



# **A Multi-Stage Deep Learning Framework for Currency Detection and Authentication for Visually Impaired Users**

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**ABSTRACT:** In today's scenario, the identification of Indian currency notes at the time of exchanging with the help of visually impaired as well as aged people has become a major concern. They have to rely entirely on others' assistance, and they are also cheated at times. Hence, in this paper, a multi-stage deep learning approach for the identification, verification, and denomination of Indian currency notes is introduced. The proposed system is implemented on a mobile device and works in real time by capturing images of the currency notes at specified time intervals. A Convolutional Neural Network (CNN) is used for the detection of currency notes from non-currency objects by introducing a background class as well as the denomination of the currency notes, ranging from 10 to 500. For classifying the authenticity of the detected currency notes, another deep learning approach is introduced. The proposed system is implemented as a web application using a web framework, and the images of the currency notes are captured using a mobile camera in real time. Audio feedback is also given for visually impaired people. The performance of the proposed system is measured using validation accuracy. The proposed system shows 93 percent validation accuracy for denomination identification and 81 percent validation accuracy for fake currency detection.

**KEYWORDS:** Currency Detection, Deep Learning, ResNet50, Fake Currency Detection, Assistive Technology, Image Classification, Visually Impaired

## **I. INTRODUCTION**

Identifying currency notes is a routine task for most of the individuals, but it becomes a significant challenge for the visually impaired and elderly people. During financial transactions, they often have to rely on others to verify the authenticity and denomination of currency notes. This dependency can lead to inconvenience and may also expose them to financial loss due to the circulation of counterfeit currency. In recent years, developments have opened new possibilities for solving such real-world problems. Image-based recognition systems using deep learning have shown many promising results in tasks such as object detection and classification. These techniques can be effectively used to analyze the visual features present in currency notes and distinguish between them.

This paper presents a system that will enable users to identify Indian currency notes using their mobile phones. The system follows a step-by-step approach where images captured through their mobile camera are analyzed continuously. Initially, the system checks whether the captured image is a currency note or not with the help of a deep learning model. If it's a currency note, the system then checks for its authenticity using a second model. In addition, the system again uses the first model to identify its denomination.

The proposed system is implemented as a web-based application. It provides audio output, allowing users to understand the result without relying on others. By combining real-time processing, deep learning models, and accessibility features, the system aims to support visually impaired users to be independent and have safer financial transactions.

## II. LITERATURE SURVEY

Several research works have been carried out to develop currency recognition systems aimed at assisting visually impaired users. A CNN-based mobile application for currency detection demonstrated that deep learning models can effectively recognize currency notes with high accuracy and provide real-time assistance [1]. Similarly, deep learning-based approaches for fake currency detection have shown improved performance in distinguishing genuine and counterfeit notes under varying conditions [2].

Real-time currency detection systems using deep learning have also been explored, where models are trained on augmented datasets to improve performance in dynamic environments [3]. In addition, application-based solutions developed using platforms such as MIT App Inventor have demonstrated the feasibility of implementing assistive systems on mobile devices, although with limited accuracy [4].

Lightweight deep learning models such as MobileNet have been used for currency detection in mobile applications, offering faster performance while maintaining reasonable accuracy [5]. Earlier approaches based on feature extraction techniques such as SIFT have also been used for currency recognition, but these methods are less robust when compared to deep learning-based techniques [6].

Some studies have also focused specifically on Indian currency recognition using feature extraction and classification techniques, achieving moderate accuracy in controlled environments [7]. Machine learning approaches combined with image processing have also been applied for detecting the authenticity, but their performance is limited compared to deep learning models [8].

More recent works have utilized deep neural networks such as ResNet for currency classification, achieving high accuracy due to their ability to learn complex image features [9]. Additionally, object detection models such as YOLO have been used for real-time currency and object detection with audio feedback, making them suitable for assistive applications [10].

Although these studies demonstrate significant progress, most existing systems focus on either denomination recognition or fake currency detection as separate tasks. There is limited work that integrates currency detection, denomination recognition, and authenticity verification within a single system. The proposed work addresses this gap by developing a multi-stage framework that combines these functionalities along with real-time processing and audio-based assistance.

