COIN DETECTION REPORT

Project Overview

This project involves detecting and counting coins in a dataset of images using OpenCV. The goal is to:

- Identify coins in the images.
- Evaluate detection accuracy using metrics such as Precision, Recall, and F1-score.
- Analyze results to identify strengths and weaknesses of the detection algorithm.

Detection Approach

1. **Image Preprocessing**:
    - Convert images to grayscale.
    - Apply median blur to reduce noise.
2. **Circle Detection**:
    - Use the Hough Circle Transform to detect circular objects (coins).
    - Configure parameters such as edge thresholds and radius ranges for detection.
3. **Ground Truth Comparison**:
    - Match detected circles with ground truth annotations using Euclidean distance and relative size comparison.
    - Classify matches as True Positives (TP), False Positives (FP), or False Negatives (FN).
4. **Evaluation Metrics**:
    - Calculate **Precision**, **Recall**, and **F1-score** for each image and overall dataset.

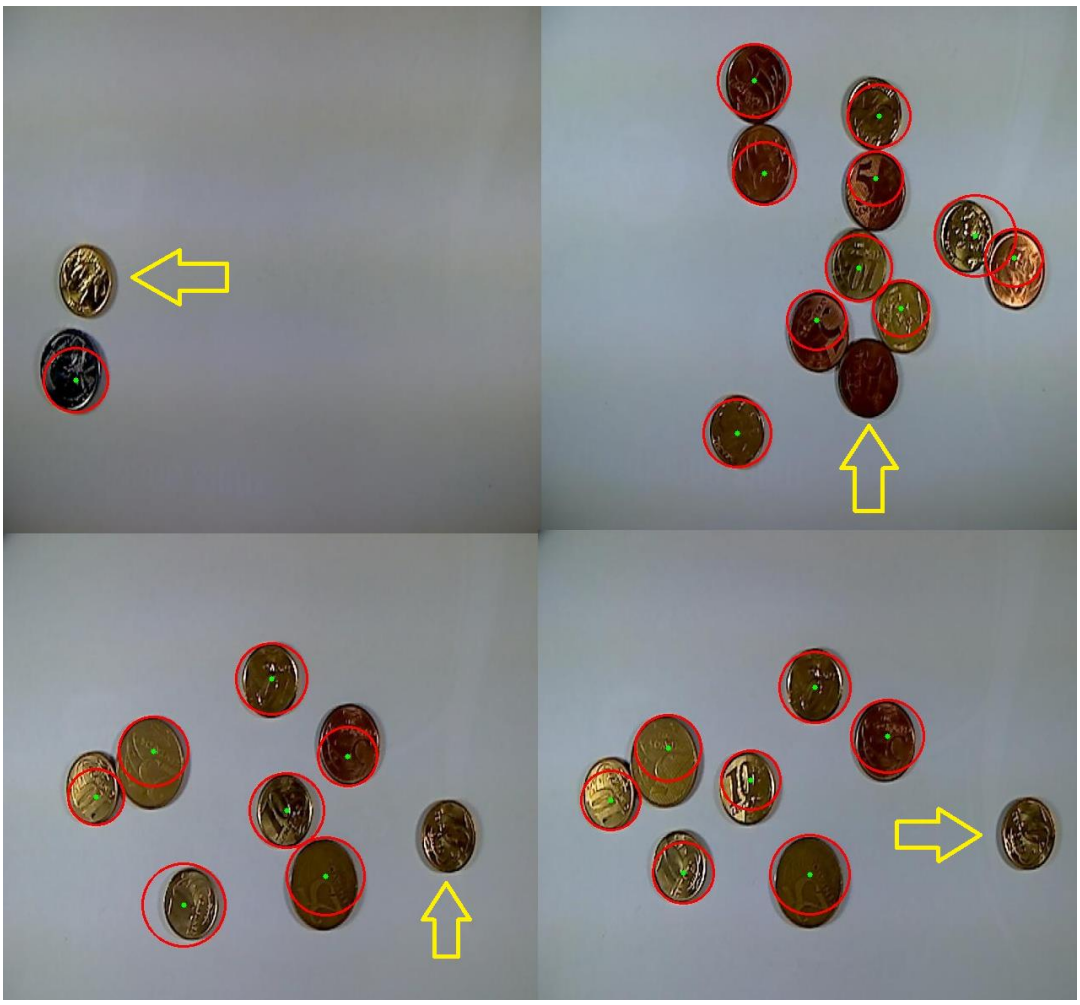
Results Summary

Overall Metrics:

- **Total Ground Truth (GT)**: 70 coins
- **Total True Positives (TP)**: 66 coins
- **Total False Positives (FP)**: 0 coins
- **Total False Negatives (FN)**: 4 coins
- **Precision**: 1.0
- **Recall**: 0.943
- **F1-score**: 0.971

Performance:

- The algorithm demonstrated excellent precision, with no false positives.
- Recall was slightly lower due to four missed coins (false negatives).



There could be several reasons why one of the coins wasn't detected. Here are potential explanations:

1. **Low Contrast**:
    - The upper coin blends with the background due to poor contrast. The coin's edges may not be pronounced enough for the algorithm to detect them.
2. **Hough Transform Sensitivity**:
    - The parameters for Hough Circle Transform (e.g., accumulator threshold, edge detection thresholds) might not be sensitive enough to detect faint or poorly defined edges.
3. **Illumination Issues**:
    - Uneven lighting could cause shadows or highlight certain areas of the coin while obscuring others, making edge detection inconsistent.
4. **Preprocessing Limitations**:
    - The preprocessing step (e.g., Gaussian blur or median blur) might have smoothed out subtle details that were critical for detecting the coin.
5. **Size or Radius Constraints**:
    - If the coin's size is outside the defined minimum or maximum radius, it won't be detected.
6. **Noise or Artifacts**:
    - The algorithm might mistakenly classify noise or reflections as part of the background instead of detecting the coin's circular shape.