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CLASSIFICATION MODEL FOR INDIAN CURRENCY USING DEEP LEARNING

P.P. Joshi,
Department of CE.
SCTR's Pune Institute of Computer Technology
Pune, India ppjoshi@pict.edu

Adhish Chindhade
Department of CE PICT,
Pune.

Kartik Lanjewar
Department of CE
PICT, Pune

Jigyarth Joshi
Department of CE PICT,
Pune

Kaustubh Adhe
Department of CE
PICT, Pune

***Abstract* :**
The field of deep learning has revolutionized computer vision and image recognition, enabling significant advancements in various domains. Image recognition, in particular, has become a prominent use case for deep learning, finding applications in diverse fields for tasks such as image filtering and categorization. One domain where image processing plays a crucial role is the banking sector, where it is used to classify and verify currency notes.

In this project, our aim is to propose a machine learning model specifically designed for the classification of Indian currency notes and coins. The model will have the capability to accurately classify and identify the denomination value of paper notes as well as coins. This classification system can be instrumental in detecting fake and counterfeit currencies, providing a valuable tool for ensuring the integrity of financial transactions.

Furthermore, the proposed model can be integrated into existing notes and coins counters, as well as vending machines, to automate the classification process and enhance efficiency. By leveraging machine learning techniques, this project aims to streamline currency recognition processes and provide a reliable solution for accurately identifying the denomination value of Indian currency, benefiting various industries and sectors that deal with cash transactions.

Keywords—Deep Learning, Convolutional Neural Network, Image Classification, Feature Extraction, Currency Recognition, Data Augmentation

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I. INTRODUCTION

The currency classifier can be a very important tool in many places. It can be used to replace manual classification and human intervention. The blind and visually impaired (BVIP) individuals face lots of problems while dealing with the currency. They are unable to properly identify the notes and coins and are therefore subject to money frauds at times. So this project will help them to accurately identify currency using a mobile app developed upon this project. Though some apps based on our search, intend to work on the same idea of identification of the currency, when it was tested by us the classification was giving incorrect results even for the basic notes. Also, the classifier for Indian currency including notes as well as coins is not existent. This project works for the coins' identification as well. The second motivation for the development of this project came from the currency counters. The widely used currency counters are only counters who do not identify the denomination. If they include the classification work also then they can be faster and more efficient.

II. LITERATURE SURVEY

Recognizing currency is particularly challenging for blind or visually impaired individuals, especially in countries like India where reliable systems are lacking. Currency denominations are primarily identified by size and patterns, but Indian notes have similar sizes and patterns that deteriorate over time. Automated recognition systems face obstacles like folded or partial views, inconsistent lighting, and background clutter. This paper, "IPCRF: An End-to-End Indian Paper Currency Recognition Framework for Blind and Visually Impaired People"[1] presents IPCRNet, a resource-constrained network utilizing dense connection, multi-dilation, and depth-wise separable convolution layers. The study includes a diverse dataset of over 50,000 Indian currency images and introduces the "Roshni-Currency recognizer" Android application. Experimental results demonstrate the superiority of IPCRNet, achieving more than 2% higher classification accuracy compared to cutting-edge networks on the proposed dataset. The framework aims to provide a comprehensive and reliable solution for blind and visually impaired individuals to identify Indian paper currency denominations.

Technological advancements have replaced human labor with machines in various fields, including currency recognition. Accurate identification of worn-out and damaged currency notes is crucial for automated systems. People with visual impairments face difficulties in examining real currency notes without technological assistance. This research, "Indian Currency Classification Using Deep Learning Techniques"[2] proposes an improved approach using a Deep Learning CNN model for accurate currency identification. The model achieves increased accuracy, high speed, and efficiency, reducing the need for human involvement. The study presents a twopart solution: a DL model trained using Keras and a Flask-based web app hosted on Heroku. The algorithm and validated results provide valuable assistance to visually impaired individuals in distinguishing between different denominations. The proposed approach enhances the effectiveness of currency recognition and enables a fully automated process.

