of the models is going to be assessed by making use of the testing dataset. The Epochs, Learning Rate, and Batch Size for the model that has to be trained are then fed into the system. In order to validate the performance of the models and alter the hyperparameters in order to improve accuracy, cross-validation will be used.

c. Optimize the model

The third phase of our methodology involves optimizing the model by making use of the findings received from first training the model and then testing the model. Modifying the parameters of the Epochs, Learning Rate, and Batch Size in which the model is to be trained allows for the possibility of the model's performance being improved. After the model has been retrained, a process called cross-validation will be carried out to evaluate the performance of the models and to adjust the hyperparameters in order to achieve a higher level of accuracy.

d. Evaluation Metrics

When evaluating the performance of our models, we will utilize a range of metrics, such as accuracy per class and confusion matrix. These metrics, which are often used for classification tasks, provide an indicator of the model's accuracy and performance by allowing the user to compare it to other similar models. The accuracy of one class (which is indicated by the pos_label) is compared to the accuracy of all the other data points in the dataset to arrive at the per-class accuracy. The term "confusion matrix" refers to a table that provides an overview of the performance of a classification system. The number of correct positive results, incorrect positive results, correct negative results, and incorrect negative results are all presented.

e. Prediction

After the model has been trained and refined, you can use it to make predictions about the denominations of the different currency notes. Keep an eye on how well the model performs over time, and retrain it if you feel it's required to get the desired level of precision

Fig. 1. Model Block Diagram

f. Model Deployment

We want to be able to run the models for apps locally so that users may still make use of the app even when they do not have an online connection. The following categories of modules are the most common ones:-

1. Camera.
2. Tflite.
3. Text to Speech.
4. Path Provider.

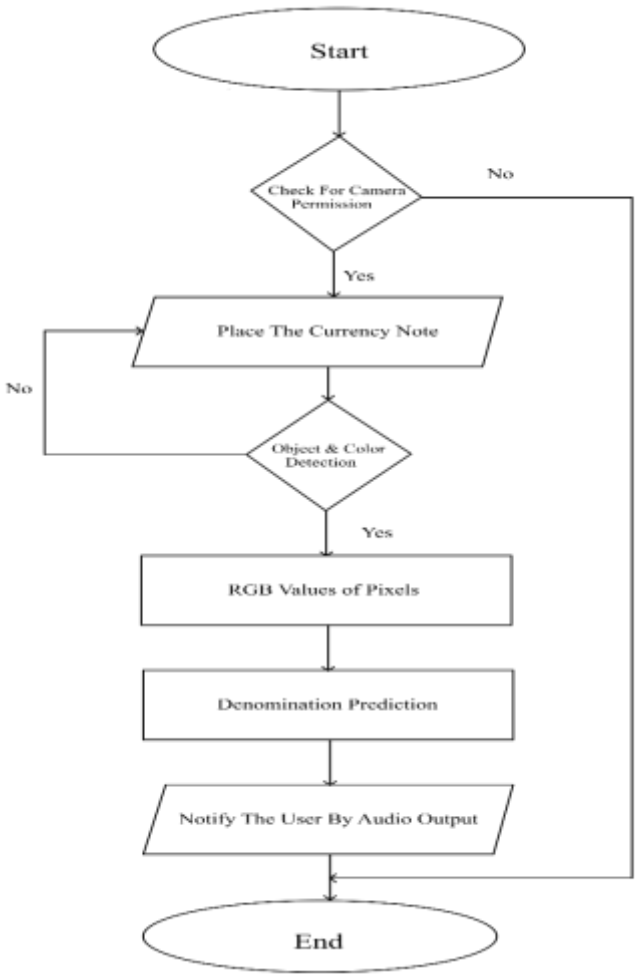

Fig. 2. Application Block Diagram

The backend consists of the tflite package, a tflite model, and labels that define each of the classes. Additionally, the backend includes a set of labels. The Tts module, which can convert written text into spoken language, is being used in this instance so that the final product may be made available as an audio file.

4. Conclusion and future work

With the help of our technique, we were able to reach an identification accuracy of 96.3 percent on an experimental collection of Indian rupees, and the mean calculation pace was quicker on a regular Smartphone. Our mission to devise a method that people who are blind or have low vision may utilize to differentiate between different currencies was accomplished with flying colors. We solved problems such as limited computing power and storage by migrating the system to a mobile platform. This allowed us to retain a high level of accuracy while reducing the amount of time it took to make announcements. In the great majority of instances, the processes that were used were successful in recovering evidence from images that were taken on a mobile phone. During the course of the research for the project, we got the chance to learn about the challenges that persons who are blind or visually impaired confront in the modern society. In addition, we came to the realization that the currently available frameworks for sparse representation, edge detection, and other similar tasks are both unportable and too complex. A novel method for the identification of Indian currency notes was presented and analyzed in the course of this research. The framework of this project is made up of two essential stages: in the first stage, we train our model by making use of architecture that has already been pre-trained. In the second step, we use the camera to take a photo of the currency and then extract features from it so that we may train on previously-learned architecture. As a direct consequence of this, it is able to accurately recognize paper cash.

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