Indian Coin Denomination Recognition And Automated Sorting Using Convolutional Neural Networks

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***Abstract*—This paper presents a CNN-based Indian coin denomination recognition system capable of classifying ₹1, ₹2, ₹5, and ₹10 coins. Image preprocessing and data augmentation techniques are applied to improve robustness. The trained CNN model is integrated with OpenCV for real-time detection and Streamlit for sorting simulation. Experimental results demonstrate high recognition accuracy and efficient performance under varying lighting and orientation conditions.**

I. INTRODUCTION

In recent years, automation in financial systems has gained significant importance due to the increasing need for speed, accuracy, and efficiency in currency handling processes. Manual identification and sorting of coins is time-consuming and prone to human errors, especially in environments such as banking systems, vending machines, retail counters, and automated payment systems. This has led to the development of intelligent systems capable of recognizing and processing currency automatically.

Deep learning, particularly Convolutional Neural Networks (CNNs), has emerged as a powerful technique in the field of computer vision for image classification and object recognition tasks. CNN models are capable of automatically learning complex visual patterns such as edges, shapes, textures, and object structures directly from image data without requiring manual feature extraction. This makes them highly suitable for applications like coin and currency recognition.

Indian coins vary in denomination, design, and visual patterns, making manual classification challenging in real-world scenarios. Factors such as lighting variations, background noise, coin orientation, and image quality further increase the complexity of the recognition task. Therefore, an automated system that can accurately identify coin denominations under varying conditions is highly desirable.

This project proposes a deep learning-based system for Indian coin denomination recognition using a CNN model. The system is designed to classify coin images into their respective denominations and simulate an automated currency sorting process. It also incorporates image preprocessing and data augmentation techniques to improve model performance and robustness.

The objective of this work is to develop an efficient, accurate, and real-time coin recognition system that reduces manual effort and enhances automation in currency handling applications. The proposed system demonstrates the practical application of deep learning in financial automation and intelligent systems.

II. LITERATURE REVIEW

1) Deep Learning in Coin Recognition Systems

Reddy et al. [1] (2026) proposed a hybrid CNN-Transformer model for Indian coin denomination recognition. The study focused on improving coin classification accuracy through the integration of convolutional neural networks and transformer-based attention mechanisms. The proposed framework was evaluated on the IMCD, ICCD, ICDD, and CIDCIC benchmark datasets and achieved weighted F1-scores exceeding 97%. The methodology consisted of image acquisition, YOLO-based coin segmentation, Region of Interest (ROI) extraction, DenseNet feature

extraction, Adaptive Dilated Pyramid Convolution, CBAM attention, Transformer Token Fusion, pooling, and final classification. Experimental results demonstrated the effectiveness of combining CNN-based feature learning with transformer-based contextual representation for accurate and robust Indian coin recognition.

2)Machine Learning-Based Classification

Vishva et al. [2] (2025) proposed a CNN-based Indian currency note classification system using 3,166 images from the Kaggle dataset. The study employed data augmentation, convolutional layers, pooling layers, fully connected layers, and a Softmax classifier for image classification. Experimental results showed high accuracy in recognizing different currency denominations, demonstrating the effectiveness of deep learning for automated currency recognition.

3)Real-Time Recognition Systems

Saumya et al. [3] (2017) developed a currency recognition system using image processing and feature extraction techniques. The method included preprocessing, aspect ratio analysis, country identification, and denomination recognition using empty region detection and template matching algorithms. The system successfully identified currency notes but relied on traditional image processing methods rather than deep learning techniques.

4)Automated Currency Sorting Systems

Recent advancements have extended recognition systems to automated sorting applications. By combining CNN-based classification models with sorting logic, these systems can automatically categorize coins into predefined groups based on denomination. Such approaches improve operational efficiency, reduce manual effort, and provide reliable performance in banking, retail, and vending machine environments [5].

