All lab assignments must be done individually. You should submit your codes to SUCourse during the lab hours (In-Lab Code Submission) and you should submit your lab-reports (Post-Lab Report) on December 30,2020, until 23:55.
Grading : In-lab Codes has a weight of 20% and Post-lab Reports has a weight of 80%. Your programs should be modular, bug-free, commented in MATLAB, self- explanatory. Also, your report should include necessary comments and discussions. Please note that if you miss the lab, you will get automatically zero (even if you submit post-lab report)

In this lab, you will use MATLAB's built-in corner detector, edge detector and Hough line extraction functions to get the corner points of checkerboard sticked to a cube for calibration purposes.

Important Note: Submit all your codes and the resulting images you used in the lab to SUCourse as a single zip file. Deadline for submission to SUCourse is **until the end of the lab**.

Things to do:

Write a program ("lab5calibprep.m") to detect corner points with **two** different methods:

1. Harris corners (integer values)
2. Intersection point of two lines (sub-pixel accuracy)

Implement the following steps:

- Read the image of calibration cube given in SUCourse (Figure 1**(a)**) and convert it to a black-white edge image with your edge detector choice.

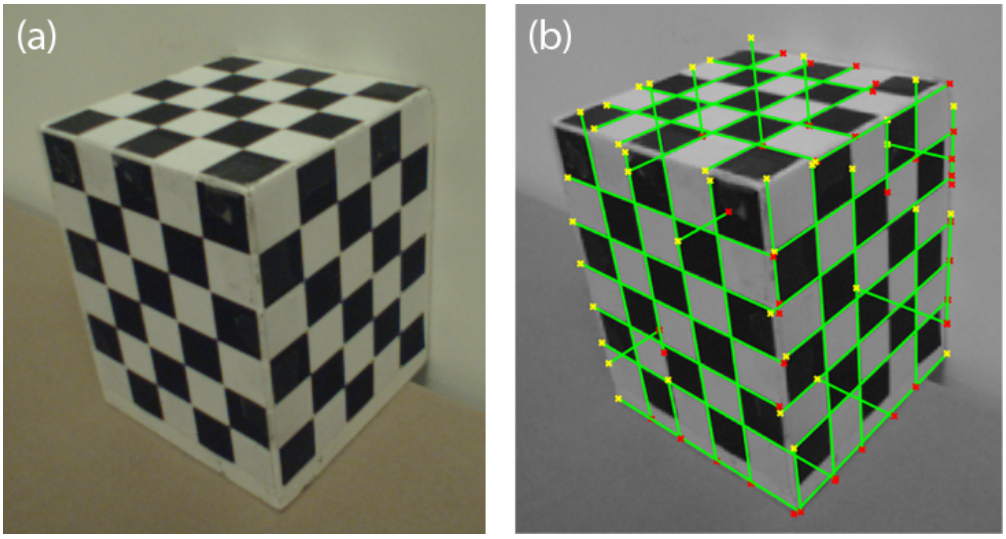

Figure 1: **(a)** Calibration Object **(b)** Result of Hough line detection

- Find the lines in the edge image by utilizing `'hough'`, `'houghpeaks'` and `'houghlines'` functions with appropriate parameters.

- Plot the beginnings of the lines with yellow cross, ends with red cross and the in-between line with green color on the gray-scale version of the original image (Figure 1**(b)**).
- Look at the output of `'houghlines'` function which returns ρ, θ and the beginning and end points of the detected lines. Select two intersecting lines manually from the plot that you obtained in previous step and extract the corresponding ρ and θ values from the output of `'houghlines'` function.
- Find the equations of these two lines by using the line equation given below and plot the lines with magenta color on the same figure:

$$x\,cos(\theta) + y\,sin(\theta) = \rho \tag{1}$$

- Solve these two line equations to find the intersection point with sub-pixel accuracy and plot that point on the same figure.
- Using the gray-scale version of the original image, find the Harris corners and plot them on the same figure with blue circles (Figure 2). Calculate and display the distance between two corner points that you obtained with two different methods.

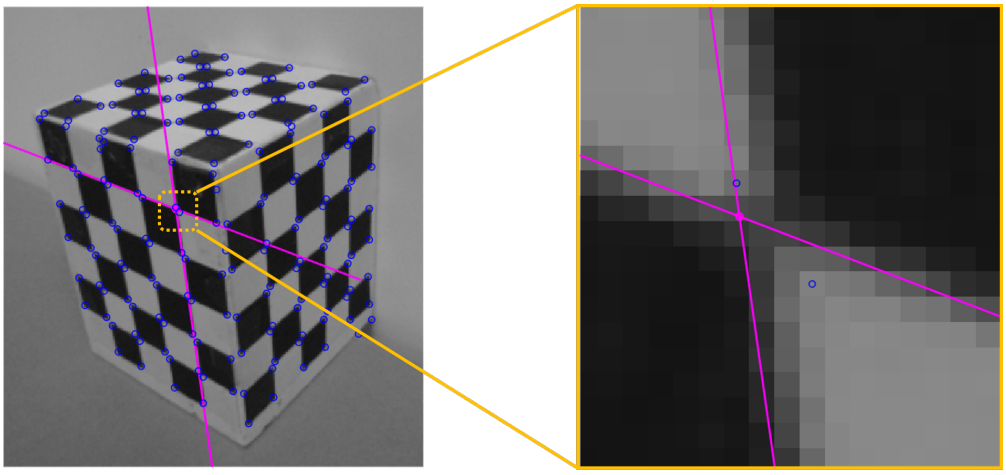

Figure 2: Corners extracted by the intersection point of two lines and Harris corner detection algorithm

Post Lab

Create your own 3D calibration object, take a picture of it and extract at least 8 corner points by following the steps above. Provide the resulting image with the extracted lines and corner points displayed on it, in addition to providing the obtained equations. Discuss your results. Which corner extraction method would you prefer for calibration purposes? Can you suggest better methods?

Deadline for post lab report submission to SUCourse+: **30 December 2020, 23:55**.