CDS 270: Problem Set #3

(Due Wednesday, May 18, 2011)

Problem #1: (10 points) In class (and in Chapter 2 of Rimon & Burdick), we developed a 2-parameter coordinatization of a c-obstacle boundary for the special case when the object $\mathcal{B}$ is a convex planar rigid body with a smooth boundary, and the finger body $\mathcal{O}$ was a circular disk. In this problem, develop a parametrization of a c-obstacle boundary for the more general case when the finger body is any convex planar body with a smooth boundary. **Hint:** assume that the boundaries of both $\mathcal{B}$ and $\mathcal{O}$ can be arc-length parametrized.

Problem #2: (40 points) Using the parametrization developed in Problem #1, plot the configuration space boundary for the case when the grasped object $\mathcal{B}$ is an ellipse with principle axes having dimensions of 3 and 5 units, while the finger body is also an ellipse having major axes of 2 units and 3 units (see Figure 1(a))

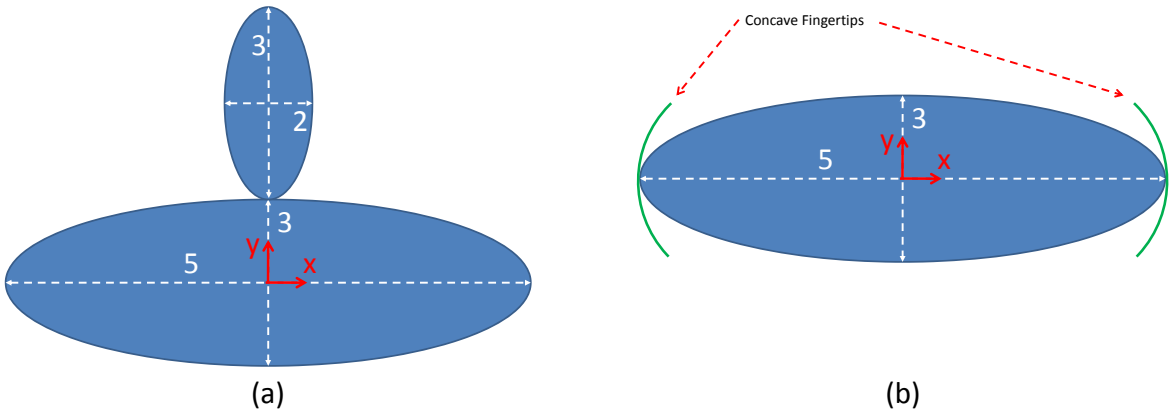

Figure 1: (a) Ellipse object and elliptical finger tip body; (b) Elliptical object in contact with two *concave* finger tips, each having the same radius of curvature at the contact points.

Problem #3: For the same set up as Problem #2, computer the curvature form of the c-space obstacle when the object $\mathcal{B}$ is positioned in the configuration shown in Figure 1(a).

Problem #4: Assume that the object $\mathcal{B}$ is the same as in Problems 2 and 3. Now assume that the object is grasped by two finger boddies with *concave* curvature at the contacts (see Figure 1(b)). Assuming that both fingers have the same radii of curvature at the contacts, and that the fingers form an *antipodal point grasp* on both ends of the major axis of the elliptical $\mathcal{B}$, determine the maximal radius of curvature of the finger bodies needed to immobilize $\mathcal{B}$.