5)Research Gap

Although significant research has focused on currency note recognition and counterfeit detection, limited work has been reported on Indian coin denomination recognition and automated sorting systems. Existing studies primarily focus on recognition accuracy without integrating a sorting mechanism. Therefore, the proposed work aims to develop a CNN-based Indian coin recognition system with automated sorting simulation.

Author	Method	Accuracy
Reddy et al.	CNN	97.98%
Bhutkar et al.	MobileNetV2	94.38%
Singh et al.	CNN-LSTM	92.55%
Proposed work	CNN	95.01%

III. OBJECTIVE OF THE PROJECT

The aim of our project is to develop an efficient and automated system for recognizing Indian coin denominations using a Convolutional Neural Network (CNN) model. The proposed system focuses on accurately classifying coin images into their respective denominations while eliminating the need for manual identification and reducing human errors.

The project further aims to enhance the robustness of coin recognition by utilizing deep learning techniques that can effectively handle variations in lighting conditions, coin orientation, and background complexity. Additionally, the system is designed to perform real-time coin detection using a webcam-based input mechanism, enabling fast and reliable predictions.

Another key objective is to integrate data augmentation techniques during model training to improve generalization performance and ensure consistent accuracy across diverse real-world scenarios. Finally, the project aims to simulate an automated currency sorting mechanism through a software-based approach, demonstrating a practical and cost-effective application of deep learning in financial automation systems.

IV. SCOPE OF THE PROJECT

The scope of this project is to design and develop a deep learning-based system capable of recognizing Indian coin denominations using Convolutional Neural Networks (CNN). The system focuses on image-based classification of coins and aims to provide an automated and efficient solution for currency identification.

This project covers the development of a CNN model trained on coin images captured under different lighting conditions, backgrounds, and orientations. It

includes image preprocessing techniques such as resizing, normalization, and data augmentation to improve model performance and generalization.

The system also includes real-time coin recognition using a webcam-based input, making it suitable for practical and interactive applications. Additionally, a software-based sorting simulation is implemented to demonstrate how recognized coins can be categorized into respective denominations automatically.

The scope further extends to applications in automated cash handling systems, vending machines, banking systems, retail billing systems, and educational computer vision projects. The proposed system can also be extended in future to support multi-coin detection, hardware-based sorting machines, and mobile application deployment for real-world usage.

V. RESEARCH GAP AND PROPOSED SOLUTION

Traditional coin sorting systems largely depend on manual identification and sorting processes, which are time-consuming and prone to human errors. To address this limitation, the proposed system employs a Convolutional Neural Network (CNN) to automatically recognize Indian coin denominations, thereby improving accuracy and reducing manual effort.

Earlier image processing-based coin recognition systems relied on handcrafted features such as shape, size, and edge information. These methods often exhibited poor performance under varying lighting conditions, backgrounds, and coin orientations. In contrast, the proposed CNN-based approach automatically learns complex visual features from coin images, making it more robust and reliable in real-world environments.

Machine learning-based classification methods generally require manual feature extraction and selection, limiting their ability to capture intricate coin characteristics. The proposed CNN model overcomes this challenge by automatically extracting discriminative features such as coin edges, textures, engravings, and patterns directly from image data.

Another limitation of conventional currency recognition systems is their relatively slow processing speed and dependence on extensive preprocessing. The proposed system enables real-time coin recognition through webcam-based image acquisition, providing faster predictions and immediate results.

Existing coin recognition systems also face difficulties in accurately identifying rotated, partially worn, or damaged coins. To improve model robustness, data augmentation techniques including rotation, flipping, and zooming are incorporated during training, allowing the CNN model to generalize better to unseen variations.

Furthermore, hardware-based coin sorting systems often involve high implementation and maintenance costs due to the requirement of specialized sensors and mechanical components. To provide a cost-effective alternative, the proposed work integrates a software-based sorting simulation with a graphical user interface (GUI), eliminating the need for expensive hardware while effectively demonstrating automated currency sorting functionality.