The counterfeiting of paper money is a global concern, impacting nations worldwide. This project, "Indian Currency Detection using Image Recognition Technique"[3] aims to identify Indian paper currency using a portable hybrid approach that includes a mobile application. Features of Indian currency notes are extracted and compared with input money to determine authenticity. MATLAB image processing toolkit is utilized, enhancing visual information. Principal component analysis and local binary patterns are employed for note identification, with Euclidean distance for metric merging. Recognizing

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currency notes is challenging due to issues like dirty notes, watermarks, and resolution. By leveraging image processing techniques and feature analysis, this approach enables reliable currency recognition.

Recognizing and verifying currency notes solely with the human visual system is challenging due to its limitations. Deep learning approaches have shown superior performance, surpassing human visual recognition abilities, especially when trained on large datasets. ”Overview of currency recognition using deep learning”[4] provides a comprehensive literature review on currency identification and addresses the issue of limited available data. It summarizes deep learning techniques like CNN, SSD, and MLP, and presents the authors’ own efforts in applying deep learning to improve currency recognition accuracy. Additionally, potential future research directions are discussed.

The paper, ”Fake Currency Detection with Machine Learning Algorithm and Image Processing”[5] focuses on detecting counterfeit currency by analyzing colors, widths, and serial numbers. Advanced computer science techniques, such as machine learning and image processing, offer a high accuracy of 99.9% in identifying fake cash. Beyond algorithms, features like color, shape, paper width, and note-specific image filtering are utilized for detection and recognition. The study proposes the use of K-Nearest Neighbors (KNN) combined with image processing for counterfeit money identification. KNN is well-suited for computer vision tasks due to its high accuracy with small datasets. A sophisticated dataset for banknote authentication is created, leveraging computational and mathematical techniques for accurate data analysis. Machine learning algorithms and image processing ensure reliable data processing and extraction, leading to desired outcomes and accuracy.

The production and use of unauthorized counterfeit notes have led to significant financial losses for the government. Money plays a crucial role in a community’s or country’s development, but India faces challenges like corruption and black money. This system, ”An Exemplary Template Matching Techniques for Counterfeit Currency Detection”[6] proposes a procedure for banknote verification using image processing techniques. The dissimilarity space is used to analyze currency images, employing various pixel levels to detect counterfeit money. While counterfeit money was once limited to a few locations, it can now be produced accurately with inexpensive laser printers. Phony currency recognition is a hot topic for researchers, and methods like pattern recognition and neural networks are employed. MATLAB is used in this study to identify counterfeit notes

Counterfeit money, generated to deceive, poses a significant problem. Demonetization led to an influx of counterfeit currency, increasing questionable transactions. Current efforts primarily rely on image processing for detection. This paper, ”Counterfeit Currency Detection using Deep Convolutional Neural Network”[7] proposes a convolutional neural network (CNN) model for portable devices like smartphones. The model is trained and tested on a dataset created by the author. Images taken with a smartphone’s camera are processed by the CNN network, yielding promising results. Further research and architectural advancements can enhance the model’s performance. The testing accuracy achieved is approximately 85.6%, while training and validation accuracy are 98.57% and 96.55% respectively.

Automatic coin recognition systems are vital in vending machines, slot machines, and banking equipment. Existing approaches rely on image processing and physical characteristics of coins. This research, ”Deep Learning Based Indian Currency Coin Recognition”[8] presents a deep learning strategy using the pre-trained convolutional neural network, AlexNet. Features like textures, colors, and shapes are used to train the model, which can classify Indian coins into four categories: one, two, five, and ten rupee coins. The model is evaluated on diverse datasets, considering rotated, translated, and shifted images. Performance is measured in terms of response time and recognition accuracy. The results show that the proposed methodology outperforms established systems,

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demonstrating its effectiveness in coin recognition and detection.

In India, distinguishing between different currency notes poses challenges for foreigners and visually impaired individuals. Even healthy individuals can struggle with identical notes featuring new designs. Human eye limitations also lead to occasional failure in detecting counterfeit money. This study, "Indian Currency Recognition from Live Video Using Deep Learning"[9] evaluates a deep learning-based detection model's accuracy with various Indian currencies, yielding positive results.

