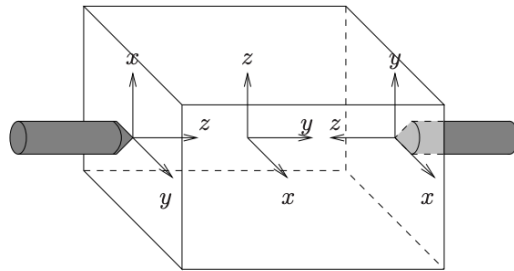# Discussion #7

Author: Tiffany Cappellari

Problem 1 - Grasp Maps

1. Find the net object wrench F_o for k frictionless point contacts.

   Hint: Each individual contact wrench can be written as $F_{o_i} = \begin{bmatrix} R_{c_i} & 0 \\ \hat{p}_{c_i} R_{c_i} & R_{c_i} \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \\ 0 \\ 0 \end{bmatrix} f_{c_i}, \ f_{c_i} \geq 0$
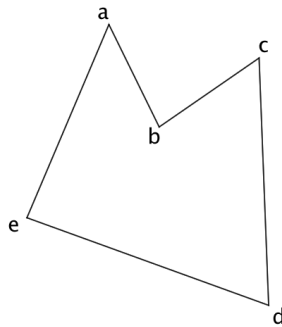
2. Consider the box grasped by 2 soft-finger contacts shown below. Find the grasp map.

(0.1)

Problem 2 - Force Closure and Convex Hull
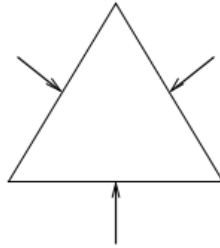
Consider the figure below.

(0.2)

1. Draw the convex hull of the figure.

2. Construct a frictionless force closure grasp of the part with four contacts and draw the points of contact showing there are no valid centers of rotation.

3. What is the minimum number of frictionless contacts needed to put a 2D object in force closure?
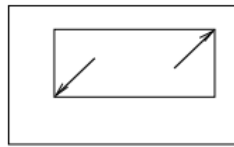
Problem 3

Construct the grasp map for each of the following grasps and write the friction cone conditions with respect to the contact basis you chose. Are they in force closure? Assume that all contacts are point contacts with friction.
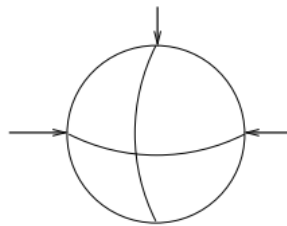
   1. $\mu = \tan 15°$

$$(0.3)$$

   2. $\mu > 0$

$$(0.4)$$

   3. $\mu > 0$

$$(0.5)$$