Currency Recognition for Visually Impairment People Using Deep Learning Algorithm

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Abstract

Modern automation systems in real world require a system for currency recognition. It has various potential applications including banknote counting machines, money exchange machines, electronic banking, currency monitoring systems, assist blind persons etc. The recognition of currency is a very important need for Blind and visually impaired people. IN this project, we present a simple system currency recognition system applied on Indian bank note. The proposed system is based on simple image processing utilities that insure performing the process as fast and robust as possible.

Introduction

In this modern era, currency identification devices are crucial in all monetary sectors. In the case of Brazil, a country renowned for its rich cultural history and diverse coinage, the task of classifying Brazilian coins presents unique challenges due to the substantial variations in size, design, and appearance across different denominations and minting years. Currency recognition techniques may be used in coin-based printing devices, vending machines, automated toll gates, various bank hardware, etc. According to the prediction made by the International Chamber of Commerce (ICC), there will be a global financial loss of US $2.3 trillion by 2022 due to the exchange of fake currencies. Due to the same issue, India also suffers from an economic loss of Rs 1.05 lakh crore every financial year. Traditionally, coin classification has been manual and time-consuming, requiring expertise in numismatics and a painstaking examination of each coin. However, recent advancements in deep learning and computer vision have paved the way for automated coin classification systems that efficiently handle large volumes of coins with high accuracy. The classification of Brazilian coins presents a distinctive set of challenges. Unlike paper currency, coins are not uniform in size and color, and their designs evolve. Furthermore, factors such as wear and tear can further complicate the recognition process. These challenges necessitate a sophisticated and adaptable solution that can handle the intrinsic variability in coin appearance. An intelligent currency identification framework utilizing a convolution neural network has been proposed by taking motivation from this. The Brazilian coin dataset in the Kaggle repository has been used for model training and validation. The spare part of this paper contains a literature survey, a dataset description, and proposed model details, followed by a performance analysis and conclusion. The solutions for the problem mentioned above are mechanical, image-based, and electromagnetic techniques. Automated methodologies generally depend on attributes like mass, length, and thickness. But these methodologies only succeed when multiple currencies have the same physical properties. Based on the features identified, coins are categorized into different classes. In image-based methods, prediction depends on the design of the currency. This strategy includes two stages: the initial stage is snapping a photo of the money, and the subsequent advance is to contrast it with the reference currency dataset. The dataset has pictures of several coins taken by different angels. This paper showcases the effectiveness of our deep learning framework in accurately classifying Brazilian coins, providing not only high classification accuracy but also robustness to the diverse condition's coins may exhibit. Comparative analyses with existing coin classification methods underscore the superiority of our approach. Beyond Brazilian coins, the adaptability of our framework positions it as a valuable tool for recognizing coins from other regions, like Indian Coins, that share similar challenges related to visual diversity and variability.

Literature Review

As of my last knowledge update in September 2023, specific literature may not have addressed the ‘‘Deep Learning Framework for the Classification of Brazilian Coins.’’ However, I can provide a general literature review on related topics such as coin classification, deep learning for object recognition, and numismatic research. Tajane et al.have established a Deep Learning-based model using AlexNet to identify Indian coins. Here, the data sample consists of one, two, five, and ten-rupee coins and around 100 images of each class. Such fewer images give higher accuracy. On Indian coins, Chetan and Vijaya devised a side and rotation invariant coin detection system. Here, segmentation was used to identify by rotating the image and utilizing the radius of the coins as a template; the coin prediction can be made. Modi ET alone Indian coins, an ANN-based automatic coin recognition system was proposed. After the pre-processing and pattern averaging processes are completed, the feature vectors of the picture of size 20 × 20 are created. They used 70-coin pictures to generate 5040 images using various rotations. CNN might perform better in terms of classification accuracy. Reisert et al. suggested a quick technique for coin recognition on the CIS benchmark dataset. Inverse bilinear interpolation addresses the tiny gradient changes in the input images. To improve performance, the feature function’s FFT is also precomputed. These systems don’t give higher accuracy. Capece et al. created a deep learning-based coin detection system for mobile devices. This research employs five different models for five other datasets of Euro coins. Schlag et al.constructed a deep-learning model to predict ancient Roman coins. Based on the cash condition, the coins are classified into three categories: very fine, delicate, and highly fine the Saudi Paper Currency Recognition System using the Weighted Euclidean Distance approach. The system’s four tasks are image capture, preprocessing, noise removal, feature extraction, classification, and recognition. On Indian currency paper notes, Swami et al.applied the CNN model’s Deep Learning technique. This paper represents a technique that is divided into two sections. Keras trained a DL model and hosted a Flask-based web app on Heroku. Bahrani has presented a model that differs from frequently used neural network-based models such as VGG16, VGG19, Xception, InceptionV3, AlexNet, and ResNet50 regarding training and testing accuracy. The dataset contains all available Indian currency notes.

