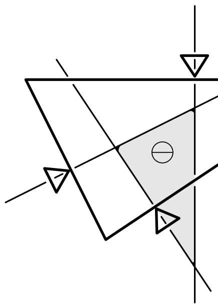
16-741 Mechanics of Manipulation
Spring term, 2004

Assignment 3, Out: 18 Feb 2004 Due: 25 Feb 2004

1. Exercise 3.17 from the text:
   Write screw coordinates for the three contact constraints of figure 2.19(b). You can make the job easier by your choice of origin, scale, and coordinate axes.



2. Exercise 3.18 from the text:
   Consider an octahedron with vertices at $(0,0,1)$, $(0,0,-1)$, $(0,1,0)$, $(0,-1,0)$, $(1,0,0)$, and $(-1,0,0)$. Pick two edges that are neither intersecting nor parallel. Find the Plücker coordinates of each edge. Use reciprocal product and cross product to find the distance and angle between the two edges, as in the example on page 65.

3. Exercise 4.1 from the text:
   Let A be a mobile unit-edge square robot which can translate but not rotate in the plane (figure 1). Let B be a unit-edge equilateral triangle obstacle. Use the simple procedure suggested by equation 4.4 to construct $CO_A(B)$:

   - Plot the vertices of the obstacle B.
   - Choose a reference point $\mathbf{q}$ on A and construct $\ominus A$ by reflecting every vertex through $\mathbf{q}$.
   - Plot the vertices of $B \ominus A$: for each vertex of B plot a copy of $\ominus A$ with $\mathbf{q}$ coincident with that vertex.
   - Construct the convex hull.

4. Exercise 4.3 from the text:
   We can adapt the procedure of exercise 3 for concave polygonal obstacles as follows: we divide the concave object into convex polygons. We construct C-space obstacles for each convex sub-obstacle. The union gives the total C-space obstacle. Use this method to construct the C-space obstacle of figure 2. Here the robot is a unit-edge equilateral triangle that can translate but not rotate in the plane.

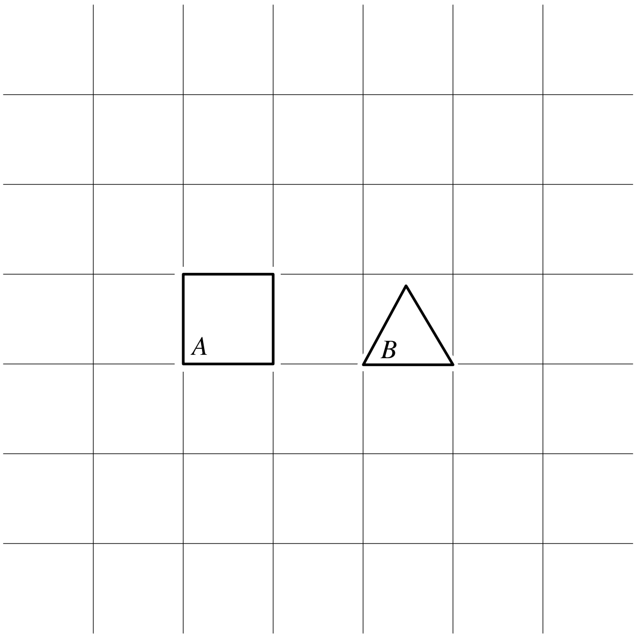


Figure 1: For exercise 3.

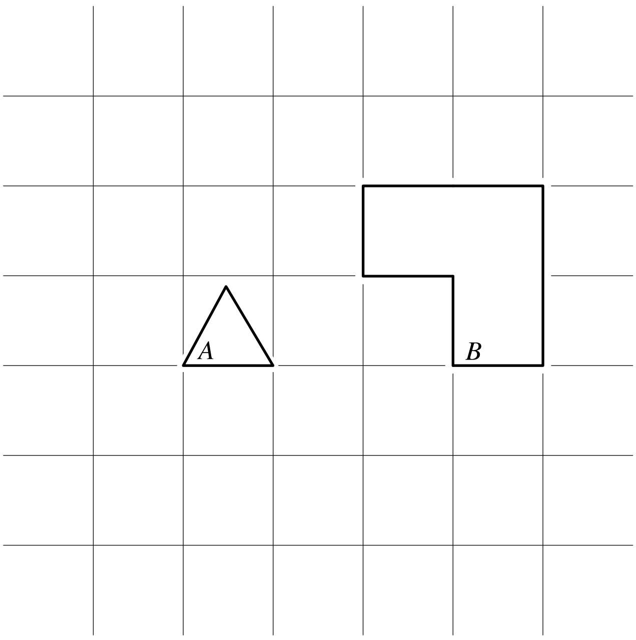


Figure 2: For exercise 4.