VI. METHODOLOGY

A. Image Preprocessing Module

Before classification, the coin image undergoes preprocessing to improve the quality of input data. Images are resized to 128 × 128 pixels and normalized to scale pixel values between 0 and 1. Data augmentation techniques such as rotation, zooming, and flipping are applied to improve model generalization and robustness against variations in orientation and lighting conditions.

B. CNN Feature Extraction Module

The proposed system employs a Convolutional Neural Network (CNN) for automatic feature extraction and coin denomination classification. Unlike traditional machine learning methods that require handcrafted features, the CNN automatically learns discriminative features from the coin images.

The CNN architecture consists of:

1. Convolution Layers
2. ReLU Activation Layers
3. Max Pooling Layers
4. Flatten Layer
5. Fully Connected Dense Layers
6. Softmax Output Layer

The convolution layers extract important visual features such as:

- Coin edges
- Surface textures
- Engraved symbols
- Numerical patterns

These features help distinguish among ₹1, ₹2, ₹5, and ₹10 coins.

C. Pooling and Classification Module

Max Pooling layers reduce the spatial dimensions of feature maps while preserving significant information. The extracted features are flattened into a one-dimensional feature vector and passed through fully connected dense layers for classification.

The final Softmax layer computes the probability of each denomination class:

$$P(y_i) = \frac{e^{z_i}}{\sum_{j=1}^{C} e^{z_j}}$$

where:

- $P(y_i)$= Probability of class i
- z_i= Output score
- C= Number of coin classes

The denomination corresponding to the highest probability is selected as the final prediction.

$$\hat{y} = argmax\big(P(y_i)\big)$$

D. Real-Time Detection Module

The trained CNN model is integrated with OpenCV to perform real-time coin recognition using a webcam.

The system:

1. Captures live video frames
2. Applies preprocessing
3. Feeds images to the trained CNN
4. Displays denomination and confidence score

This enables real-time recognition and practical deployment.

E. GUI-Based Sorting Module

A Streamlit-based graphical user interface is developed to simulate automated coin sorting.

Based on the predicted denomination:

- ₹1 → Bin A
- ₹2 → Bin B
- ₹5 → Bin C
- ₹10 → Bin D

The system also maintains the total detected amount, providing a complete software-based currency sorting simulation.

Tools/Techniques Used in Data Analysis

- Python (NumPy, Pandas – basic dataset handling)
- Matplotlib / Seaborn (graphs of accuracy & loss)
- TensorFlow/Keras (training metrics)
- Confusion Matrix (performance evaluation)

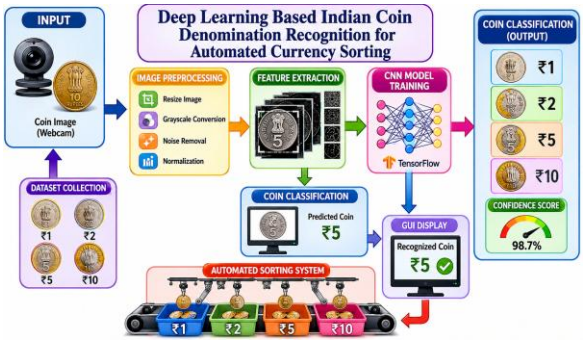

Fig. 1 Proposed CNN-based Indian coin Recognition System Architecture.

VII. CONCLUSION AND FUTURE WORK

The proposed CNN- based Indian coin recognition system successfully classifies coin denominations and performs real-time detection. The integration of Streamlit - based sorting simulation demonstrates practical applicability. Experimental results confirm the effectiveness of CNN in automated currency recognition tasks.

Future Work

The proposed CNN-based Indian coin denomination recognition system can be further improved and extended in several directions. In future, the model can be enhanced by training on a larger and more diverse dataset containing coins captured under extreme variations in lighting, background, blur, and occlusion to improve robustness and real-world applicability.

The system can be extended to support multi-coin detection, where multiple coins present in a single image or frame can be identified and counted simultaneously using advanced object detection models such as YOLO or SSD.