Research Methodology

This RFE-CNN helps filter out the recognition pattern from the repetitive spatial information of an image. With deeper convolutions, the high-level feature becomes more exact and less redundant. In this proposed work, filters of size 3 × 3 are used because they are considered the smallest sized filter for extracting low-level features. It is impossible to discover the low-level information with a 1 × 1 filter as the size of the image, and the feature map remains the same after every convolution operation for the feature extraction from the input image, 16, 32, 64, 128, and 256 kernels/filters of size 3 × 3 used in every convolution layer, respectively. The same padding is used here, with a default stride of size 1, to ensure that the output is the same size as the input. This layer is primarily used for the successive size reduction of the input image, resulting in fewer number computations in the upcoming network layers. It generally performs max pooled or average pooled operations for spatial information reduction. In this proposed architecture max pool of size 2 × 2 is used after each convolution in the first 4 Repetitive Feature Extractor (RFE) blocks. In the 5th RFE block, the global average pooling layer is introduced after the convolution operation. The model contains five convolution layers, five pooling layers, and two fully connected dense layers. A max-pooling layer is used after each convolution layer, and a global average pooling layer is used after the last convolution layer. The activation functions that have been used are ReLU and SoftMax. The input image size is 240 × 320 for the feature extraction from the input image, 16, 32, 64, 128, and 256 kernels/filters of size 3 × 3 used in every convolution layer, respectively. The same padding is used here, with a default stride of size 1, to ensure that the output is the same size as the input.

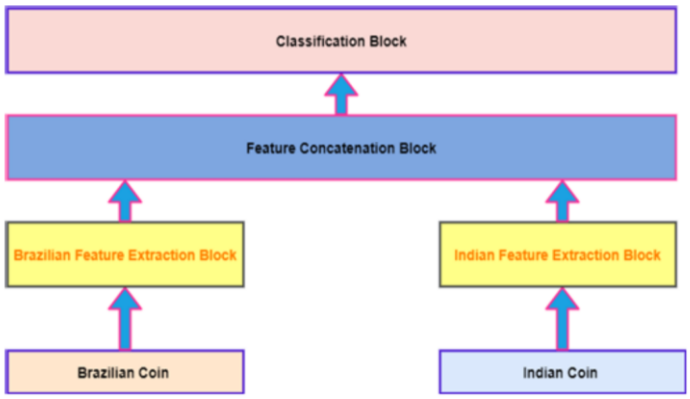

FIGURE 3. **The structure of the proposed coin prediction system.**

N) In the proposed model we used a customized Neural Network layers block is formed in this work, known as a Repetitive feature extractor. This block is mainly used as a feature map to reduce the number of features and identify the underlying pattern from the original currency image during classification. Initially, the system is trained and evaluated with the Brazilian Currency dataset. But in the next stage, to prove the customized model's robustness, it is trained and evaluated using the Indian currency dataset. In both cases, the model has shown a promising result in terms of classification accuracy. The model was fine-tuned during the experimentation using different hyper-parameters related to the Neural Network, such as other optimizers and different learning rate.

Conclusion

In this study, we introduced a deep learning framework tailored to classify Brazilian coins, addressing the challenges posed by the visual diversity and variability inherent to this task. Our framework RFE leveraged convolutional neural networks (RFE-CNNs), transfer learning, and comprehensive datasets to achieve significant progress in accurately classifying Brazilian coins. The major strengths of the proposed model are Visual Variability, Transfer Learning, Comprehensive Dataset, and Interpretability The proposed method has shown promising execution as far as classification accuracy, precision, recall, f1-score, and AUC score are concerned. The parameter optimization has been done using the Adam optimizer. Using the ReLU activation function aided in attempting to avoid the vanishing gradient decent issue. Because of the blend of Adam and ReLU, the classifier has shown good accuracy during training as well as validation and assists with keeping away from overfitting and underfitting. The model has given a meager misclassification score that has helped the precision, recall, and f1-score, and the equivalent is likewise seen in the ROC curve. The experimental results demonstrated the effectiveness of our deep learning framework. We achieved a high classification accuracy of 98.34% on our test dataset, underscoring the model's capability to distinguish between different denominations, minting years, and conditions of Brazilian coins. This level of accuracy is promising and aligns with or surpasses similar studies in coin recognition.

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