Data Eccentric Engineering

Computational Engineering

Computer Vision and Pattern Recognition

Coin Counting System for Calibration, Detection and Classification

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Abstract

The purpose of this report is to detect and classify European Union coins of various shapes and colors. The system uses image processing from MATLAB Tools and edge detection technologies both from Matlab software to detect coins later there is use of detected images and features of the image to effectively classify the coins into **€1, €2, 50, 20, 10, 1 and 2 cents**. European coins have a variety of values and can be categorized based on either size, surface, area, centroid, shape, color, and other attributes. This report is mainly concerned with designing a system able to detect coins in a certain image after the application of various preprocessing steps and then combine the detected coin with the coin's features to classify it as to whether its **€1, €2, 50, 20, 10, 1 or 2 cents**. To implement the coin categorization, there is the use of MATLAB codes are tested using sample images provided for this task. The categorization will use the Nearest neighbor method to classify coins with reference to diameters from *Euro coins in pictures - Common sides* (n.d.).

Contents

1 INTRODUCTION

Background

Institutions dealing with historical coins need an automatic coin classification, which will aid historians in their job. For private coin collectors, it can also be a helpful tool. In this way, the community may benefit from a free online coin recognition and classification system (Tang et al. 2021). The sorting and classification of the substantial quantities of European coins that were gathered following the introduction of the euro is another potential application area (Modi & Bawa 2013).

The project focuses on imaging measurements with an emphasis on characterizing and calibrating imaging setups for specific measurement tasks. The primary goal is to implement a system capable of estimating the number of various coins in an image. The task was solved in two parts, In the first part we dealt with the detection of the coins for the provided images (Shen et al. 2011) using different MATLAB functions, the second part is storing color features as it was shown by Adameck et al. (2003) for each coin followed by feeding both the detected coin and its color features into a classifier to classify it as **€1, €2, 50, 20, 10, 1 or 2 cents** (*Euro coins in pictures - Common sides* n.d.). The algorithm used can work on simple and complex background images of different resolutions.

1.1 Objectives and delimitations

The objectives for the project are:

1. Imaging Setup, Calibration and segmentation
2. Coin Detection
3. Coin Classification

The project delimitations are:

- The project will be delimited to the use of specific software tools, such as MATLAB toolbox functions available at LUT University.

- The images used have the same Environmental Conditions and if needed to be implemented elsewhere the preprocessing steps would be modified if needed.

2 Methods

2.1 Data Description

For the task, we were provided with 12 images each with coins making a sum of 76 coins to be detected and classified. Additionally, we had Bias, Dark, and Flat Field Images that were used in illumination correction for the given images.

2.2 Implementation

We have used different approaches to solve the given task as said above. We will use a flowchart to show the course of our actions as follows: After loading and presenting coin

