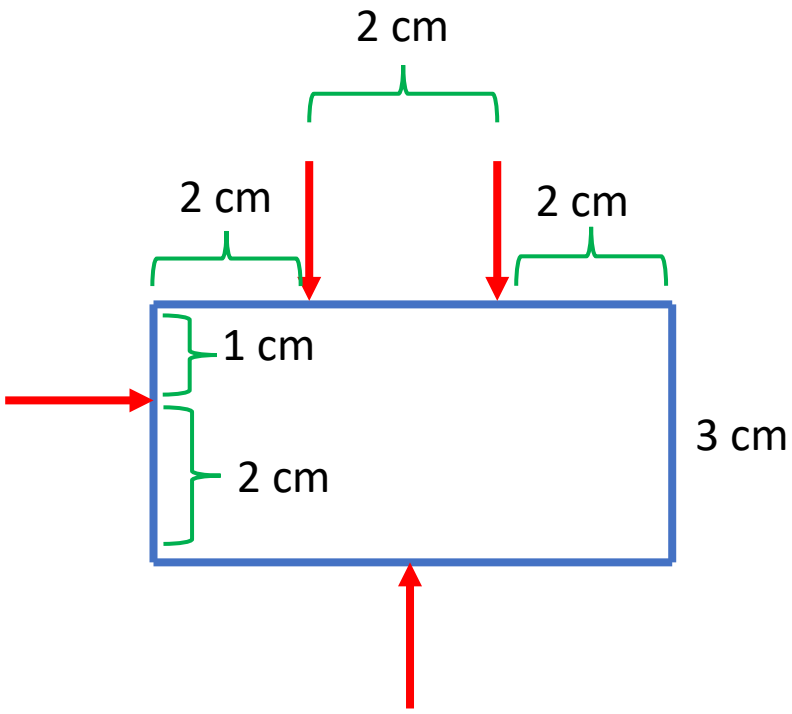
RBE 450X – Homework 2

Part 1 (3pts) Consider the same object hand configuration in HW 1.

- Derive the hand Jacobian
- Derive the hand-object Jacobian
- Calculate the values of joint velocities in order to achieve the twist that you have used in your previous HW.

Part 2 (7pts) We will consider the planar case grasps, and analyze how various grasp quality metrics work.

- Read the first four pages of "Grasp quality measures: review and performance" by Maximo A. Roa and Raul Suarez (I recommend reading the whole paper as it presents a very detailed analysis of various grasp metrics, and some examples that could be useful for this homework).
- Simplify the grasp matrix formulation from 3D case to the planar case (so that your twist is only a 3 dimensional vector).
- Using Matlab (or any other software you like), write a function that generates the grasp matrix for a given object center and contact locations, considering the hard finger contact model
- Now consider the shape below with the force vectors



- We will try to find the best way of applying the 5^{th} force vector. For that, we will use three different grasp quality metrics from the paper you have read. Using the grasp matrix function you wrote, sample the location of the 5^{th} vector as follows:
    - Choose a location for the 5^{th} force vector (this location can be random).
    - Derive the grasp matrix for the 4 vectors in the figure + a 5^{th} vector you chose.
    - First, we will consider the grasp quality matrix in 3.1.1. (minimum singular value of G). Calculate the value of this metric for the current grasp matrix.
    - Now start moving the 5^{th} vector along the object edges in 0.1 cm increments and keep calculating the grasp quality value.
    - Plot the grasp quality value vs. vector location. Find the best location for the vector and draw it on the object.
    - Now, do the same thing for grasp quality metric in 3.1.2 and 3.1.3. Are the locations of the 5^{th} vector different? Why? (check what these metrics are trying to calculate).

Submit a report together with your Matlab code.