

# Artificial Intelligence-based Indian Currency Note Recognition Using Deep Learning

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**Abstract:** Automatic identification of Indian banknotes has become increasingly important in both assistive and financial technology domains. In many practical situations, manual denomination recognition can cause confusion, delays, or mistakes, especially for individuals with visual impairments. To overcome such limitations, an intelligent image-based classification system has been developed using deep learning techniques. The system is built upon a Convolutional Neural Network (CNN) architecture capable of learning distinctive visual patterns directly from currency images. Training data includes multiple denominations captured under different illumination conditions, backgrounds, and viewing angles to improve adaptability in real-world scenarios. Once trained, the model is integrated into an online application that allows users to upload images and receive instant denomination predictions. Performance evaluation indicates reliable and stable classification results across varied testing conditions. This approach provides a practical solution for assistive applications and digital financial environments.

**Keywords:** Indian Banknote Detection, CNN-Based Classification, Deep Learning Model, Image Analysis, AI-Driven Systems

## I. INTRODUCTION

Automatic currency denomination identification represents an applied use of computer vision within financial systems. In India, where paper-based transactions are still common, correctly recognizing banknotes is important for ensuring smooth monetary exchange. Relying solely on manual recognition may result in mistakes or delays, particularly for individuals with visual impairments or in fast-paced environments. Advancements in artificial intelligence have transformed image analysis techniques over the past decade. Among these, deep learning models have shown strong capability in visual classification tasks. Convolutional Neural Networks are particularly suitable for such applications, as they learn hierarchical image features directly from pixel data without depending on handcrafted feature extraction methods[1].

Indian currency notes possess identifiable visual attributes, including unique colour schemes, denomination numbers, security patterns, and printed motifs. However, practical implementation of recognition systems must account for variations such as uneven lighting, background interference, shadows, perspective distortion, and image noise. These factors increase the complexity of accurate classification. To address these challenges, a deep learning-based classification model has been developed for identifying Indian banknote denominations. The trained network is incorporated into a web-based platform that allows users to obtain instant predictions from uploaded images. The overall system is structured to provide dependable performance and practical usability in real-world scenarios[2].

## II LITERATURE REVIEW

Earlier studies on currency recognition mainly focused on conventional image processing approaches. Commonly used techniques included edge detection, colour analysis, texture feature extraction, and template matching. These methods offered basic recognition capability; however, they relied on manually selected features and were highly affected by changes in lighting and background conditions. Later, machine learning algorithms such as Support Vector Machines (SVM)[3], k-Nearest Neighbours (k-NN)[4], and simple Artificial Neural Networks [5] were applied to improve classification performance. Although these models increased recognition accuracy, they continued to depend on handcrafted features, which limited their performance in dynamic real-world environments[6].

With advancements in artificial intelligence, deep learning approaches have become widely adopted for image classification tasks. CNNs automatically extract layered feature representations from input images, improving resistance to variations such as illumination differences, scaling, and rotation. Many research works have reported that CNN-based models provide better accuracy compared to traditional methods in currency recognition applications. Even though the results are encouraging, certain limitations still exist, including restricted dataset diversity and higher computational demands for real-time implementation. Nevertheless, deep learning remains a reliable and scalable approach for developing efficient currency recognition systems [7].

### 2.1. Existing system

Most existing currency recognition systems are built using traditional image processing combined with basic machine learning techniques. These methods determine denominations based on manually crafted features such as colour variations, edge structures, texture patterns, and shape descriptors. Feature extraction approaches like Histogram of Oriented Gradients (HOG), Local Binary Patterns (LBP), and colour histogram techniques are frequently utilized for this purpose. In practical applications, classifiers including Support Vector Machines (SVM), k-Nearest Neighbour (k-NN), and Artificial Neural Networks (ANN) are commonly adopted to perform denomination classification. Although such models may deliver satisfactory accuracy under controlled conditions, their performance tends to decrease when exposed to uneven lighting, cluttered backgrounds, or changes in viewing angles.

Additionally, many conventional systems require significant pre-processing and manual feature selection, which increases computational load and processing duration. These limitations reduce their suitability for real-time applications, particularly in assistive technologies and dynamic financial environments.

Table 1 : Comparative analysis of existing approaches

Aspect	Existing System	Limitation
Recognition Method	Manual observation or rule-based image processing	Low accuracy and not reliable
Feature Extraction	Handcrafted features (colour, edges, texture)	Sensitive to lighting and background changes
Analytical Approach	Traditional image processing algorithms	Cannot handle complex image variations
Machine Learning Use	Basic ML models (SVM, k-NN)	Requires manual feature selection
Real-Time Adaptability	Offline or batch processing	Not suitable for real-time recognition
Robustness	Works only in controlled environments	Fails under noise and rotation
Manual Effort	High human involvement	Time-consuming and error-prone
Decision Support	Limited output (text-based result)	No intelligent assistance or scalability

## III. RESEARCH METHODOLOGY

The designed framework performs Indian currency note identification using deep learning algorithms. The methodology is carried out in sequential phases, beginning with data gathering and pre-processing, followed by model development, training, validation, and final system deployment.

