AIN 433 - Introduction to Computer Vision Laboratory

HACETTEPE UNIVERSITY

Department of Computer Engineering

Programming Assignment 2
Fall 2023
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Due Date: 29.11.2023 - Wednesday (23:00:00) **Programming Language: Python 3**

Overview

The Hough transform is a feature extraction technique used in image analysis, computer vision, and digital image processing. The purpose of the technique is to find imperfect instances of objects within a certain class of shapes by a voting procedure. This voting procedure is carried out in a parameter space, from which object candidates are obtained as local maxima in a so-called accumulator space that is explicitly constructed by the algorithm for computing the Hough transform.[1]
Aim of this project is getting used to Hough Transform and HoG features. At the first part of the project, you will try to find circles at the given images with help of Hough Transform (See Figure 1). Then you will use your approach for finding circles at first part of the project for recognizing the given coins with help of their HoG features at the second part of the project.

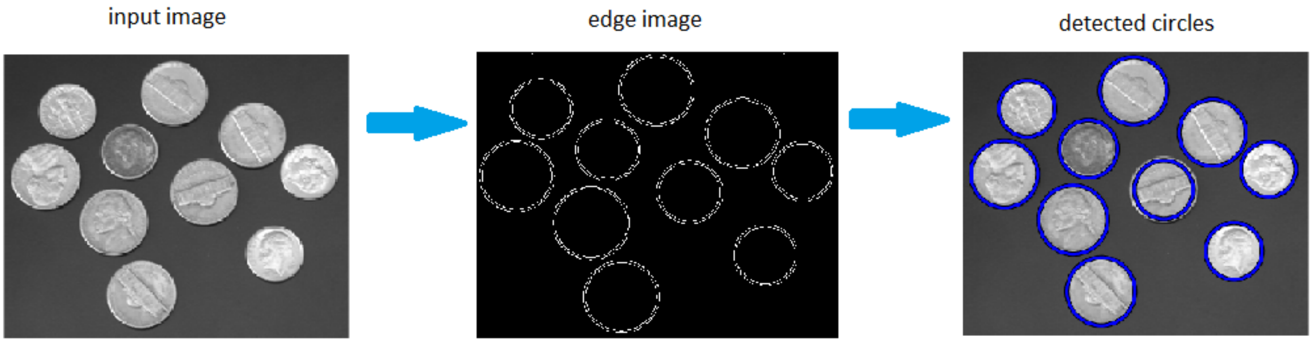

Figure 1: Hough Transform

PART 1: Edge Detection and Hough Transform

In this part of the project, you are expected to figure out the circles on the train and the test images.

- ✓ Use an edge detection method to obtain an edge map of the input image. *You may use the available functions from the libraries for obtaining the edge map. You may use; Sobel Edge Detector, Laplacian Edge Detector, Canny Edge Detector etc.*
- ✓ Utilize **your very own** Hough Circle Transform on obtained edge map to detect possible circles within the image.
- ✓ Plot your detected circles on the original image and segmentation map of the corresponding input image to measure visually how good your method's performance is.
- ✓ Pay attention to code readability such as comments, function/variable names and your code quality: 1) no hard-coding 2) no repeated code 3) cleanly separate and organize your code 4) use consistent style, indentation
- ✓ Your code must read all of the images at the all of the folders at the dataset. There will be three folders namely "Train", "TestV", and "TestR". Your code must store the results for them in the folders namely "Train_Hough", "TestV_Hough", and "TestR_Hough" accordingly.

