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Novel Feature Extraction and Representation for Currency Classification

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ABSTRACT

In an era marked by the rapidly growing levels of international trade and tourism, the accurate recognition of various currency notes has become a necessity. This paper presents research on an image processing technique for classifying the origin of currencies. Individuals are hardly distinguishing between different currencies from various countries. Therefore, it becomes necessary to develop an automated currency recognition system that helps in recognition notes easily, accurately and efficiency. The methodology consists of five stages, which are image acquisition, image pre-processing, feature extraction, classification, and, lastly, results and analysis. The currency image will be pre-processed in grayscale and split into 100x100 blocks at selected regions of interest (ROI) on the currency. Next, binary matrix image features and representations will be extracted. Lastly, the similarity percentage of the binary matrix will be calculated and compared with all currency image matrices. The highest similarity percentage will be chosen as the currency's origin. The proposed algorithm successfully classified the currency and improved the accuracy of currency classification, achieving a 93.4% accuracy rate from the experimental results. The proposed method could be useful for various applications, including financial institutions, security agencies, and automated currency processing machines.

1. Introduction

Any type of money issued by governmental officials in one jurisdiction is known as currency [1]. The currency's importance in facilitating the overall management of countries' economies [2]. Currency notes are an essential aspect of our daily lives and are required for various activities such as investments, business transactions, and marketing. Therefore, the recognition of banknotes becomes a necessity. According to survey all currencies around the world look different [3]. Almost every currency in use around the world has a different appearance and, as a result, different characteristics, for instance, the paper's size, identification marks, colour, pattern, and so on [4].

There are about 180+ currencies worldwide and the necessity for an automatic currency mechanism [5]. In the era of rapidly growing levels of trade between countries and also tourism all over the world, it becomes necessary to recognize each currency note correctly [6,7]. Automatic

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currency recognition systems have become a main source of concern for researchers and developers due to the currency's importance in facilitating the overall management of countries' economies [3]. However, it is not an easy task to differentiate between different currencies and remembering the symbols for each currency is a challenging job that can lead to incorrect recognition [4,8]. And also, it is exceptionally challenging to characterize different coins and notes [5]. Individuals are hardly distinguishing between different currencies from various countries. Therefore, it becomes necessary to develop an automated currency recognition system that helps in recognition notes easily, accurately and efficiency.

In order to ensure the accurate classification of currency origin, a novel feature extraction method for currency classification has been proposed to reduce the inaccuracies in currency quality classification.

The main objective of this research is to accurately classify the currency according to their origin. The study aims to focus on the extraction of currency features and representation that are essential in the classification process. This, in turn, can aid in various applications, including financial transactions, foreign exchange, and counterfeit detection, by ensuring that the currencies are identified correctly.

2. Related Works

In Devi's [9] approach, the image is converted into grayscale for uniformity. This approach focuses on the diagonal vector and compares it with a set of values from the database to identify the currency. Abburu *et al.,* [10] approach identifies the currency origin by template matching, based on empty areas and regions of interest, and then identifies the denomination of the banknote using certain characteristics such as size, colour, and text extraction. This approach achieves an accuracy of almost 93%. In the approach of Tiwari and Dominic [3], banknotes are first converted from BGR to grayscale and then the converted image is checked for binary threshold and pixel value, and the system compares it with the template image. Those approaches [11,12] mainly recognizes India's currency. Rauyani *et al.,* [13] extracted the Region of Interest (ROI), which includes the area where image processing operations and feature extraction operations will be performed. The edges of the currency are detected using Canny's edge detection method. Template matching is used for object detection, which matches required elements in the sample image.

Additionally, some machine learning approaches have been used for classifying the currency origin. Akter *et al*., [14] split the banknote into three channels, filter the channels separately, and then merge them into an RGB picture. A co-occurrence matrix for features such as HSV, edges, and grey levels is computed and saved. This matrix is used to determine the currency's origin by calculating Euclidean distances based on a set of reference values. Zhang [15] proposed a Single Shot MultiBox Detector (SSD) model based on deep learning as the framework, which employs a Convolutional Neural Network (CNN) model to extract the features of paper currency. The recognition of the denomination of the currency, both front and back, is more accurate with the CNN and SSD models.

Chowdhury *et al.,* [16] proposed a method for recognizing the denomination of Indian currency using deep learning and image processing techniques. The banknote is pre-processed before being passed through template matching techniques to identify whether the input banknote is Indian or not. The template matching technique used in this system is Normalized Cross-correlation. If the input banknote is Indian, features such as colour, contrast, correlation, energy, and homogeneity are extracted.