## III. PROPOSED METHODOLOGY

The proposed system is designed as a multi-stage deep learning framework that performs currency detection, authenticity verification, and denomination recognition using a mobile phone in a continuous real-time environment. The overall workflow is implemented as a web-based application where image frames are captured from a mobile camera and processed sequentially.

The system captures image frames at regular intervals using the device camera through a web interface. These frames are sent to the backend server, where preprocessing operations such as resizing, color conversion, normalization, and label encoding are applied to make the images suitable for model input. In the first stage, a Convolutional Neural Network based on ResNet50 architecture is used to analyze the captured image. This first model is trained to classify the input into multiple classes, which include different currency denominations such as 10, 20, 50, 100, 200, and 500 rupees, as well as a background class. The background class has non-currency objects, such as railway tickets, bus tickets, etc., that enable the system to distinguish between currency and non-currency objects. A confidence threshold is applied to the prediction to improve reliability. If the predicted class corresponds to the background, the system gives the audio output as This is not a currency note. Otherwise, it gives audio output as This is a currency note and it proceeds to the second stage, where another ResNet50- based model is used to determine whether the currency note is genuine or counterfeit. This second model is trained on a dataset that contains both real and fake currency notes. The predictions give the audio output as either Warning, this is a fake currency or This is a real currency. The denominations of the note are also predicted with the help of the first model and given as audio output. Audio feedback is done using

the text-to-speech technology. To enhance user experience, the system avoids repeating the same output continuously by maintaining the previously spoken result.

The entire system operates in a continuous loop, ensuring that image frames are processed in a real-time manner without interruption. The application is deployed as a Progressive Web App, allowing it to function on mobile phones with features similar to native applications. This design ensures accessibility, ease of use, and real-time performance for visually impaired users.

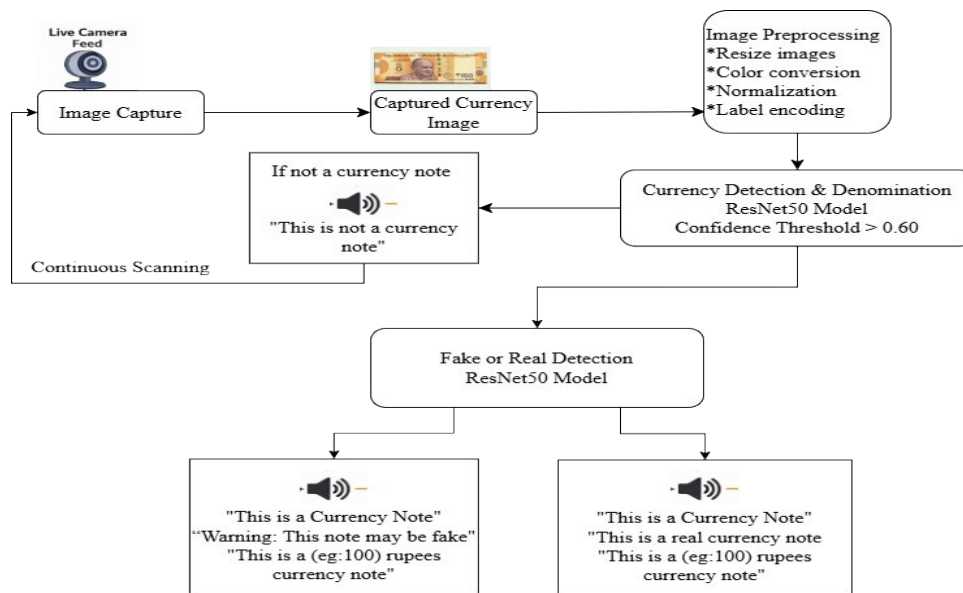


fig. 1. System Architecture of the proposed system

#### IV. SYSTEM ARCHITECTURE

As shown in fig. 1, the architecture of the proposed system is designed to support continuous real-time detection and analysis of Indian currency notes using a mobile phone. The system consists of a frontend interface for image capture. When the application is opened, the frontend presents a blank full-screen interface where the entire screen is touch-enabled to start the camera. Then there is a backend processing unit, and deep learning models for classification.

