cmput412 Robotics Exam 2
Mar 31 2015

Last Name:
First Name
Student ID:

Instructions: Read all questions first. You can write on the back side of sheets if needed, but space provided is a hint of the expected length of the answer. Short and concise answers are preferred. **Allowed:** 4 single sided letter size sheets with your own notes, calculator.

I. Basic Concepts (1% each, 4% total)

1. In a IBVS task a **2DOF** joint robot arm (see fig exc III) is commanded to touch a sphere inside the robots work space. If only one camera is used and the tracking algorithm can only track the sphere. What is the most suitable configuration to achieved this task:
   a. eye-in-hand configuration
   b. eye-to-hand configuration
   c. It is not possible
   d. None of the above
Add a short explanation to your answer:

2. The operation performed from image A to B is after convolving with the mask:
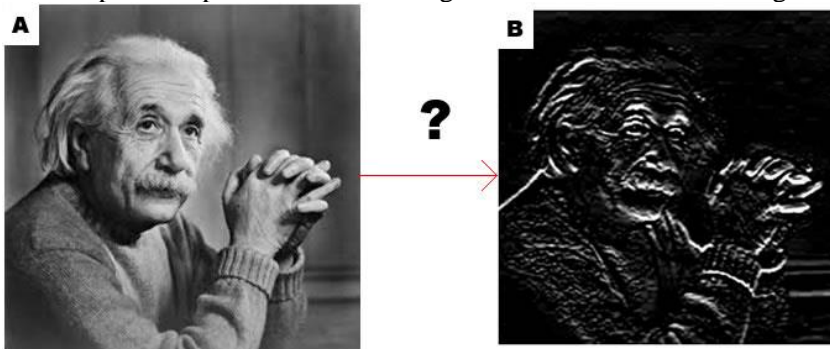
a.[-1,-2,-1;
   0, 0, 0;
   1, 2, 1]
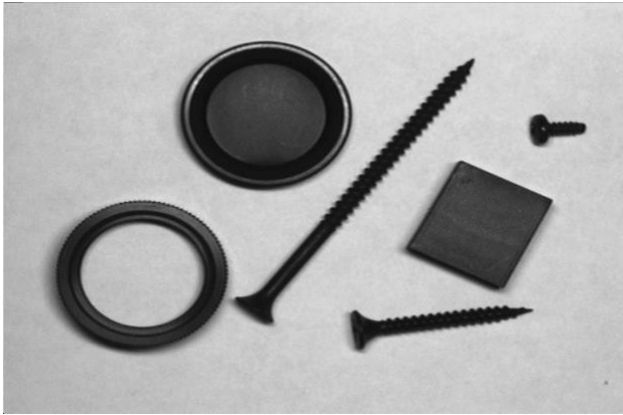You might want to make this one
b.[-1, 0, 1;
  -2, 0, 2;
  -1, 0, 1]
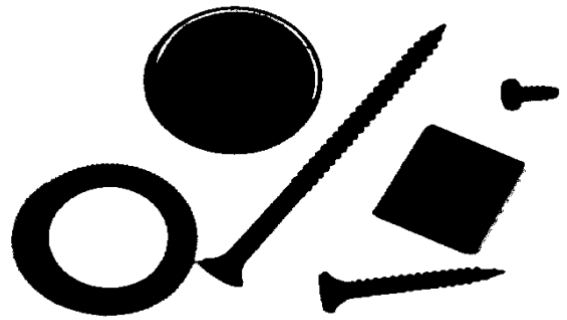
c. [0 -1 0;
   0 -2 0;
   0 -1 0]
d. None of the above

3. Explain what image aliasing is and when it happens:

4. Explain the differences between the Jacobian used in the inverse kinematics(Jk) solution and the one used on the uncalibrated IBVS (Ju):

