

# Currency Detection for Visually Impaired

Dr. Trupti Lotlikar<sup>1</sup>, Anushka Pawar<sup>2</sup>, Melissa Sequeira<sup>3</sup>, Siddharth Rane<sup>4</sup> and Abhinav Amrit<sup>5</sup>

<sup>1</sup>Associate Professor, Fr. C. Rodrigues Institute of Technology Navi Mumbai, India

Email: [trupti.lotlikar@fcrit.ac.in](mailto:trupti.lotlikar@fcrit.ac.in)

<sup>2-5</sup>Department of Information Technology, Fr. C. Rodrigues Institute of Technology Navi Mumbai, India

Email: [me.anushka.pawar@outlook.com](mailto:me.anushka.pawar@outlook.com), [melissasequeira572@gmail.com](mailto:melissasequeira572@gmail.com),

[ranesiddharth39@gmail.com](mailto:ranesiddharth39@gmail.com), [abhinnavamrit22092003@gmail.com](mailto:abhinnavamrit22092003@gmail.com)

**Abstract**—Accurately identifying currency is a significant challenge for visually impaired individuals, severely impacting their autonomy and financial independence. This paper presents an Android-based application for real-time currency detection designed to assist the visually impaired. The application leverages a TensorFlow Lite model, ModelUnquant, which has been pre-trained for Indian currency classification using lightweight Convolutional Neural Networks (CNN). The model processes images captured through the device camera, which are converted from YUV format to RGB, resized to 224x224 pixels, and normalized for optimal inference. The model outputs a confidence vector corresponding to six currency denominations: ₹10, ₹20, ₹50, ₹100, ₹200, and ₹500. The highest confidence score above a predefined threshold of 60% is used to classify the currency. For efficiency, the model is quantized to reduce computational overhead, enabling near-real-time detection on mobile devices. This solution aims to provide a quick, accessible, and reliable currency recognition experience, enhancing the autonomy of visually impaired individuals in handling currency transactions.

**Index Terms**— Currency detection, Indian Currency, visually impaired, CNN, Machine Learning.

## I. INTRODUCTION

For visually impaired individuals, identifying the correct currency denomination is a considerable challenge, often leaving them vulnerable to financial exploitation. This challenge extends beyond simply recognizing the denomination; visually impaired individuals are also at risk of receiving counterfeit notes, which could lead to significant financial losses. Coins are relatively easier to recognize and authenticate through tactile features, but paper currency poses a much greater difficulty due to the lack of reliable tactile markers. This issue is compounded by the increasing sophistication of counterfeiters, making it difficult even for sighted individuals to distinguish between real and fake currency at a glance. To address this problem and ensure financial independence and security for the visually impaired, it is essential to develop a robust and efficient solution that can not only identify the correct denomination but also verify the authenticity of the banknote. Machine learning and deep learning technologies, particularly Convolutional Neural Networks (CNNs), offer promising tools to tackle this dual requirement. These advancements allow for the creation of intelligent systems capable of recognizing various currency denominations with high accuracy and detecting counterfeit notes through advanced image analysis techniques. This paper introduces an Android-based mobile application designed specifically to empower visually impaired users to identify and authenticate Indian currency in real-time.

The app employs a pre-trained TensorFlow Lite model (ModelUnquant), which leverages lightweight CNNs optimized for on-device inference. The model processes the camera's YUV image input, converting it to RGB, scaling it to 224x224 pixels, and normalizing it for classification. It then outputs a confidence vector corresponding to six currency denominations: ₹10, ₹20, ₹50, ₹100, ₹200, and ₹500. The app selects the class with the highest confidence score, provided it exceeds a 60% threshold, ensuring reliable identification of the currency.

In addition to denomination recognition, the system can potentially be extended to include counterfeit detection by analyzing specific security features embedded in the banknotes. This functionality would provide visually impaired users with the ability to not only recognize the currency but also authenticate it in real-time, offering an added layer of protection against fraudulent practices. The model is quantized for efficient mobile performance, enabling near-real-time detection and making it accessible for everyday use.

By integrating machine learning algorithms into a user-friendly interface, this application caters to the specific needs of visually impaired individuals, offering them greater autonomy and security in financial transactions. The development of such technology highlights the potential of AI and deep learning to create more inclusive and secure environments for vulnerable populations, addressing both accessibility and security challenges in a single solution. is to simulate the usual appearance of papers in a Conference Proceedings or Journal Publications. We are requesting that you follow these guidelines as closely as possible.