Another possible improvement is the integration of a hardware-based automated sorting machine using microcontrollers like Arduino or Raspberry Pi, which can physically separate coins based on predicted denominations, making the system suitable for real-time industrial applications.

The project can also be deployed as a mobile or web application, allowing users to capture coin images using smartphones and receive instant denomination results.

Additionally, advanced deep learning architectures such as EfficientNet or lightweight MobileNetV3 can be explored to improve accuracy while reducing computational cost, enabling deployment on low-power devices.

Finally, features such as fake coin detection, currency value calculation, and multilingual voice output can be integrated to make the system more intelligent, user-friendly, and applicable in real-world financial and assistive systems.

VIII. ORGANIZATIONS AND WEBSITES

The following organizations, platforms, and websites were used for dataset collection, model development, and research reference for this project:

- Kaggle – Used for reference coin image datasets and inspiration for dataset creation in image classification tasks. https://www.kaggle.com
- Google Dataset Search – Used for exploring publicly available image datasets related to coins and currency recognition. https://datasetsearch.research.google.com
- TensorFlow / Keras (Google AI) – Used for developing and training the Convolutional Neural Network (CNN) model. https://www.tensorflow.org
- OpenCV (Open-Source Computer Vision Library) – Used for image preprocessing such as resizing, filtering, and enhancement. https://opencv.org
- NumPy & Pandas (Python Software Foundation ecosystem) – Used for numerical computation and dataset handling. https://numpy.org, https://pandas.pydata.org
- Matplotlib – Used for visualization of accuracy and loss graphs during model training. https://matplotlib.org
- Scikit-learn – Used for performance evaluation metrics such as confusion matrix and classification report. https://scikit-learn.org
- IEEE Xplore Digital Library – Used for studying existing research papers on CNN-based currency and coin recognition systems. https://ieeexplore.ieee.org
- SpringerLink – Used for referencing research articles on deep learning-based image classification systems. https://link.springer.com

IX. TOOLS AND MODELS

Tools Used

1. Python – Primary programming language used for implementation of the project.
2. Jupyter Notebook – Used for model training, testing, and experimentation.
3. TensorFlow – Used as the deep learning framework for building and training the CNN model.
4. Keras – High-level API used for designing the Convolutional Neural Network architecture.
5. OpenCV – Used for image preprocessing tasks such as resizing, filtering, and image enhancement.
6. NumPy – Used for numerical computations and array operations.
7. Pandas – Used for dataset handling and organization.
8. Matplotlib / Seaborn – Used for visualization of training accuracy and loss graphs.
9. Streamlit (optional GUI tool) – Used for creating a simple web-based interface for coin prediction.

Models Used

The proposed system uses a Convolutional Neural Network (CNN) for Indian coin denomination recognition. The model is designed to automatically extract features from coin images and classify them into respective denominations.

1. Input Layer

The input layer receives coin images from the dataset or webcam.

- Images are resized to a fixed dimension (e.g., 128×128 or 224×224)
- RGB images are normalized (pixel values scaled between 0 and 1)

2. Convolutional Layer (Conv2D)

This is the core feature extraction layer of the CNN.

- Applies multiple filters (kernels) on the image

- Extracts features like edges, curves, textures, and coin patterns
- Each filter learns different visual patterns

3. Activation Layer (ReLU)
After convolution, ReLU activation is applied:
ReLU (Rectified Linear Unit)
- Converts negative values to zero
- Keeps only positive feature responses

4. Pooling Layer (MaxPooling2D)
- Reduces spatial dimensions of feature maps
- Keeps only the most important features
- Example: 2×2 pooling reduces image size

5. Dropout Layer
- Randomly disables some neurons during training
- Prevents overfitting

6. Flatten Layer
- Converts 2D feature maps into a 1D vector

7. Fully Connected (Dense) Layer
- Combines extracted features
- Learns relationships between features
- Performs classification logic

8. Output Layer (Softmax)
Softmax function
- Produces probability for each coin class (₹1, ₹2, ₹5, ₹10)
- Highest probability = final prediction

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