In this lab, you will use MATLAB's built-in Hough transform functions to detect lines and circles in grayscale images.

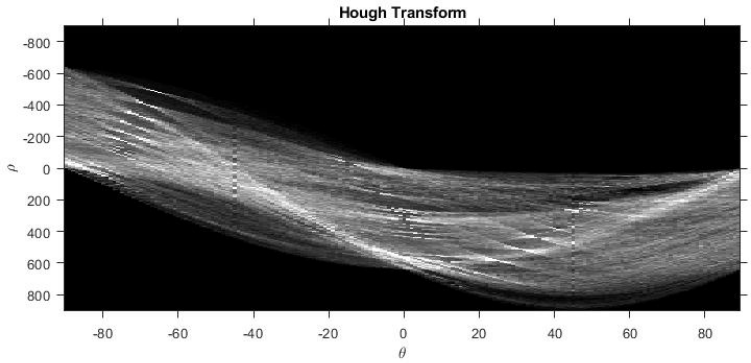
Important Note: You should complete the lab until the end of the lab hours and submit all your codes to SUCourse as a single zip file. Deadline for in-lab code submission to SUCourse is **15:30**.

Things to do:

Write two programs ("lab4houghlines.m" and "lab4houghcircles.m") to detect lines and circles by using Hough transform built-in functions **with different parameters**. Use "tic-toc" commands to evaluate the execution time performances of each method.

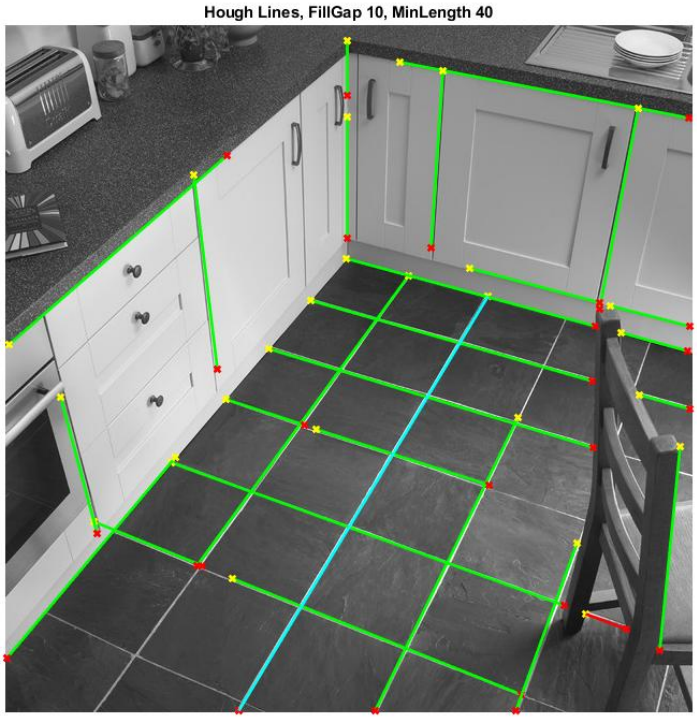
Line Detection

- Read the original image in the figure below and convert it to a black-white edge image with an edge detector of your choice. *Hint*: use the built-in `'edge'` function.
- Obtain the Hough transform of the edge image and display it along ρ vs θ axes. *Hint*: use the built-in `'hough'` function.



- Select the peak Hough points with an appropriate threshold (e.g., half of the maximum cell value in the Hough transform matrix H). *Hint*: use the built-in `'houghpeaks'` function.
- Find the lines in the image by using these peak points. *Hint*: use the built-in `'houghlines'` function.
- Plot all the lines that you detected with green color and highlight the longest and shortest detected lines with cyan and red colors, respectively. What are the maximum and minimum lengths of the detected lines?

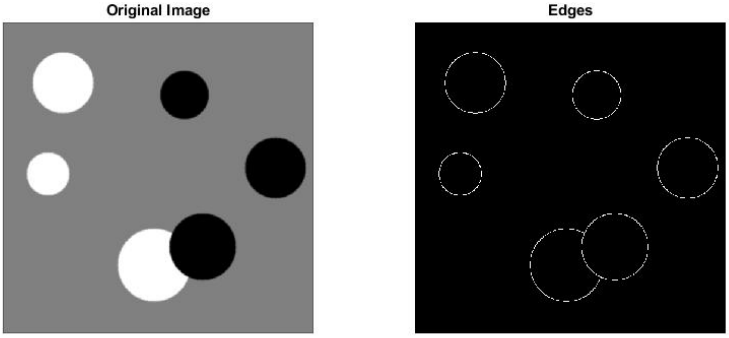
Your results should look as follows:



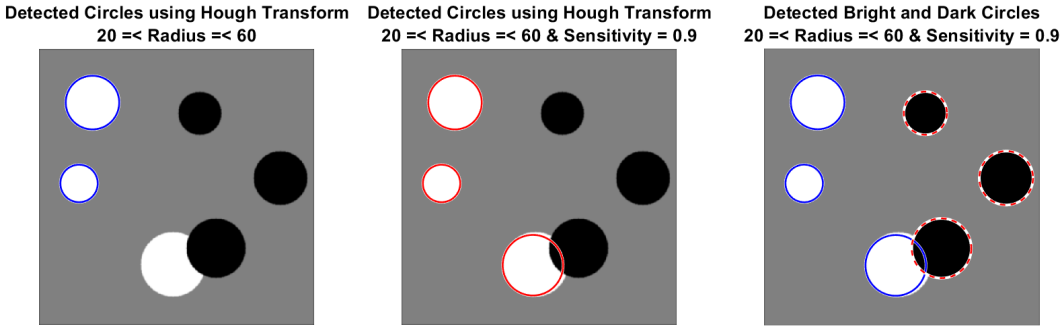
Circle Detection

- Read an image that contains several different size circles and convert it to an edge image.
- Detect all the circles with radius r such that $20 \leq r \leq 60$ pixels by using Hough transform. *Hint*: use the built-in `'imfindcircles'` function.
- Change `'Sensitivity'` factor and test the performance of circle detection.
- Change `'ObjectPolarity'` parameter to detect `'bright'` and `'dark'` circles separately.

  You can call the function as `imfindcircles(I,[Rmin, Rmax],'Parameter',value)` where parameter can be `'Sensitivity'` and value is a number between 0 and 1, or `'ObjectPolarity'` and value is either `'bright'` or `'dark'`.



Your results should look as follows:



Post Lab

Post lab reports must include brief explanations of each method that you used in this lab. Provide resulting images by utilizing all these methods and discuss your results. How do changing parameters such as threshold, edge detector choice, number of Hough peaks or sensitivity affect the accuracy of the line and circle detection?

Deadline for post lab report submission to SUCourse: **14 November 2022, 23:55**.