CS472 - Computer Vision

Spring Semester, 2024

Assignment 03: Hough Transform for coin value estimation

➔ 4.75 Euros

(1 coin of 2 Euros, 2 coins of 1 Euro, 1 coin of 50 cents, 1 coin of 20 cents, 1 coin of five cents)

Due date: 19/04/2024

General description

In this assignment you will implement the Hough Transform as a means to count the total value of a number of coins that are shown in an image. As the example above shows, your input will be an image showing coins. Your output will be the number of coins of each particular value, from which you can obviously assert the total value of coins shown in the image.

In a baseline scenario, we assume that coins are placed on a flat surface of uniform color. The camera is placed at a constant height from that surface (you have to decide that), so that its optical axis is perpendicular to the surface. Under these conditions, coins appear as circles of a certain radius. Therefore, the detection of coins amounts to finding and counting all circles of different radii.

The baseline scenario for solving this task has the following steps:

1. Image filtering (e.g., Gaussian smoothing) to remove noise
2. Edge detection (e.g., your "myEdgeFilter" implementation of the second assignment, or any other implementation of edge detection that you find in any image processing library).
3. Implementation of a Hough Transform that detects the locations of circles of different radii. It is assumed that during a "training" phase, you can build a lookup-table that relates a coin of a certain value to the radius of the circle of that coin, as this is imaged from a camera placed at the specific height. So, detecting how many circles of different radii exist in an image, solves the problem of detecting how many coins of each value exist in that image.

Having implemented a solution to the baseline scenario you can (a) test it under different conditions (b) identify failure cases and (c) try to come up with solutions to these problems (suggest them or even implement them). For example:

1. How tolerant is your solution to changes of the height at which the camera is placed relative to the surface on which the coins are placed?
2. How tolerant is your solution to changes of the angle at which the camera is placed relative to the coins surface?
3. How tolerant is your solution to the presence of overlapping coins? How much overlap can be tolerated?

4. What happens if the surface on which the coins are placed is not of uniform color but contains arbitrary textures?
5. In a certain scenario, there might be other circular objects of similar radii (e.g., beer bottle caps) that will obviously confuse your system and appear as disguised coins. How could SIFT features and/or the Generalized Hough Transform approach assist you to disambiguate such settings and improve the accuracy of your solution? Note that, if you follow such a path, ideally, you need to model both sides of a coin. While it would certainly be nice to do that, to save time and effort, you may assume that coins need to appear only in one (selected) of their two faces.

Test images

In this assignment, you will need to acquire your test image set yourselves! Please, include it in the DATA folder of the zip file that you will provide when turning-in your assignment.

Important notes

1. Ideally, your system should be able to handle all different coin values (1, 2, 5, 10, 20, 50 cents, 1 Euro, 2 Euros). However, you should note that, certain values have very similar radii (for example the coins of 5 and 10 cents). This has certain implications on the requirements regarding the resolution of the acquired images, the distance of the camera to the coins, etc. At a minimum, you may select a subset of coin values to work with (e.g., 1cents, 50 cents, 2 Euros). Ideally, you should find other ways to disambiguate the situation.
2. The coins of 2 euros and 1 Euro may give rise to two concentric circles, each. You can take advantage of this to disambiguate the recognition task.
3. When showing your results on an image, do so by (a) showing the detected coins (e.g., draw the circle or its bounding box, and show its value by adding text or some color-coding of the values).

General Guidelines

- The selection of MATLAB is quite natural, however, there is absolutely no constraint on the programming language used.
- Your code cannot employ calls to available implementations of Hough Transform. However, you may use such implementations for debugging your code and comparing it with the results you obtain.
- For whatever question and/or clarification, you may ask Antonis Argyros (argyros@csd.uoc.gr) and Stelios Perrakis (stperrakis@csd.uoc.gr). It is also recommended that you email hy472-list@csd.uoc.gr so that everybody becomes aware of the questions and the answers.
- For our purposes, code does not have to be efficient necessarily. Focus on clarity, correctness and function.
- Your report should contain a brief description of your implemented solution, focusing especially on the more "non-trivial" or interesting parts of the solution and/or results. What implementation choices did you make, and how did they affect the quality of the result and the speed of computation? What are some artifacts and/or limitations of your implementation, and what are possible reasons for them?
- Whatever idea you have on the problems is not only acceptable but highly welcomed. Describe it briefly in your report, even in the case that it did not give the desired/expected results.

Turning in the assignment

Your submission should consist of **a single zip file** (**a3_lastname_firstname.zip**) containing the following:

- **CODE:** All your code.
- **DATA:** All the test images that your acquired and experimented with, along with the results of your method. **Please, include failure cases! No matter how good was your ideas and implementation, there will always be situations where your solution will not provide correct**

results. Showing failure cases is the best way to showcase what needs to be done for further improving a solution!

- **REPORT:** A brief report **in a single PDF file** with all your results and discussion. The filename should be **a3_lastname_firstname.pdf**.

Send the zip file to argyros@csd.uoc.gr, and cc this to stperrakis@csd.uoc.gr with email subject: **"[CS472] – assignment 03".** In case the file is too big to be sent by email, place it somewhere in the cloud and send an email as above with a link to the repository.

Academic integrity

Feel free to discuss the assignment with each other in general terms. Coding should be done individually. If you use existing material, be sure to acknowledge the sources in your report. Usage of AI Language Models like ChatGPT for producing your reports or implementation is prohibited and submissions will be verified against an AI detector tool.