ME 115(a): Homework #5

(Due Thursday, Feb. 28, 2002)

Problem #1: Consider the two screws, S_1 and S_2, shown in Figure 1(a). The screw axis of S_1 is perpendicular to the plane, P, and has zero pitch: $h_1 = 0$. Similarly, the screw axis of S_2 is also perpendicular to the plane. It intersects the plane a distance a from the intersection of S_1, and its pitch is also zero: $h_2 = 0$. Describe the set of all screws whose axes lie in P and that are reciprocal to both S_1 and S_2.

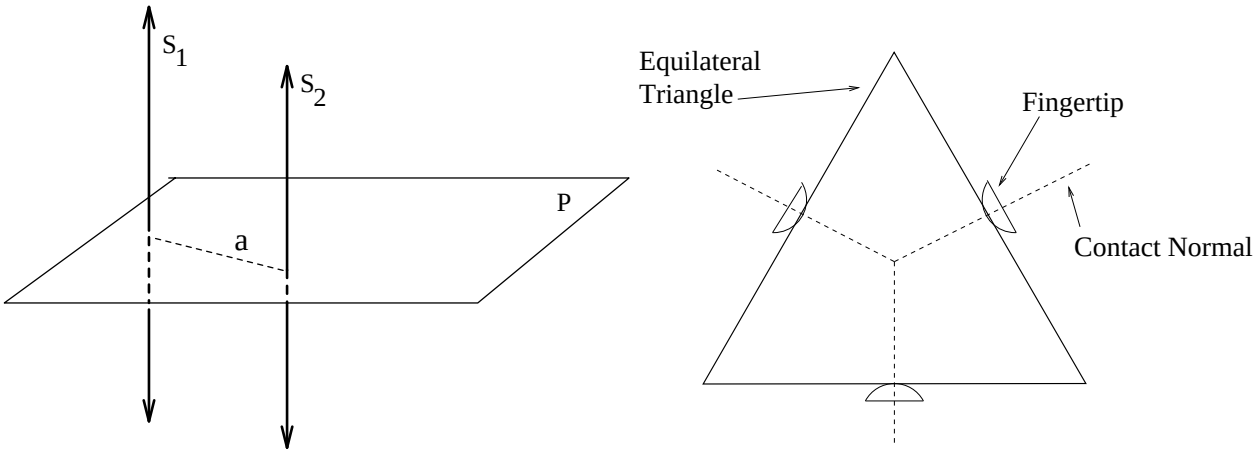

Figure 1: (a) Two Screws; (b) grasp of a triangle

Problem #2: 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(b) where a planar triangle is touched by 3 "planar" fingers. Assume that each finger touches the disc with *frictionless* point contact. Also assume that each finger can generate any magnitude of force.

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

Problem #3: Find the Denavit-Hartenberg parameters for manipulators (ii) and (iv) in Figure 3.23 of the MLS text

Problem #4: Consider the simple manipulator (iii) associated with Prob.4 in Chapter 3 of the MLS text.

- Determine the Denavit-Hartenberg parameters of this manipulator
- Find the forward kinematics using the Denavit-Hartenberg approach.
- Find the forward kinematics using the Product-of-Exponentials approach.