### 3.1.1 Data Collection

A comprehensive collection of Indian banknote images was assembled, covering all major denominations including ₹10, ₹20, ₹50, ₹100, ₹200, and ₹500. The images were intentionally captured under diverse conditions such as different illumination levels, backgrounds, and orientations. Variations in angle, brightness, and size were included to improve the model's robustness and ensure consistent performance in practical environments.

### 3.1.2 Data Pre-processing

Before feeding the currency images into the model, several pre-processing steps are performed to optimize training. First, all images are resized to a consistent dimension to ensure uniformity and reduce computational load. Next, pixel intensity values are normalized to enhance training stability and accelerate convergence. Finally, image enhancement methods are employed to reduce noise and adjust for variations in lighting conditions[8].

Finally, the images are formatted appropriately and labelled according to their respective denominations so that they can be efficiently processed by the Convolutional Neural Network. These pre-processing steps improve the overall performance and accuracy of the proposed system[9].

### 3.1.3 Model Development

A CNN was employed as the primary model for classifying Indian currency notes. CNNs are ideal for this task because they can automatically identify and extract relevant visual features from images without relying on handcrafted descriptors. The network consists of several convolutional layers that capture key patterns present in the input images. Non-linearity is introduced through the Rectified Linear Unit (RELU) activation function, which enhances the model's learning capacity. Max-pooling layers are incorporated to reduce spatial dimensions and mitigate overfitting. The features obtained from the convolutional blocks are then processed by fully connected layers to perform final classification. At the output stage, a Soft max layer generates probability distributions for each currency denomination, enabling the model to recognize distinct visual characteristics such as colour variations and numerical patterns, numerical text, and structural elements present in Indian currency notes.

### 3.1.4 Model Training and Testing

The dataset was split into separate training and testing sets to assess the model's performance. The training set was used to optimize the weights of the Convolutional Neural Network through backpropagation. During this phase, the model gradually learns to recognize patterns and features unique to each currency denomination. A loss function was applied to quantify prediction errors and guide parameter updates. Once training was complete, the model was tested on the unseen images in the testing set to evaluate its classification accuracy. This procedure ensures that the network not only performs well

on the training data but also generalizes effectively to new, unseen currency images.

### 3.1.5 System Deployment

After successful training, the model was integrated into a web-based application using Flask. Users can upload an image of a currency note, and the system predicts the denomination in real

time. The deployment ensures that the system is user-friendly and suitable for practical applications such as assistive tools for visually impaired individuals. This methodology ensures:

- Accurate classification
- Reduced manual intervention
- Real-time recognition capability
- Scalability for future improvements