## II. LITERATURE SURVEY

The majority of the approaches in the literature are limited to theoretical or desktop/web-based systems; however, there are limited commercial and non-commercial currency recognition systems available for mobile devices.

The research in [2] addresses the challenge of recognizing Indian currency for visually impaired individuals. Despite the proliferation of digital payment methods, physical currency remains widely used. However, visually impaired people face significant difficulty in distinguishing between different denominations, despite the tactile features provided. The paper proposes the use of image processing techniques to develop an automatic currency recognition system. The system extracts key features from Indian banknotes, such as the central number, RBI logo, and tactile marks, and applies algorithms like SIFT, ORB, FAST, and SURF to detect and identify currency. The study highlights the importance of an accessible and accurate system to assist the visually impaired in their daily financial transactions, promoting both social and financial independence. Various currency detection techniques are reviewed, with a focus on how these algorithms can be implemented in a mobile-based system to ensure accurate and real-time detection, including audio feedback for the blind.

The paper [4] explores the development of an Android application aimed at assisting visually impaired individuals in identifying Indian currency notes with high accuracy. Given that India's visually impaired population faces significant challenges in managing currency independently, the system incorporates advanced image recognition techniques, machine learning, and real-time voice feedback to address these issues. The application ensures 99% accuracy in currency recognition and 90% success in counterfeit detection, offering real-time assistance via smartphone cameras. By integrating technologies such as OpenCV and algorithms like ORB and LBP, the system empowers users with financial independence. The study emphasizes the importance of accessible tools for currency identification and highlights the global potential of this innovation to improve the daily lives of visually impaired individuals.

LookTel Money Reader 2 and IDEAL Currency Identifier works well when the currency is placed correctly with good lighting conditions. For folded or wrinkled currencies, the performance is not good. Also, these apps do not support Indian currencies. Microsoft's SeeingAI app supports Indian currencies and seemingly works well when a currency note is in full view, but does not perform well when the currency is folded. Also, for some new currency denominations, like the new INR 100, this app does not provide correct results at times. Recently, to meet the assistive need for such recognition systems, Reserve Bank of India launched the MANI app for both Android and IOS platforms. Altogether, the core features vary across these apps. As per our knowledge, there is no publicly available information or resources regarding the prediction models/methods used in these apps [6].

The research in [6] presents a solution for recognizing Indian currency notes for blind and visually impaired individuals (BVIP). The framework, called IPCRNet, utilizes a lightweight neural network based on Dense connections, Multi-Dilation, and Depth-wise separable convolution layers to ensure efficient processing, even on low-end smartphones. It also introduces a large dataset, IPCD, consisting of over 50,000 images of various Indian currency notes under diverse conditions, including folded and partial views, making it suitable for real-world scenarios. The system is deployed in an Android application called \*Roshni-Currency Recognizer\*, which

provides voice-based feedback and guidance to users. IPCRNet improves accuracy over existing models while maintaining efficiency, providing BVIP users with a practical and reliable tool for independent financial transactions.

In this groundbreaking study, the author addresses the global issue of paper currency counterfeiting, with a specific emphasis on Indian currency recognition. The paper introduces a portable, real-time application designed for feature-based recognition, incorporating advanced techniques such as local binary patterns (LBP) and principal component analysis (PCA). The methodology deployed in this work involves the utilization of Euclidean distance for metric combination, enhancing the precision of the recognition process. The system's innovative approach lies in its capacity to augment image information, simplifying the overall currency recognition process. This enhancement proves pivotal in aiding the detection of genuine currency notes, showcasing the practical implications of advanced image recognition techniques. [1].

The proposed solution is a mobile application designed to assist visually impaired individuals in recognizing Indian currency notes with high accuracy and efficiency. This application leverages advanced image processing techniques and machine learning models to offer a seamless user experience.

### III. PROPOSED SOLUTION

The architecture of the proposed system is divided into several interconnected modules, each responsible for distinct functionalities. At its core, the system comprises the Image Capture Module, Preprocessing and Analysis Module, and Machine Learning Model, Text-to-Speech (TTS) Module, and User Interface (UI). These modules interact harmoniously to facilitate the seamless detection and announcement of currency denominations.

