UNIVERSITY OF KWAZULU-NATAL ™

INYUVESI YAKWAZULU-NATALI

South Africa Bank Coin Recognition

Nkosiyazi Myaka 217045205
Sipho Gwala 219041311

University Of KwaZulu-Natal

School of Mathematics, Statistics and Computer Science

Motivation

Counterfeit currency is a significant concern in the market, and bank coins play a vital role in our trading culture. While digital currency and banknotes are more prevalent, physical bank coins still dominate local transactions. Therefore, the ability to identify bank coin accurately can help address issues related to counterfeit currency. Such systems are beneficial for visually impaired individuals, providing them with greater independence and reducing reliance on untrusted individuals. Furthermore, these systems can enhance the security and efficiency of ATMs by ensuring proper maintenance operations and preventing counterfeit bank coins from being inserted [6]. They also find applications in automated bank coins sorting and counting, facilitating faster transactions and money transfers. To be effective and practical, these systems must be capable of recognizing bank coins from various viewpoints, accommodating size variations, and handling challenging conditions such as cluttered areas and variable lighting. Additionally, they should be able to differentiate folded, wrinkled, and aged bank coins.

Introduction

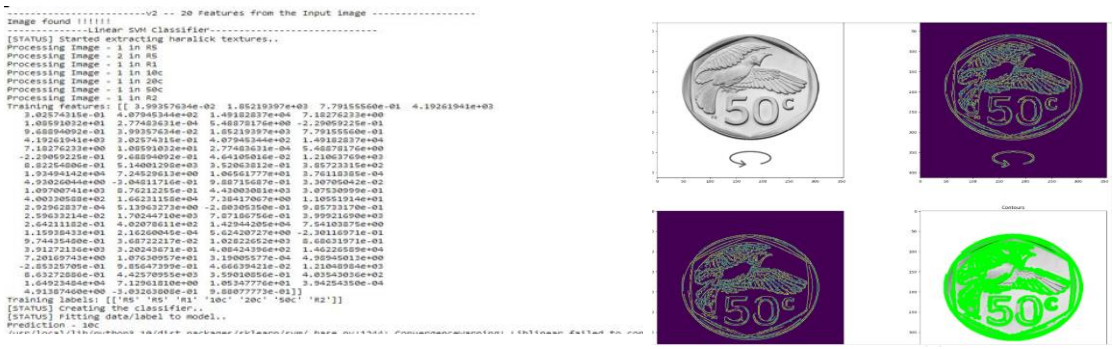
The purpose of this project is to develop a system that can accurately identify South African coins. The system utilizes image processing techniques to preprocess the input images, removing ambient noise and enhancing contrast and brightness. These preprocessing steps are crucial for implementing a robust bank coins recognition system. The objective of this examination is to analyse the techniques and algorithms used for identifying the properties (features) of South African bank coins in a reference collection. The Bank Coin Recognition System aims to compute a similarity measure that is invariant to sides, scale, and rotations, considering that the bank coins have two appearances (upstanding and upside down). Image processing techniques are employed to achieve the desired results. The system consists of several steps, including input image handling, image processing and enhancement, image segmentation, feature extraction and image classification, comparison, and output image generation. Various methods can be used to acquire images, such as cameras or scanners, ensuring that the acquired images retain the necessary features for processing.

