UNIVERSITY of HOUSTON | ECE

ECE 5397/6397: Intro to Robotics
HW 5, Due April 5 Computer vision

This homework may be completed in groups of two.

Name 1: _____
(opt) Name 2: _____

Part I
Given the Matlab code AutoThreshold.m, fill in the 5 TODOs to implement image thresholding. Copy the text for these TODOs below.

1. TODO #1

2. TODO #2

3. TODO #3

4. TODO #4

5. TODO #5

6. Run your code on the file Duplos.png. Copy Figure 1 below

Part II

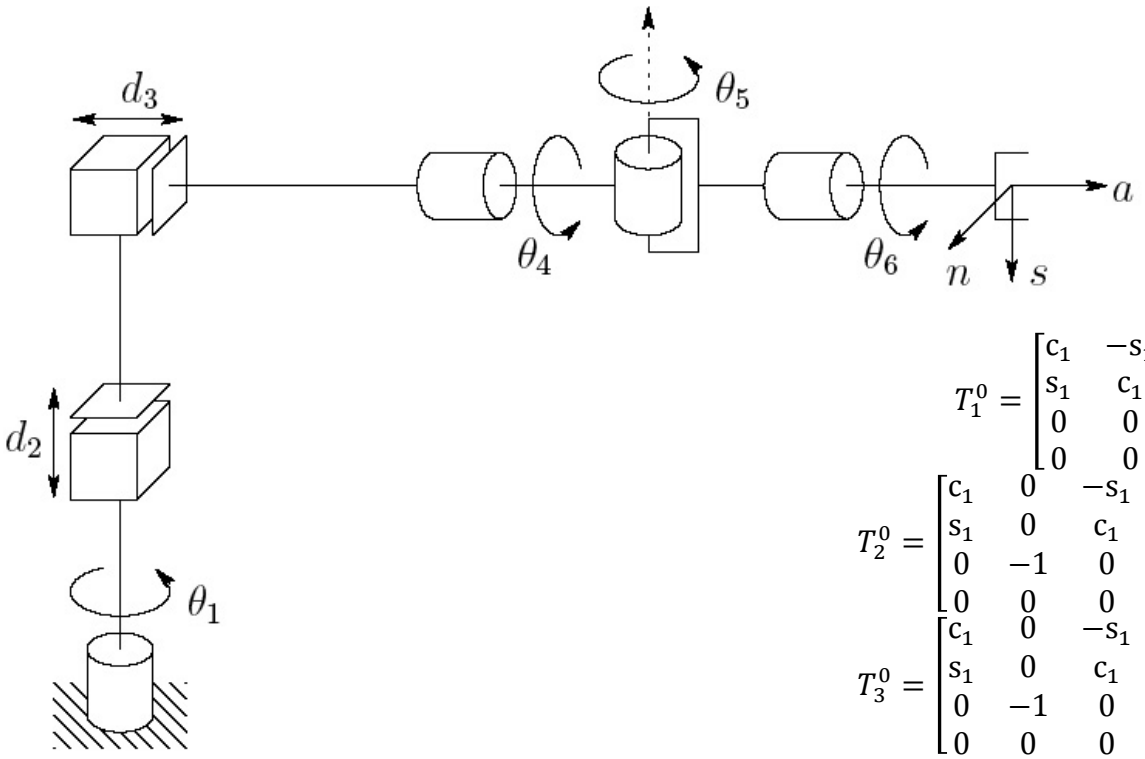
Using the same image, label the connected components using the two-pass algorithm from section 11.4. Call your file ConnectedComponents.m with function call
cc = ConnectedComponents(binary_img), where binary_img is a binary image and cc is a matrix the size of binary_img with 0 assigned to background pixels and integers to different connected components.
Show a screenshot of the connected components applied to the thresholded Duplo.png

Attach your code

Part III

Compute and label the centroids and orientation of each connected component. Call your code CentroidAndOrientation.m, with function call
[centroids, orientations] = CentroidAndOrientation(cc), where cc is the output from part II.
Show an image applied to the output from Part II. Draw the centroids and orientation lines in white.

1. Calculate the manipulator Jacobian of the cylindrical robot with spherical wrist manipulator at the position z_6.
    a. Write out the J matrix in terms of z_i and o_i.
    b. Write out the J values. Calculate the cross products. You may use your previous calculations for the A and T matrices.



$$T_1^0 = \begin{bmatrix} c_1 & -s_1 & 0 & 0 \\ s_1 & c_1 & 0 & 0 \\ 0 & 0 & 1 & d1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_2^0 = \begin{bmatrix} c_1 & 0 & -s_1 & 0 \\ s_1 & 0 & c_1 & 0 \\ 0 & -1 & 0 & d1 + q2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_3^0 = \begin{bmatrix} c_1 & 0 & -s_1 & -q3s_1 \\ s_1 & 0 & c_1 & q3c_1 \\ 0 & -1 & 0 & d1 + q2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_4^0 = \begin{bmatrix} c_1c_4 & s_1 & -c_1s_4 & -q3s_1 \\ c_4s_1 & -c_1 & -s_1s_4 & q3c_1 \\ -s_4 & 0 & -c_4 & d1 + q2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_5^0 = \begin{bmatrix} c_1c_4c_5 + s_1s_5 & -c_1s_4 & -c_5s_1 + c_1c_4s_5 & -q3s_1 \\ c_4c_5s_1 - c_1s_5 & -s_1s_4 & c_1c_5 + c_4s_1s_5 & q3c_1 \\ -c_5s_4 & -c_4 & -s_4s_5 & d1 + q2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$T_6^0 = \begin{bmatrix} c_6s_1s_5 + c_1(c_4c_5c_6 - s_4s_6) & -s_1s_5s_6 - c_1(c_6s_4 + c_4c_5s_6) & -c_5s_1 + c_1c_4s_5 & -(q3 + d6c_5)s_1 + d6c_1c_4s_5 \\ c_4c_5c_6s_1 - c_1c_6s_5 - s_1s_4s_6 & -c_6s_1s_4 + (-c_4c_5s_1 + c_1s_5)s_6 & c_1c_5 + c_4s_1s_5 & c_1(q3 + d6c_5) + d6c_4s_1s_5 \\ -c_5c_6s_4 - c_4s_6 & -c_4c_6 + c_5s_4s_6 & -s_4s_5 & d1 + q2 - d6s_4s_5 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$