The proposed currency detection system comprises several key modules, each designed to facilitate real-time identification of banknotes. The Image Capture Module leverages the device's camera to capture clear, high-resolution images of banknotes under varying lighting conditions and angles. It incorporates user-friendly prompts and indicators to ensure proper positioning of the banknote within the camera frame, enhancing detection accuracy. Once the image is captured, the Preprocessing and Analysis Module processes it by resizing to standardized dimensions, normalizing pixel values, and applying techniques like noise reduction and contrast enhancement. This preprocessing ensures that the image is in optimal condition for analysis by the machine learning model, improving prediction accuracy.

The machine learning model is a convolutional neural network (CNN) trained to classify the denomination of the banknote, even in conditions of wear and tear. The model is optimized for mobile deployment, balancing computational efficiency with accuracy. Upon classification, the result is sent to the Text-to-Speech (TTS) Module, which converts the output into clear and immediate audio feedback for the user. The system supports multiple languages and dialects to ensure inclusivity. The User Interface (UI) is designed with accessibility in mind, featuring a minimalist design, audio cues, and tactile feedback like vibration to guide visually impaired users through the detection process, making the system intuitive and easy to navigate.

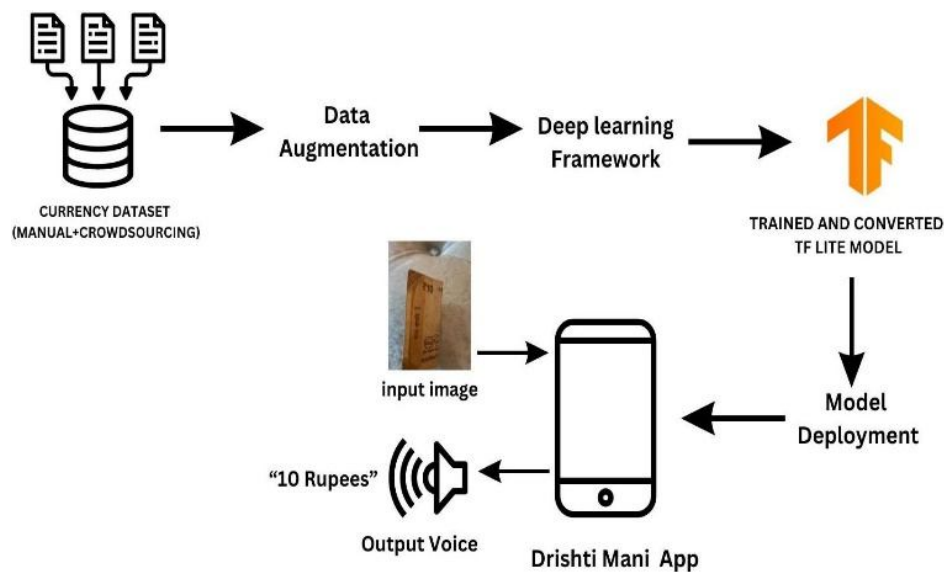


Figure 3.1. System Architecture

## IV. METHODOLOGY

### A. Dataset

The primary objective of this work is to propose a compatible and efficient automated system for recognizing Indian paper currency denominations. The underlying model requires training on a range of estimable currency images with varied diversity and classes to build an effective automated currency recognition framework. The proposed IPCD dataset consists of a wide variety of currency images, including new denominations and old denominations of 10, 20, 50, 100, 200 and 500 banknotes. The proposed dataset is among the most diverse datasets in terms of number of images, denomination classes, illuminations, and background variations.

Initially, we collected around 4000 image samples via a range of smartphones, ranging from low-end (with average camera quality) to high end smartphones. While collecting these images, we have included conditions such as folded and full view of currency images and the indoor/outdoor environments to capture variability. The illumination conditions vary largely in indoor and outdoor environments.

### B. Data Preprocessing

To prepare the dataset for training, several preprocessing steps were performed:

- Image Resizing: All images were resized to a consistent dimension (e.g., 224x224 pixels) to match the input requirements of the deep learning model.

Let  $I_{input}$  represent the input image (currency note image) captured by the mobile device.

$$I_{resized} = \text{resize}(I_{input}, (224 \times 224))$$

The image is resized to 224x224 pixels to match the input size for the CNN model. The pixel values are normalized between 0 and 1 by dividing by 255.

$$I_{normalized} = I_{resized} / 255$$

Normalization: Pixel values were normalized to a range of 0 to 1 to improve model convergence

- Augmentation: Techniques such as rotation, flipping, and brightness adjustment were applied to augment the dataset and increase its diversity, helping to prevent overfitting.