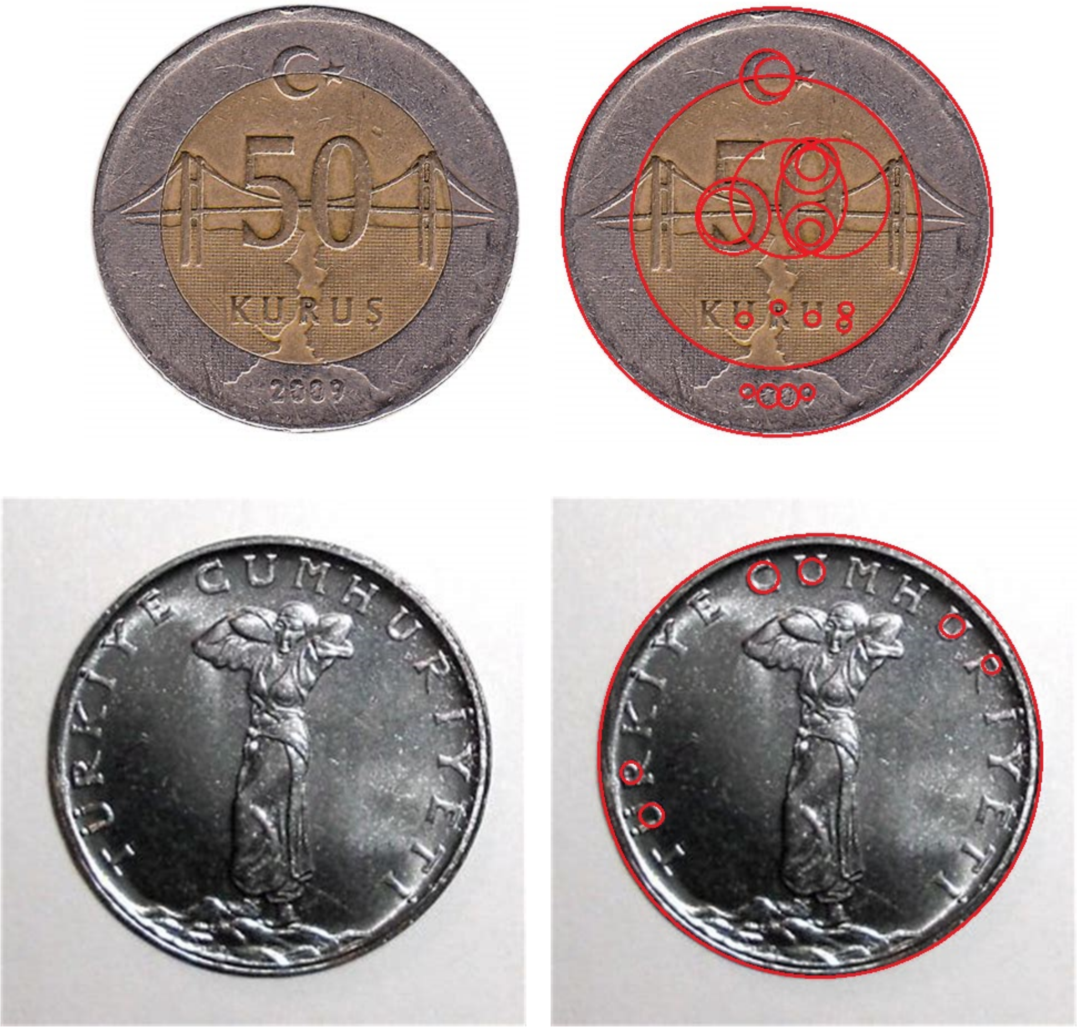

Figure 2: Sample Circle Detection

PART 2: Histogram of Oriented Gradients

In this part of the project, you are expected to find, count, and recognize the coins at the "TrainV" folder.

- Detect all the circles at the images at the "TrainV" folder as stated at the Part 1.
- Use **your very own** algorithm to extract HoG (Histogram of Oriented Gradients) Features of that circles and the coins at the "Train" folder.
- Use train images to train your detection algorithm. You may use SVM Algorithm from scikit-learn library.
- Count and identify the coins at the "TrainV" folder. You must draw your results over the image.
- Plot the offsets of the coins at the images at the "TrainV" folder and segmentation map of the corresponding input image to measure visually how good your method's performance is. Save your outputs to "TrainV_HoG" folder.
- You should pay attention to code readability such as comments, function/variable names and your code quality: 1) no hard-coding 2) no repeated code 3) cleanly separate and organize your code 4) use consistent style, indentation
- You can use any kind of reshaping, resizing, data augmentation etc., but keep in mind that your code must do them itself with the dataset that have been shared with you, you are not allowed to add or discard data to/from dataset manually. Moreover, it is up to you to decide how to use train images.