Image Processing and Enhancement

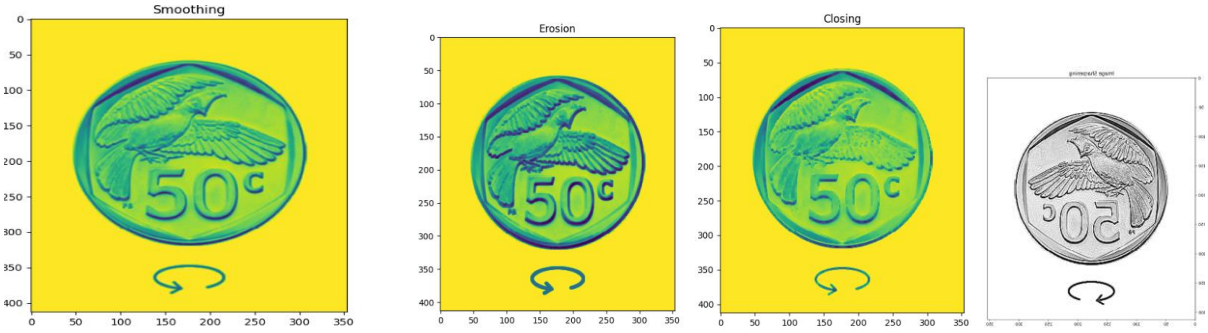
Pre-processing Analysis is used to ensure the authenticity of identified bank coins. It addresses potential challenges such as matching different pieces of wrinkled bank coins or partial matches with images resembling bank coins from other countries. A preprocessing phase is implemented to boost the identification of positive features and maintain a reliable perception of the system even though the images have significant noise [5]. Noise is removed during the first phase using a bilateral filter, smoothing, erosion, closing and a CLAHE (Contrast Limited Adaptive Histogram Equalization) is applied to boost the contrast after the noise is reduced. These techniques have better results than simple histogram equalization as it can be applied to images that have high and low contrast areas, and limits the noise spread.

The input images undergo a series of preprocessing steps to ensure optimal recognition results. Ambient noise is eliminated, and the contrast and brightness of the images are adjusted to enhance the visibility of coin features. Key points and their descriptors are then calculated, enabling the system to find the best match against a valid bank coins database. A preprocessing analysis is implemented to ensure the authenticity of the identified coins. The postprocessing phase involves computing the bank coins contour using obtained homograph

and excluding results with convex contours or inappropriate area, circularity, and aspect ratio[1].



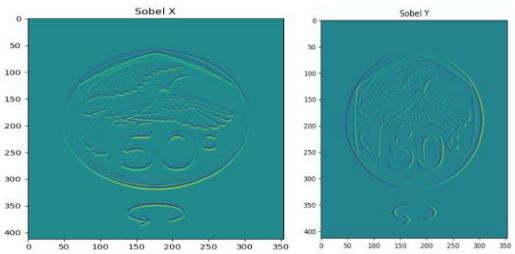
The caption illustrates the processing of image datasets and, the combination of contour and filtering at the right.



The caption illustrates the image enhancement operations performed on the image, which include Smoothing, Erosion, closing and image sharpening.

Image segmentation

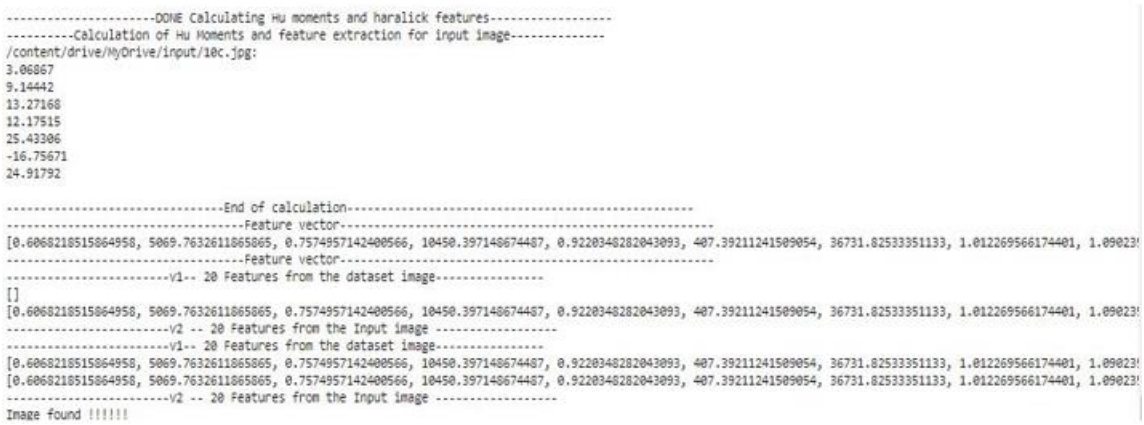
Image segmentation in digital image processing and computer vision is the method of partitioning a digital image into several segments (sets of pixels, often known as image objects). The segmentation objective is to simplify and/or change the image representation into something that is more meaningful and easier to analyse [2]. Traditionally, image segmentation is used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process by which each pixel in an image is assigned a label, so that pixels with the same label share certain characteristics [4]. Thus, we will implement the Image Segmentation with Watershed Algorithm that mark the area to be the foreground or focus with one colour (or intensity), mark the area we're sure to be background or non-object with another colour and eventually mark it with 0 for the region we're not sure of anything. This is the marker for us. Then apply watershed algorithm. Therefore, our marker will be modified to the labels we've provided, and the object boundaries will have a value of -1, we will also implement the edge detection and the thresholding as our mask to have more accurate results.