II. Image processing (6%)
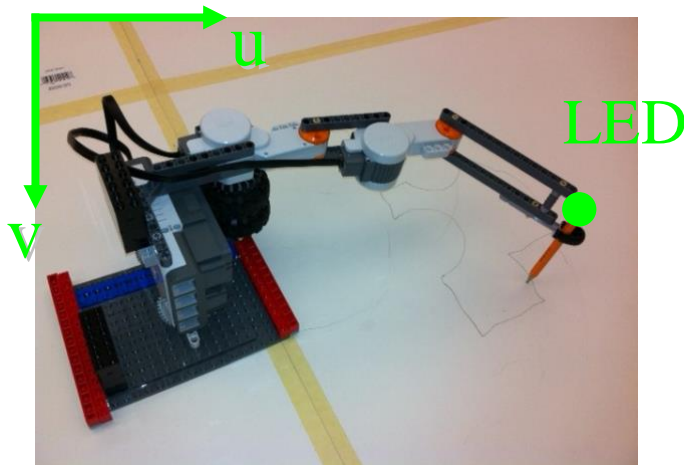

A robot workspace   a thresholded image of the same workspace.

a. Identify 3 artifacts from thresholding in the right image. Circle each, 1,2,3, and write what the problem is
b. Suggest and describe how to use image processing (e.g. morphology) to remove each of the artifacts.

III. Visual Servoing 8%

A visual servoing setup controls two joints x = [r1, r2], and reads image coordinate measurements y =[u, v].
The following absolute coordinate measurements were recorded in radians and pixels respectively:

x = [0   0
     .1 .2
     .1 .4]

y = [80 100
     120 160
     130 220]

a. What is the Jacobian J after the three movements? Solve and calculate the numeric values.

b. We wish to move the end effector to image position [180 240]. Calculate the corresponding joint angles.

IV. Three dimensional vision. 6%

The following shows an overhead image and a mesh plot of a 20x20 pixel detail of that image. The focal length f=10mm, pixel size a = 0.01mm, viewing distance Z = 1m.
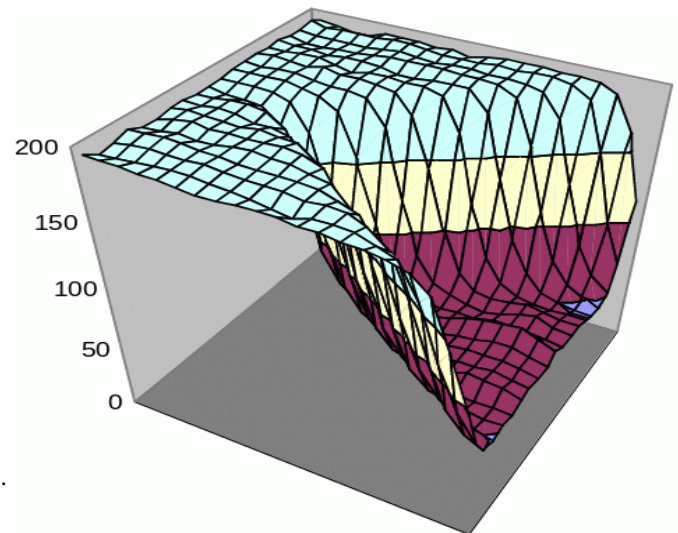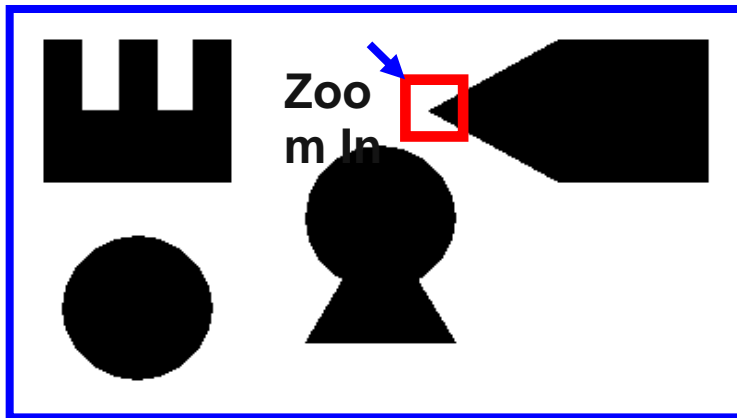
a. Draw sketch of the viewing geometry, marked with f,a,z etc.
b. With what error can the object boundaries be determined in the 3D workspace? Does it depend on how the object is extracted? (e.g. thresholding, line finding, model fitting) Motivate.