Real-time Coin Detection and Counting via Perspective Correction, Hough Detection, and Classification

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I. Introduction

This project implements a real-time euro coin counter in C++ using OpenCV. The workflow consists of: (1) detecting a rectangular paper sheet in the camera image and warping it to a fixed size (A4); (2) detecting coin circles and estimating diameters (with optional calibration); (3) classifying each coin by denomination using a trained classifier (SVM by default, with KNN, Random Forest, and Naive Bayes alternatives for testing); and (4) aggregating counts and total value in euros. Figure 1 summarizes the end-to-end flow.

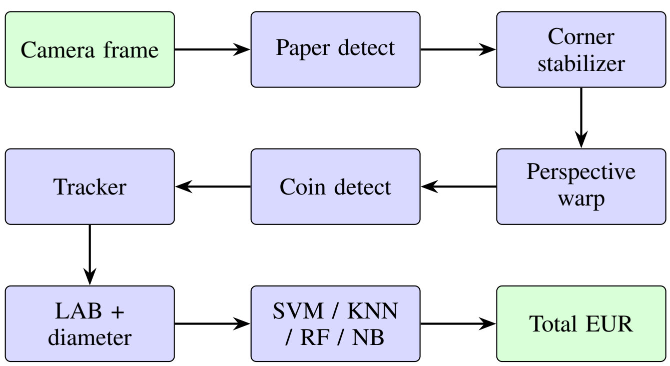

Fig. 1: Processing pipeline.

II. Paper Detection and warping

The system assumes that coins lie on a rectangular sheet of known size (A4). In each frame we detect the four corners of this sheet to compute a perspective transform.

A. Detection Algorithm

To isolate the workspace, the system processes the luminance channel of the input frame. A Line Segment Detector (LSD) identifies structural edges, which are filtered to remove noise. We then apply morphological operations to connect broken segments, forming a closed shape. The system selects the largest quadrilateral contour in the frame to represent the A4 paper sheet, ensuring the detected area meets a minimum size threshold to prevent false positives.

B. Corner Stabilization

To avoid jitter, a *corner stabilizer* maintains a sliding window of recent corner matrices. When new corners are available, they are pushed into the window; when the window is full, the median (per coordinate) is taken and returned. This stabilizes the quadrilateral before computing the homography.

C. Perspective Warp

Ordered corners are mapped to a destination rectangle, `getPerspectiveTransform` and `warpPerspective` produce the warped image. Figure 2 shows the unwarped image with the detected paper region in the original frame.

Fig. 2: Unwarped view with paper detection

III. Coin Detection and Measurement

On the warped image we run a detection pipeline that outputs a list of *detections*: center (x, y) and diameter in mm.

A. Detection and Validation

The warped image undergoes contrast enhancement and noise reduction to prepare for edge detection. We utilize the Hough Circle Transform to identify candidate coins.

Crucially, false positives are eliminated using physical constraints: pixel diameters are converted to millimeters, and any candidate falling outside the valid range of standard Euro coins (approx. 10–40 mm) is rejected. Overlapping detections are resolved by non-maximum suppression, retaining only the strongest candidate per location.

B. Diameter to Millimeters

Pixel diameters are converted to millimeters using a linear scale factor. To improve accuracy, an optional calibration step calculates a spatial correction factor based on the coin's position in the image. This compensates for perspective tilt and lens distortion, ensuring consistent measurements at the image edges.

IV. Coin Classification

Once a coin is detected, it must be classified into one of the Euro denominations.

A. Feature Extraction

We utilize a 4-dimensional feature vector for every detected coin consisting of:

1) **Physical Size:** The estimated diameter in millimeters.
2) **Color Properties:** The average mean values of the L, a, and b channels extracted from the coin's region of interest (ROI).

This combination allows the system to distinguish coins of similar sizes but different colors (e.g., 20 cent vs. 1 Euro).

B. Model and Training

A Support Vector Machine (SVM) was chosen as the primary classifier due to its robustness in high-dimensional separation. The model was trained on a labeled dataset collected by segmenting the warped workspace into specific zones for each denomination (Fig. 3). This dataset was further enhanced with light augmentation to improve generalization. Evaluation on a held-out test set confirms the model's ability to accurately distinguish between the six coin classes, as shown in the confusion matrix (Fig. 4).

Fig. 3: Training acquisition: warped image showing the six designated zones used for data collection.

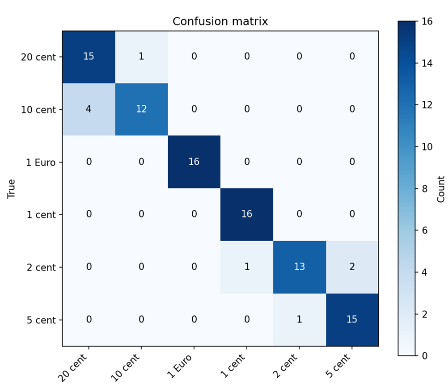

Fig. 4: Confusion matrix for the SVM classifier (six euro classes).

V. Results

The main application executes the previously described pipeline in a real-time loop. A comprehensive video demonstration of the full process is provided below:.

Video Demonstration

https://youtu.be/5UnI541KE0Q

Figure 5 illustrates a sample frame from the working system. The pipeline successfully rectifies the perspective, detects individual coins, and overlays the estimated diameter and class label for each (6FPS).

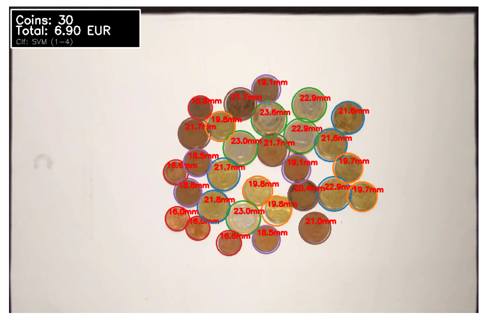

Fig. 5: Detection and counting results: detected coins are marked with circles and labeled by diameter. The overlay indicates the specific denomination color coding and the calculated total value in EUR.