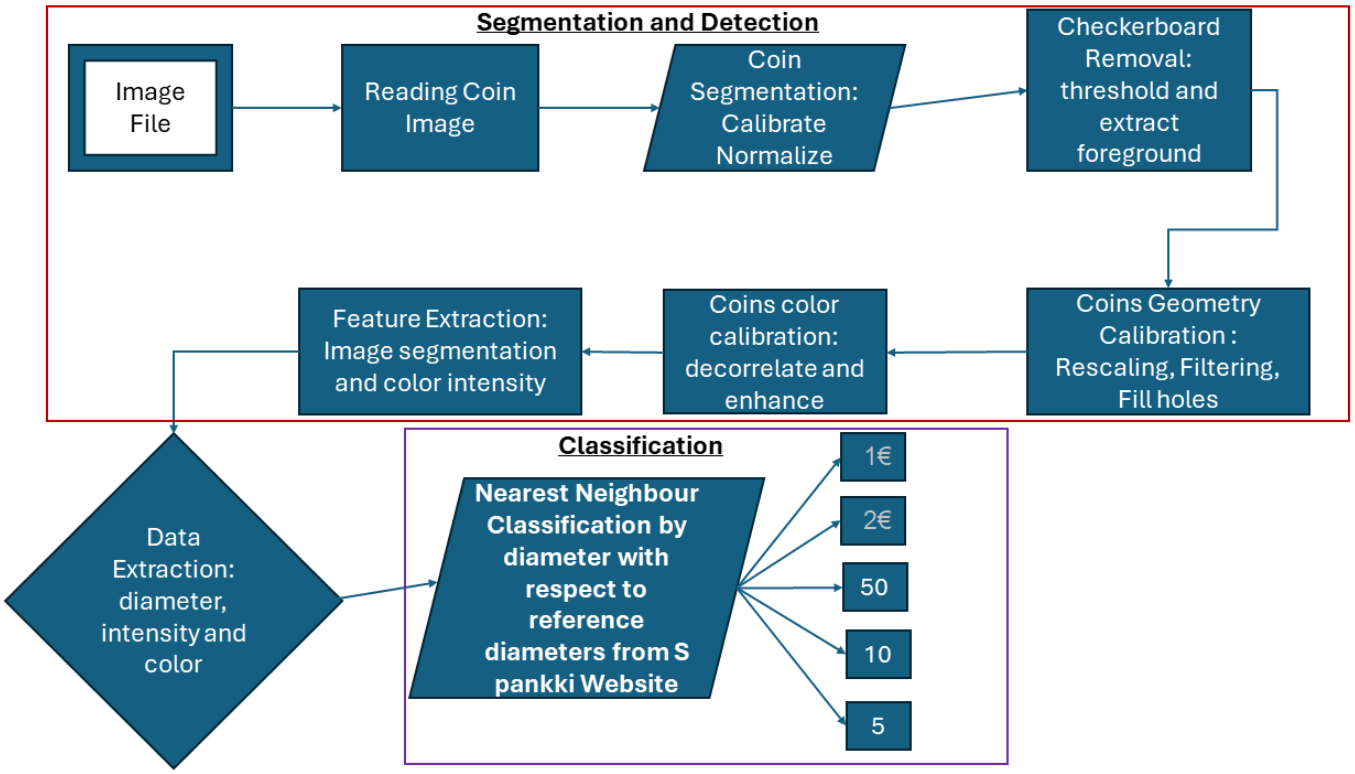

Figure 1: Coin Detection and Classification System Architecture

photos, the approach moves on to a thorough pre-processing step for lighting correction.

In order to determine mean intensity values, bias, dark, and flat field pictures must be calibrated. Image quality is improved by checkerboard removal, and coin pictures are normalized and segmented after geometry calibration. Stretched image enhancement and decorrelation are part of color calibration. Region-based analysis is required for feature extraction, which yields important geometrical and intensity data. K-means clustering is used to classify the data. Coins are separated from one another using image segmentation, which also enables quantitative measurements using real-world units. Accurate coin analysis is facilitated by the code's dedicated routines for loading bias, dark, and flat field photos. These functions add strength to the image processing pipeline.

We can see from the methodology graph, the detection steps and classification steps. For classification we have used the Nearest neighbor algorithm to classify coins depending on diameters from *Euro coins in pictures - Common sides* (n.d.). After applying all the steps, as we visualized a sample image among the 12 images we had to show visually how the steps were implemented in figure 2, we also showed an image in figure 3 of the detected coin image as shown by a red circle.

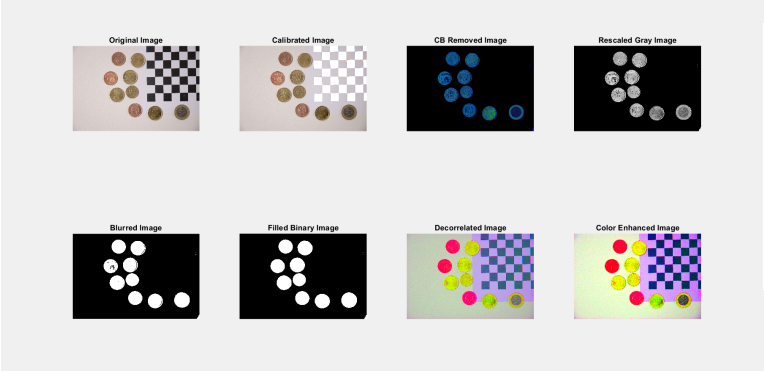

Figure 2: Preprocessing Image step by step

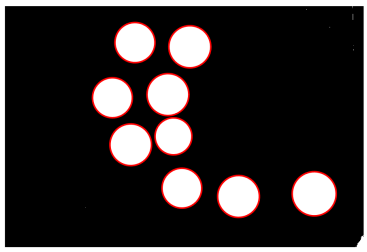

Figure 3: Detected Coin Images

Figure 4: Preprocessing and Detection Images

3 Results

We have used Nearest neaighbour classifier for our coin classification system, We used the extracted coin diameter from the detected coins and classifed them with respect to diameters from *Euro coins in pictures - Common sides* (n.d.). We did this by calculating the distances of each coin's diameter and the reference coins, then we classified the coin depending on the distance with the minimum distance. After doing that for the 71 detected coins, we calculated the accuracy. Our system was able to correctly get correct counts of each image by a 70.83% accuracy and also it was able to correctly classify coins by an 83.55% accuracy. Our system can work on different images with different backgrounds. Further work can be done to better improve our work and make it usable in real life.

We have documented and kept our codes on Github open to the public to be used. The link: DIIP Github Link

References

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