ROBÓTICA MÓVEL
Ano Lectivo 2003/2004

Homework 1

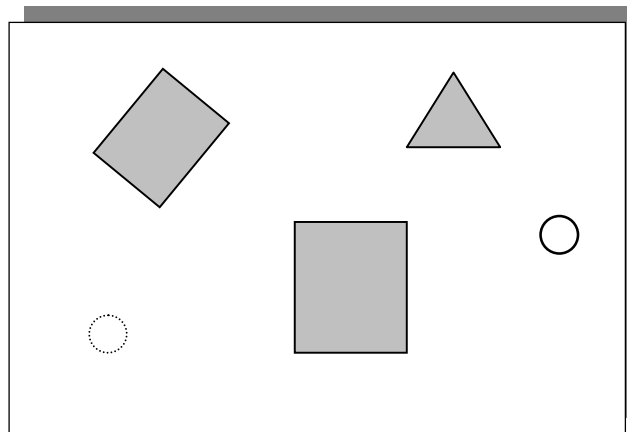Handed-in: 18/4/2005   Due: 6/5/2005

Figura 1

1. a) Sketch the Generalized Voronoi diagram for the "world map" in Figure 1, using the geometric rules explained in the course handouts. **NOTE** that the circles in the figure are not obstacles, but rather represent the start and goal positions of the robot.

b) Implement, in MATLAB, the potential fields method, so as to generate a path for an *omnidirectional circular robot*, between its start position (solid circle) and the goal position (dashed circle) in Figure 1 (assume that the map is in configuration space and the obstacles are C-obstacles). You can choose the obstacle coordinates, the robot start and goal posture coordinates, as well as the parameters of the repulsive and attractive potential functions. Show your results as a 3D map of the resulting potential fields and the path followed by the robot over the equipotential contours of the same map.

c) Repeat b) for a *differential drive vehicle*, with unit distance between the wheels and unit wheel radius, using the A* algorithm to generate the required maneuvers. You do **not** need to actually implement the algorithm nor to present the final sequence of maneuvers, only to explain the procedure followed to discretize the configuration

space (e.g., to obtain a resolution balancing computation time and number of maneuvers), expand graph nodes, and choice of cost functions.

2. Represent ISR 8th floor as a topological map where the *nodes* refer to the rooms (coffee room, labs, offices) and the *edges* to the corridors connecting them. For each node, list key element(s) which allow the robot to recognize its location (e.g., using onboard omnidirectional vision), and for each edge the key element(s) which would enable the robot to follow that edge until the goal node, using appropriate sensor(s) (tell which one(s)).

3. For the *Occupancy Grids* method of map representation, write the equations representing:

      i)   the stochastic sensor model

      ii)   the cell occupancy update using the most recent sensor reading *r*

      iii)   the map update

4. List the main differences among the circular arcs, clothoids and cubic spirals, considered as path segments to be followed by a mobile robot. List also their relative (dis)advantages, regarding:

      i)   path length

      ii)   path somoothness

5.   a) write the *holonomic* constraints for a planar manipulator with 2 links;

       b) write the *non-holonomic* constraints for a differential drive mobile robot.