Note that if you want to get bonus, you must apply the same procedure for this part for the images at the "TrainR" folder.

The Report

You must prepare a report for this project. It must contain results of your project as in visual and analytical manner which means you must put your results for both parts as in image format and you must interpret them.

What should you write in the report?

- ✓ Explain which edge detector you have chosen and your reasoning. Moreover explain how you set the parameters of edge detection algorithm. Show edge detection results at the document with relevant code snippet you have written.
- ✓ Explain all steps of Hough transform with visual examples and code snippets you have written.
- ✓ Put samples of your detected circles as in Figure 2.
- ✓ Show parts that your method fails to detect circles correctly and explain possible reasons for it. If your code successfully works, you can omit this step by denoting that your code successfully works.
- ✓ Explain all steps of HoG Algorithm with visual examples and code snippets you have written.
- ✓ Put samples of your detected coins with description.
- Show parts that your HoG Classification fails to recognize coins and explain possible reasons for it.
- You are encouraged to write your report in LaTeX
- You should give visual results by using a table structure.

What to Hand In

Your submission must contain following:

- README.txt *(Text file containing the details about your implementation, how to run your code, which libraries have to installed, the organization of your code, functions etc. The template must be followed will be shared.)*
- src/ *(directory containing all your code)*
- Report.pdf

File hierarchy is as follows and must be zipped before submitted (Not .rar, only not compressed .zip files because the submit system just supports .zip files).

```
- b<StudentID>.zip
     - README.txt
     - Report.pdf
     - <src>
        - *.*
```

Note that you MUST exactly score ONE from the submit system, otherwise you will have 20% of point deduction even if your hierarchy is correct. (For MacOS users, you can check the Piazza post for the script that zips the folder without any extra content which causes getting zero from submit)

Grading

The assignment will be graded out of 100:

- **50 % (part 1):** CODE: 40 REPORT: 10
- **50 % (part 2):** CODE: 40 REPORT: 10
- **15 % (part 2 - bonus):** CODE: 10 REPORT: 5

The score for the report will be multiplied by your code score for that part which is divided by maximum score that can be taken from code part. Each part will be evaluated individually. For example, for first part say that some scored 32 for code part and 5 for report part, his/her final score for that part will be calculated as follows: 32+(32/40)*5=36

You MUST use justify -iki yana yasla in Turkish- page alignment and passive voice at your report, otherwise 20% of your score will be deducted FOR EACH VIOLATION for the relevant part of your report. Note that also your report's alignment must be well designed, otherwise you may also face with some point deductions for bad alignments/designs

You MUST write comments to your code as necessary and also your code MUST be readable.

Academic Integrity

All work on assignments must be done individually unless stated otherwise. You are encouraged to discuss with your classmates about the given assignments, but these discussions should be carried out in an abstract way. That is, discussions related to a particular solution to a specific problem (either in actual code or in the pseudocode) will not be tolerated. In short, turning in someone else's work, in whole or in part, as your own will be considered as a violation of academic integrity. Please note that the former condition also holds for the material found on the web as everything on the web has been written by someone else.

References

[1] Hough transform - wikipedia. `https://en.wikipedia.org/wiki/Hough_transform`˙(Last access: 15.11.2023).

[2] Coins of turkey - wikipedia. `https://en.wikipedia.org/wiki/Coins_of_Turkey`˙(Last access: 15.11.2023).

[3] Turkey 1 kurus - 1 lira 6 pieces coin set, 2014-2022, km 1239-1244, mint. `https://www.banknoteworld.com/turkey-1-kurus-1-lira-6-pieces-coin-set-2014-2022-km-1239-1244-mint.html`˙ (Last access: 15.11.2023).

[4] Turkey (2005 - 2023) - circulation coins - ucoin.net. `https://en.ucoin.net/table/?country=turkey&period=55`˙(Last access: 15.11.2023).

[5] Coins of turkey. `https://worldcoingallery.com/countries/Turkey.php`˙(Last access: 15.11.2023).