Deep learning has significantly advanced visual object detection and recognition. However, recognizing moving objects remains challenging. Recurrent neural networks (RNN) with Long Short-Term Memory (LSTM) excel in capturing object motion properties. Combining LSTM and CNN effectively captures spatial and temporal characteristics of moving objects. This study, "Fast-moving coin recognition using deep learning"[10] focuses on using deep learning, specifically LSTM CNN fusion, for accurate recognition of fast-moving coins in digital videos. The proposed method outperforms human visual recognition, achieving high accuracy in fast-moving coin identification.

III. PROPOSED METHODOLOGY

After conducting the literature survey, we discovered that there are many better ways and techniques of image processing and segmentation we can use to improvise training and testing of the coin detection model. The dataset will consist of a large number of images as we will be using CNN deep learning. The data is in the form of images which will be used to train the dataset. Using the convolutional neural network of layers a classification model is formed. Now, by the testing data of some images of the dataset, the accuracy and correctness of the model is checked. The output from the test data is analysed and the percentage accuracy, TN, FP etc parameters are calculated.

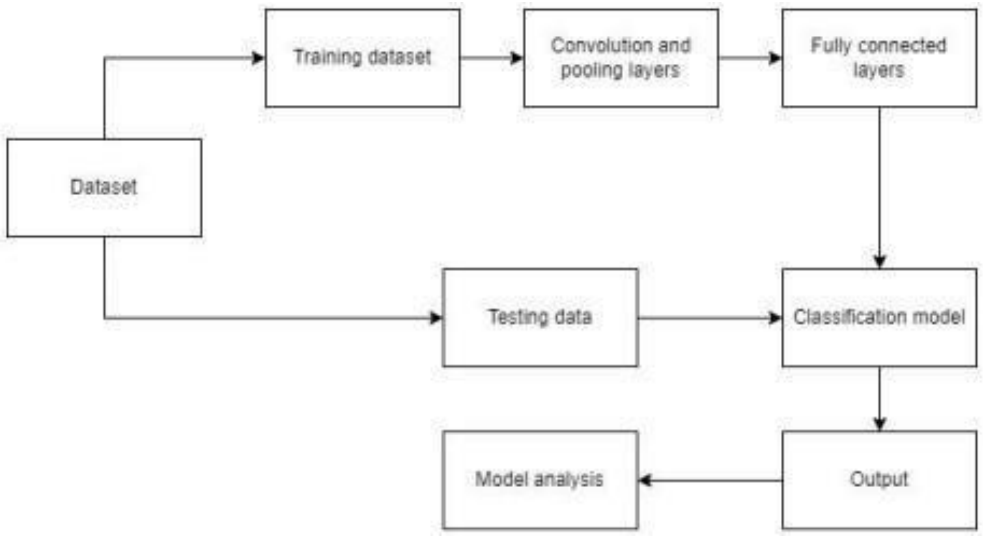

Figure 1: System architecture

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1. Dataset: The dataset is a collection of the images of the coins and notes which are taken from the various possible angles and views. The dataset contains about — coins images and notes images. The coins are of all current denominations such as 1, 2, 5, 10 and notes of 10, 20, 50, 100, 500 and 2000. The different denominations are segregated into folders containing the images of the same denomination.
2. Preprocessing: The images are preprocessed by removing the background from them and invalidating the blur and unclear images. This step is important to improve accuracy of the model.
3. Training & Testing: About 80% of the images of both coins and notes are used to train the model. The rest 20% of the dataset is used for the testing and validation.

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CNN stands for Convolutional Neural Network. It is a type of deep learning algorithm that is commonly used in computer vision applications such as image and video recognition, object detection, and segmentation.

CNNs are designed to automatically learn features from images through a series of convolutional and pooling layers, followed by fully connected layers that classify the input image. In a CNN, the input image is fed through a series of convolutional layers, where filters are applied to the input image to extract features. The resulting feature maps are then downsampled through pooling layers to reduce the spatial dimensionality of the image. Finally, the fully connected layers take the flattened feature maps and use them to predict the class label of the input image.