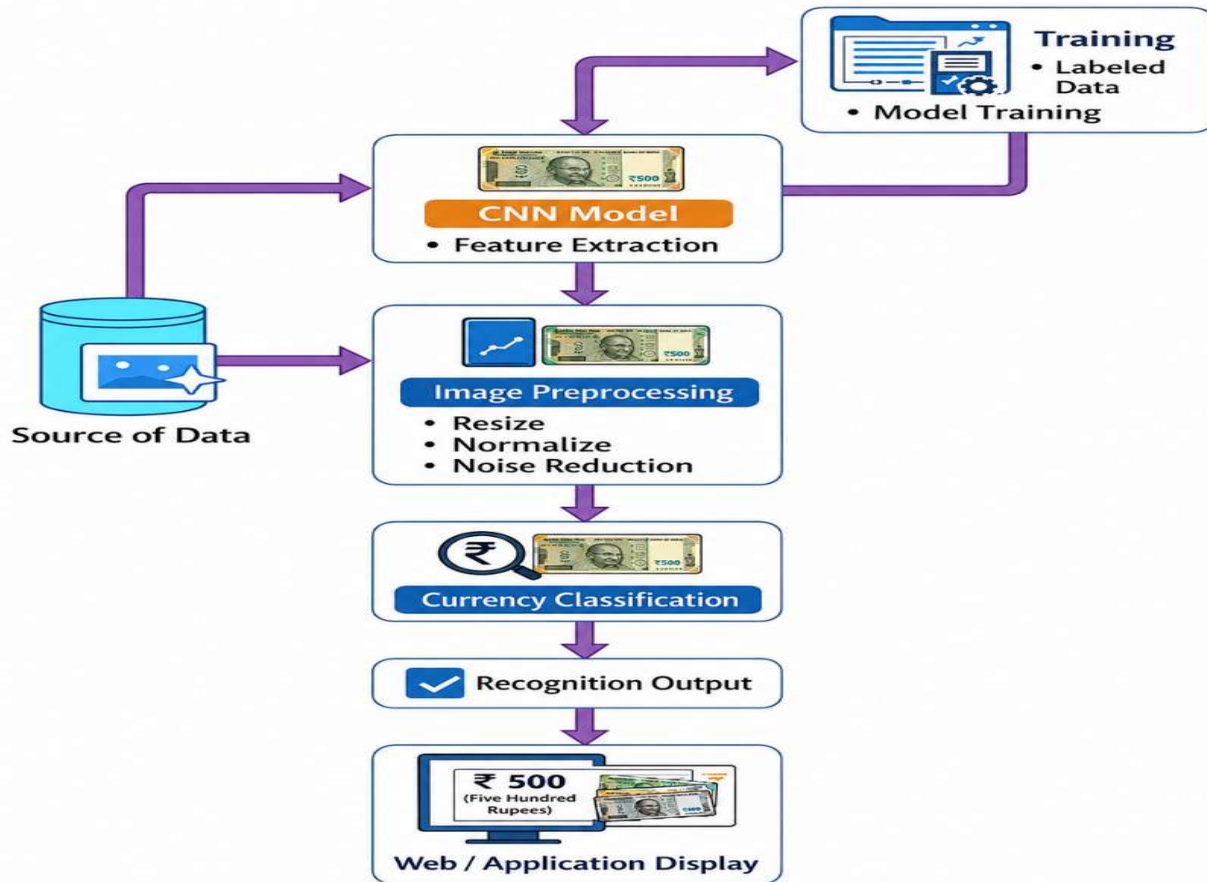


Figure 1 : Framework of proposed research work

### 3.2 Proposed System

The developed system implements an AI-driven approach for recognizing Indian currency notes using deep learning. Rather than relying on traditional image processing techniques, it employs a CNN to automatically learn and classify various denominations from input images, enabling accurate recognition with minimal human intervention. In this framework, images of currency notes are first collected and pre-processed to maintain uniform size, quality, and format. The cleaned images are then passed through the CNN, which identifies key visual features such as colour distributions, numeric symbols, textures, and structural patterns present on the banknotes. Using these learned features, the network predicts the appropriate denomination[10].

For practical use, the trained model is deployed within a web-based platform where users can upload or capture a currency image. Once submitted, the system analyses the image and provides the recognized denomination instantly. This real-time capability makes the application suitable for assistive technology for visually impaired individuals as well as for automated financial systems. Compared to conventional approaches, the system offers higher recognition accuracy, reduces manual effort, and ensures faster processing. Its scalable design allows deployment in real-world scenarios, providing an efficient and reliable solution for currency recognition tasks.

## IV RESULTS AND DISCUSSION

The AI-driven Indian Currency Note Recognition system was developed and assessed using a dataset comprising multiple denominations. Its performance was evaluated based on factors such as classification accuracy, model efficiency, and capability for real-time recognition. Once CNN was trained, it was tested on previously unseen currency images to evaluate prediction accuracy. The model demonstrated strong performance, accurately identifying various denominations even under different lighting conditions and backgrounds. The CNN successfully learned critical visual features, including colour patterns, numerical symbols, and structural details inherent to Indian banknotes.

The system maintained consistent performance when images were captured from varying angles or with slight rotations. In comparison to traditional machine learning methods that rely on manually extracted features, the deep learning approach offered greater robustness and reduced misclassification rates. Beyond accuracy, the model processed images efficiently, supporting real-time operation. Integration with a web-based interface allowed users to upload currency images and receive immediate denomination predictions. These results indicate that the deep learning-based system delivers reliable, accurate, and efficient recognition of Indian currency notes. Its ability to handle diverse conditions and provide real-time output makes it suitable for both assistive technology applications and automated financial systems.

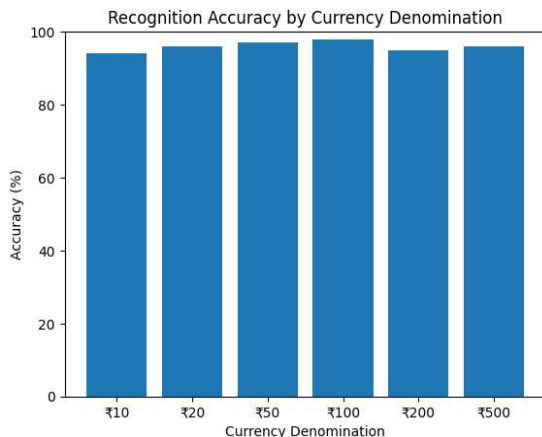


Figure 2 : Performance of results analysis

## V CONCLUSION

This research presented a deep learning-based framework for recognizing Indian currency notes. The CNN model effectively learned distinguishing visual patterns and achieved reliable classification accuracy. The integration of the trained model into a web platform enables real-time functionality, making it suitable for assistive technologies and automated financial systems. Future improvements may include expanding the dataset, enhancing model optimization, and implementing the system on mobile platforms for increased accessibility.

The proposed system can be particularly beneficial for visually impaired individuals, assistive technologies, and automated financial applications. By combining accuracy, efficiency, and scalability, the system offers a reliable solution for modern currency recognition challenges. Future enhancements may include expanding the dataset, optimizing the model architecture, and implementing the system in mobile or embedded platforms to increase accessibility and usability.

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