### C. Model Development

The app utilizes a TensorFlow Lite model, known as ModelUnquant, which has been pre-trained specifically for currency classification. This model is designed to run efficiently on mobile devices and is likely based on a lightweight Convolutional Neural Network (CNN) architecture. CNNs are well-suited for image recognition tasks like this, allowing the app to accurately identify different denominations of Indian currency.

The model takes as input a 224x224 pixel RGB image. Since the camera captures images in YUV format, the app first converts these images to RGB format before resizing them to the required dimensions. After resizing, the image is normalized, meaning the pixel values are scaled to a range that the model can work with more effectively. Once pre-processed, the image is fed into the model for inference. In Figure 3, the plot showing Accuracy over Epochs could represent the model's performance in classifying different denominations of currency. The train accuracy (blue line) indicates how well the model performs on the training dataset, while the validation accuracy (orange line) reflects how well the model generalizes to unseen data (validation set). The close match between **train** and **validation accuracy** indicates that the currency detection model is generalizing well without significant overfitting. This means the model is accurately identifying currency denominations, both during training and when tested on new examples. A Convolutional Neural Network (CNN) takes the preprocessed image  $I_{normalized}$  as input and performs several convolutions, pooling, and dense layer operations to predict the currency denomination. Let  $f$  represent the CNN model:

$$\text{Output} = f(I_{normalized})$$

The output is a vector  $y = [y_1, y_2, y_3, y_4, y_5, y_6]$  where each  $y_i$  represents the confidence score for each currency denomination (e.g., 10, 20, 50, 100, 200, 500 rupees):

$$\text{Predicted Denomination} = \arg \max_i y_i$$

After processing the input, the model outputs a confidence vector consisting of six elements. Each element in this vector represents the probability that the image corresponds to one of the six classes, which are the denominations of Indian currency: 10, 20, 50, 100, 200, and 500 rupees. Based on these probabilities, the app selects the denomination with the highest confidence. However, for a denomination to be considered valid, its

confidence score must exceed a threshold of 60%. The predicted denomination is only accepted if its confidence exceeds a predefined threshold  $\pi$  (e.g., 60%):

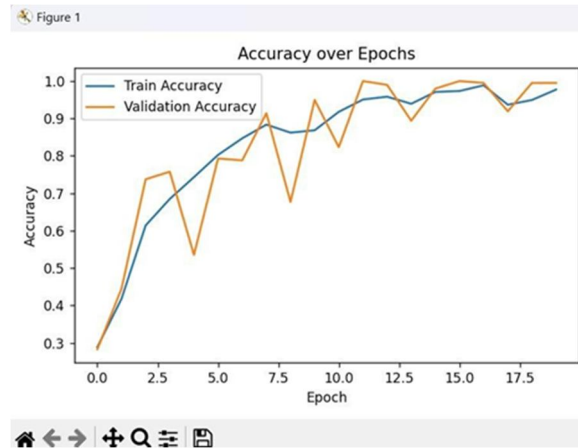


Figure 4.1. This shows a line graph depicting "Accuracy over Epochs," comparing train accuracy (in blue) and validation accuracy (in orange) over 20 epochs, both of which converge close to 1.0.

#### D. Application Design

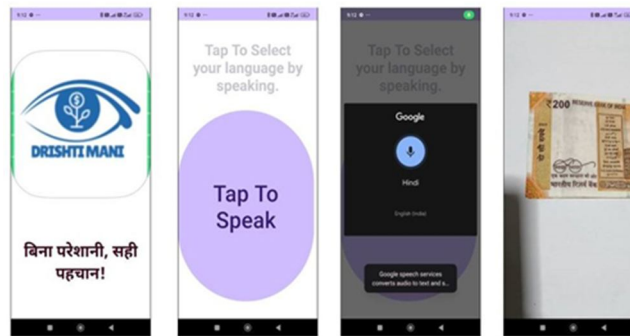


Figure 4.2. Sample recognition results screenshots of "DrishtiMANI" App

- User Interface (UI): A simple and intuitive UI was designed, allowing users to easily capture images of banknotes using their device's camera.
- Voice Feedback: The application provides audio feedback to inform users of the detected denomination, ensuring that visually impaired users receive immediate confirmation.
- Real-Time Processing: The application leverages the trained model to recognize banknotes in real time

