ME 115(a): Homework #4

(Due Friday, March 14, 2008)

Problem #1: (15 points) Next quarter we will extensively study the problem of grasping– i.e., how one can grab an object with fingers in such as way as to prevent the grasped object from slipping out of the grasp. Consider the arrangement in Figure 1(a) where a planar disc is touched by 3 "planar" fingers. Assume that each finger touches the disc with *frictionless* point contact. Also assume that each finger can apply any possible force to the object.

Question: Is the disc immobilized? That is, are there any free motions of the disc that can not be prevented by the fingers? In addition to an intuitive discussion of this question, you must back up your answer with some analysis.

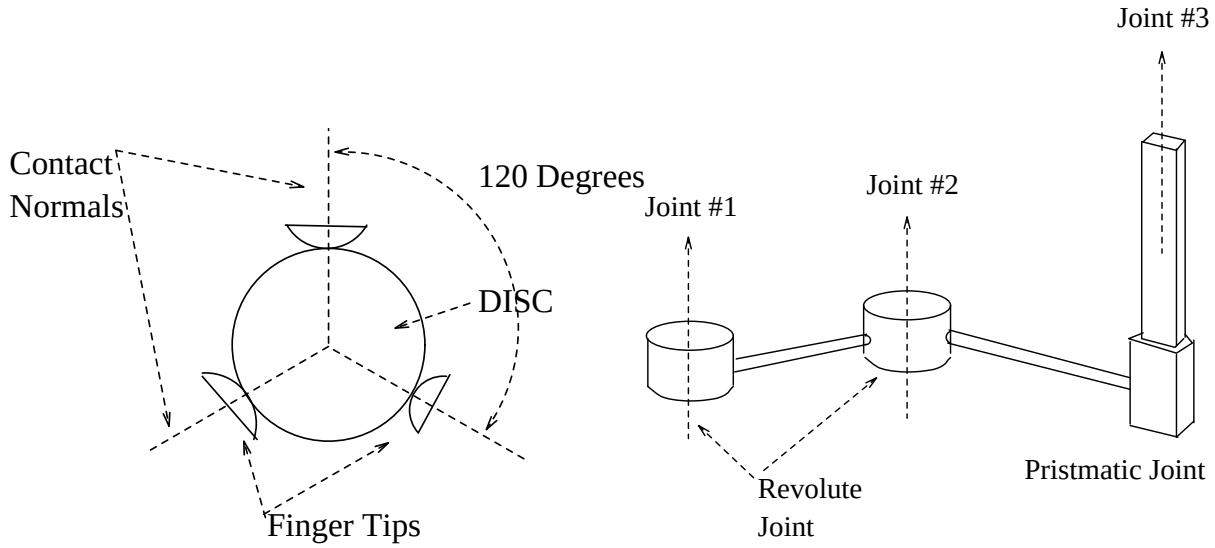

Figure 1: (a) Grasp of a disc by frictionless fingers (b) Schematic of a "Cylindrical Manipulator"

Problem #2: (15 points) Figure 1(b) shows a schematic of an 3-jointed "cylindrical" robot manipulator. This manipulator consists of two revolute joints (joints #1 and #2) and one prismatic joint (the third joint). All three joint axes are vertical and parallel to each other.

- Derive the Denavit-Hartenberg parameters.
- Derive the inverse kinematic solution, assuming that the goal is to position the tool frame origin at some desired position, (x_T, y_T, z_T).

Problem #3: (20 points)

Part (a): For Manipulator (iv) in Figure 3.23, solve the inverse kinematic problem, where the goal is to place the origin of the tool frame at a desired position.

Part (b): For Manipulator (iii) in Figure 3.24 (i.e., the "Stanford manipulator"), solve the inverse kinematics problem. That is, given a desired position and orientation of the tool frame, find the joint variables that place that manipulator tool frame at that location. Note that the "regional" part of this manipulator (the part of the linkage preceding the wrist) is exactly the same as part (a).