The process begins with the live camera feed, where image frames are continuously captured through the web interface. These captured images are then forwarded to the backend server for further processing, such as image resizing, color conversion, normalization, and label encoding to prepare the input for the deep learning models. The preprocessed image is first passed to the Currency Detection and Denomination classification model based on the ResNet50 architecture. This model will predict whether the images are currency or not using a background class. A confidence threshold of 0.60 is applied to ensure reliable predictions. If the image is identified as a non-currency object, the system provides audio feedback indicating that it's not a currency note, and the scanning process continues without any interruption. If it's identified as a currency note, then the system proceeds to the next stage, where the Fake or Real Detection classification model, which is also based on the ResNet50 architecture, is used for authenticity verification. This model classifies the currency note as either fake or real. Based on the outputs from both models, the system generates the final result. If the note is identified as fake, then it gives a warning message along with its denomination. And if the note is genuine, the system announces that the currency is real along with its denomination. The audio outputs are done using text-to-speech to ensure accessibility for the visually impaired users.

The entire system is operated in a continuous loop that allows real-time processing of image frames. It's implemented as a Progressive Web App, enabling it to run on mobile phones efficiently.

## V. RESULTS AND DISCUSSION

The proposed system was evaluated using two deep learning models, Denomination recognition and Fake currency detection, trained for different tasks. The Denomination classification model was trained on a dataset that contains multiple classes of Indian currency denominations, such as 10, 20, 50, 100, 200, 500, and a background class for non-currency objects. This model achieved a validation accuracy of 93.23 percent, making it effective in correctly identifying currency notes and distinguishing them from non-currency objects. The Fake currency detection model was trained on a dataset that contains both fake and real currency images. This model achieved a validation accuracy of 81.94 percent. Although the accuracy of this model is comparatively lower than that of the first model, it is capable of identifying counterfeit currency under varying conditions.

The system was also tested in real-time using a mobile phone camera. The continuous image capture mechanism allowed the system to process frames at regular intervals and provide instant audio output to the user. The use of a confidence threshold helped to reduce incorrect predictions for non-currency objects, thereby improving overall reliability. The integration of two classification models in a multi-stage pipeline improves system performance by separating the tasks of denomination recognition and authenticity verification. This approach ensures that the fake detection model is only applied when a currency note is detected, reducing unnecessary computations. The system provides audio feedback using text-to-speech, which is mainly done for visually impaired users. It enhances their usability.

Overall, the results demonstrate that the proposed system is capable of performing real-time currency detection and authentication with satisfactory accuracy and usability for assistive applications.



fig. 2. Real-Time Currency Detection Using Mobile Camera

## VI. CONCLUSION AND FUTURE WORK

This work presents a deep learning-based system designed to assist visually impaired and elderly individuals in identifying Indian currency notes. The system combines denomination recognition and fake currency detection within a multi-stage framework, allowing it to process images continuously in real time. By using a background class and a confidence threshold, the system is able to distinguish between currency and non-currency objects effectively. The integration of audio feedback makes the system accessible and easy to use, while the web-based implementation ensures that it can run on mobile devices without the need for installation. The experimental results show that the system performs reliably, achieving a validation accuracy of 93.23 percent for denomination recognition and 81.94 percent for fake currency detection. The overall design of the system focuses on simplicity and usability, making it suitable for real-world assistive applications.

In the future, the system can be improved by using a larger and more varied dataset, which would help in achieving better accuracy, especially for fake currency detection. At present, the system works only with Indian currency notes, but it can be extended to support currencies from other countries by training the models with appropriate data. The performance of the system can also be enhanced by using more efficient models to achieve faster processing and

smoother real-time operation. In addition, making the system work in offline mode and optimizing it for devices with limited resources would make it more practical and easier to use in real-world situations.

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