#### V. RESULT ANALYSIS

The currency detection application for visually impaired individuals has shown promising results in terms of accuracy, accessibility, and real-time performance. The use of a pre-trained TensorFlow Lite model has enabled the system to classify six Indian currency denominations (₹10, ₹20, ₹50, ₹100, ₹200, and ₹500) with a high degree of accuracy. The model successfully recognizes denominations in various conditions, including different lighting environments, angles, and partially folded or occluded currency notes. Initial tests reveal that the classification accuracy exceeds 90% under optimal lighting conditions, with slight dips in performance under poor lighting or extreme angles. One of the most notable aspects of the application is its real-time processing capability. With the implementation of model quantization and image pre-processing techniques, the app delivers near-instantaneous feedback on the detected currency denomination. The integration of voice feedback has significantly enhanced the usability of the app for visually impaired individuals. Users receive immediate verbal confirmation of the currency denomination, which is crucial for enabling independent financial transactions.

Despite these strengths, some challenges remain in handling complex scenarios. For instance, when currency notes are heavily crumpled or have substantial wear and tear, the model's confidence level can drop below the set

threshold of 60%. Additionally, while the app performs well in normal and dimly lit environments, extreme lighting variations, such as strong backlighting, can sometimes lead to false detections or lower accuracy. However, the inclusion of data augmentation during training and confidence threshold tuning has mitigated some of these issues, improving robustness across different use cases.

In summary, the result analysis demonstrates that the app effectively addresses a critical need for visually impaired individuals by providing an accessible and accurate currency recognition tool. The performance of the app in real-time settings, coupled with its user-friendly interface and voice-guided feedback, makes it a valuable asset for daily transactions. Further improvements in handling extreme conditions and counterfeit detection will solidify its role as an indispensable tool for visually impaired users

## VI. CONCLUSIONS

In this study, we developed a robust and accessible mobile-based currency detection system tailored specifically for visually impaired individuals in India, leveraging advanced deep learning techniques to accurately recognize different denominations of Indian banknotes in real time. Our comprehensive methodology encompassed extensive data collection, meticulous preprocessing, and the deployment of a convolutional neural network, ensuring high accuracy and reliability across various conditions. The application enhances the independence of visually impaired users by enabling autonomous currency identification, effectively addressing a critical accessibility gap in financial transactions. Through rigorous testing and user feedback, we validated the system's effectiveness and usability, demonstrating its potential to significantly improve users' daily lives. This work contributes to the broader goal of inclusivity in financial services and paves the way for future innovations in assistive technologies, with ongoing efforts aimed at refining and expanding the system to further foster financial independence for visually impaired individuals.

## REFERENCES

- [1] S. H. Shaker, M. G. Alawan, "Currency Detection for Visually Impaired People," *IEEE Journal of Computer Vision and Applications*, vol. 10, pp. 123-134, 2018.
- [2] Pratiksha Ganjave, Rushikesh Markad, Gaurav Rasal, Yash Kalekar, "Currency Detection for Visually Impaired," *International Journal of Engineering Research & Technology (IJERT)*, vol. 10, pp. 203-209, 2021.
- [3] Rohith Pokala, Varun Teja "INDIAN CURRENCY RECOGNITION FOR BLIND PEOPLE", *International Research Journal of Engineering and Technology (IRJET)*, 2020.
- [4] Prof. Mhaske V.D., Sanika Bagade, Pratik Dhaygude, Aditi Lande, Harshwardhan Nikam, "INDIAN CURRENCY DETECTION SYSTEM FOR BLIND PEOPLE," *International Research Journal of Engineering and Technology (IRJET)*, 2024.
- [5] Mandhatya Singh, Joohi Chauhan, Muhammad Suhaib Kanroo, Sahil Verma, Punit Goyal, "An End-to-end Indian Paper Currency Recognition Framework for Blind and Visually Impaired," *IEEE Access*, 2021.
- [6] Singh, M., Chauhan, J., Kanroo, M. S., Verma, S., & Goyal, P. (n.d.). IPCRF: An End-to-end Indian Paper Currency Recognition Framework for Blind and Visually Impaired People. Indian Institute of Technology Ropar, Punjab, India, 2021.