The captions shows the Image segmentantion l tools which include sobel.

Feature extraction

Feature extraction is a technique used to capture essential characteristics from the original data and represent them in a lower-dimensional space. It involves reducing the dimensionality of the data while retaining the most important information [3]. In this project, a combination of moment variants and Haralick features is employed to generate a feature vector for each image, comprising a total of 20 features derived from the combination of moment variants and Haralick features. To accurately classify the input image, the 20 features of the input image must precisely match the 20 features of the dataset. The proposed feature extraction technique contributes to reliable image classification and pattern recognition in this project.



The caption above shows the calculations behind Feature extractions of the image.

Coin classification

Image classification is a two-step process that involves feature extraction and machine intelligence algorithms to categorize and label groups of pixels or vectors within an image. The supervised machine learning algorithm known as Support Vector Machine (SVM) for image classification was used due to its advantages which is clear margin of separation, effectiveness in high dimensional spaces, and handling high-dimensional feature spaces [1]. SVM is a robust and reliable algorithm for image classification tasks due to its ability to handle complex feature spaces, find clear boundaries between classes, and efficient memory usage. It was also used to classify images based on the extracted visual features, resulting in accuracy and efficiency. The feature extraction technique which includes moment variants and Haralick features to represent and compare images based on their distinctive characteristics, allowing for accurate classification and pattern recognition.

The caption above shows the classification of the coin.

Results and Discussion

The coin currency recognition system is used to classify whether an input coin is depicted or not. In training and testing datasets, all images of bank coins are genuine and current working South African bank coin. The classification prototype classifies the denomination of each South African banknote as 10 Cent, 20 Cent, R1, R2 and R5 on the test set image accordingly based on the trained sample images. The system was tested with images that contained South African coin banks both old and new, and the coin has two faces, and the orientation of the coin can either be upright or up-side-down. The proposed Support Vector Machine classifier is used to find the optimal hyperplane which linearly separates the data points in two components by maximizing the margin. The figures below represent the correct classifications of the South African bank coin.

The caption shows the prediction of the coin.

Conclusion

We have utilized image processing techniques, which include preprocessing, and feature extraction, the system aims to accurately identify South African bank coins. the implemented system utilizes advanced image processing techniques to accurately identify South African coins. The combination of preprocessing, feature extraction, and post-processing phases ensures robust recognition and minimizes false identifications. By incorporating comprehensive analysis and filtering methods, the system guarantees the recognition of genuine South African coins while mitigating potential challenges related to noise, partial matches, and counterfeit coins. The system addresses challenges related to different appearances of the coins, variations in viewpoints, sizes, and lighting conditions. Through careful preprocessing analysis and postprocessing, the system ensures the recognition of genuine bank coins while mitigating false identifications caused by similar images or non-South African coins.

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