CSE 4422.03/5323.03
Lab Assignment I.

Due Date: Oct. 10, 9:30am

1. Cameras and Lines

A. What are the parameters of an inexpensive webcam with 640×480 resolution, quarter inch image sensor, square pixels and 10mm focal length? Show the calibration matrix and explain very briefly the calculations. (No programming here)

B. Write a function that demos the Gabor filters. The function takes two required arguments, k, the wavenumber of the Gabor and $\delta\theta$ which is radians per frame. The function opens a display window and displays the magnitude response of a b/w image from the camera filtered with a Gabor pair of filters. The initial Gabor has wavenumber k and angle zero. The next has the same wavenumber but the angle is incremented by $\delta\theta$. Similarly for the subsequent frames so that the orientation (angle) of the filter keeps rotating. The σ of the filter should be $1/k$.

C. Use one of the cameras in the robotics lab to take the pictures of a bright rectangle on a dark background. With the mouse select a few points on two edges of the rectangle, about ten from each in random order (e.g. 2-3 from the one edge 2-3 from the other, another 2-3 from the first, etc). During the demo the TA will select them and their order will be random

Using these points design a line fitting algorithm. It should work as follows:

(1) Selects two edge points at random.

(2) Fits a line going through them.

(3) Counts the number C of edge points that are within D [5] pixels of the line you fitted above.

(4) Iterates the above steps N [200] times and selects the line that has the highest count C.

(5) Fits using least squares a line that goes through the C points of the selected line.

(6) Overlay the line on the image.

(7) Remove (or mark as deleted) these points so that the algorithm can detect the next line.

(8) Repeat to detect the second line.

You can use any programing environment for this. Have the source code ready to discuss it with the TA during the demo.

2. Camera noise

Write a function that takes N[30] images with the Point Gray camera. Make sure that the images are focused and the apperture adjusted (turn off the automatic adjustments and do it manually). The images have to be from exactly the same scene so the camera has to be steady. The function then computes the mean and variance of the noise. Notice that both the mean and variance are images of the same size. The function returns them as a list.

3. Robot arm

Write a short function that given a position on the table the robot picks up or drops down s amll object. The function has two required arguments, the x and y position, and an optional, the state of the gripper after reaching the point (`´open` to open and drop the object, `´close` to close and grab an object and do nothing if omitted).

4. General

Students in groups of two for the project and lab assignments. You need the instructors permission to work in a group of three or alone. All students have to hand in a short report, their code and demo their programs.

All the programs you write should be properly documented and of professional quality in terms of style and usability. Common errors should be detected and useful feedback provided to the user. Your report should contain all the mathematical derivations, an overview of the design to guide the TA and a brief user manual.