CNNs have been successful in various applications, including image classification, object detection, and segmentation, and have achieved state-of-the-art performance in many benchmarks.

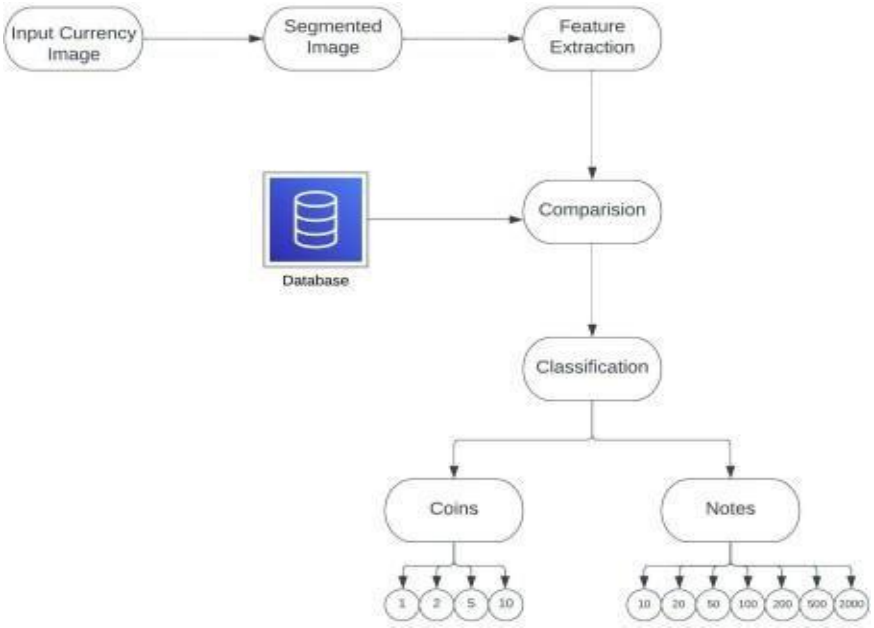

Figure 2: Data Flow Diagram

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IV. ADVANTAGES, LIMITATIONS AND APPLICATIONS

ADVANTAGES

1) Works for Coins: Apart from the notes, this project also works for the identification of coins of all denominations.
2) Counterfeit Currency : The counterfeit currencies can be suspected if they do not fall into any of the categories.
3) Automation : The process of manual identification of the currency is automated. It can be used to classify as many notes as needed without human need.
4) Faster and accurate : The classification of notes is faster and highly accurate as the model is trained using an extensive dataset containing all possible images.

LIMITATIONS

1) Very old/rare currency: Very old/outdated currency denominations (Eg: 50p Coin, 5 Rs note etc.) may not always be correctly identified.
2) Foreign Currency : The non-Indian currency cannot be identified at this stage of the project.

APPLICATIONS

1) BVIP : The blind and visually impaired individuals can use it to identify the currency correctly. The app can read aloud the amount.
2) Counterfeit currency detection : This model can be used for the fake currency identification. Those entities that only have a few matching features to the original ones are fake.
3) Currency counter : Only some of the existing currency counters are smart and can do the detection of the currency amount and counting them. Others have to be fed with the amount of notes and then it just counts the number of notes. Also, the same is true for the coin counter. So this classifier model can identify, count and verify the fakeness of the currency in one go.

CONCLUSION

The project aims to achieve that, the currency classification should be extremely efficient, while also minimizing the present time span. Also, because we are doing it with the support of convolutional neural networks(CNN) and deep learning, its more accurate in terms of currency identification and classification. Also, this project works for both the coins as well as the notes and successfully differentiates and identifies them.

The future scope of this project is for the blind and visually impaired individuals(BVIP). They can use it to identify the currency correctly. The app can read aloud the amount. This model can also be used for fake currency identification. Those entities that only have a few matching features to the original ones are fake. Also only some of the existing currency counters are smart and can do the detection of the currency amount and counting them. Others have to be fed with the amount of notes and then it just counts the number of notes. Also, the same is true for the coin counter. So this classifier model can identify, count and verify the fakeness of the currency in one go.

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