Probs_Chap6_Lavalle

Saturday, May 03, 2008
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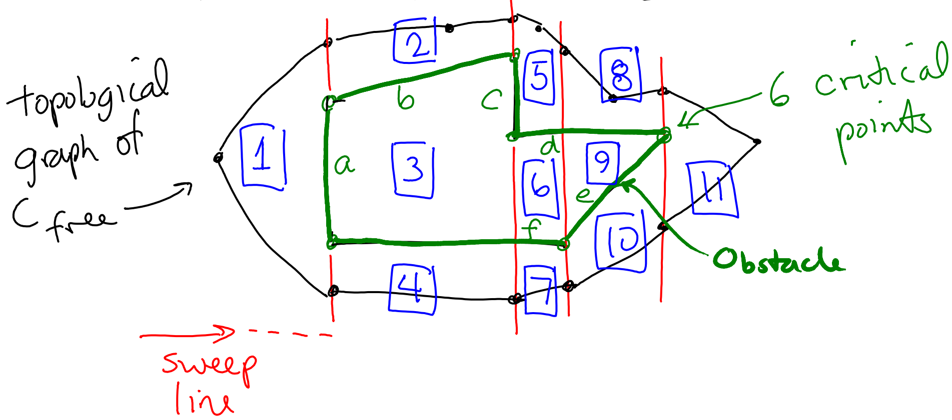
(6.1) When edges lie parallel to the vertical direction, one has to modify the way cell boundaries are entered into the list of bndries

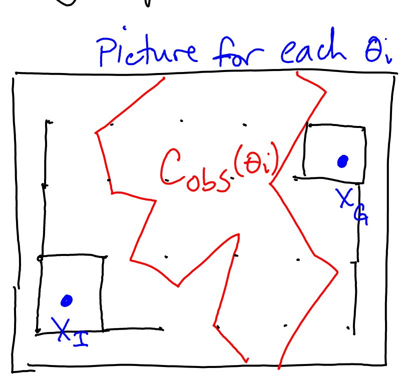


$$L = \{\emptyset\}, \{b, f\}, \{d, f\}, \{d, e\}, \{\emptyset\}$$

Note a & c are never in the list of bndries.

(6.7) Resolution complete alg for planning motion of polygon robot in field of polygonal obstacles.

1. Create an n x n grid in (x,y) space
2. Choose a v.d. Corput seq. of orientations, Θ.
3. For next $\theta_i \in \Theta$:
   a.) construct $C_{obs}(\theta_i)$
   b.) connect adjacent grid points using straight-line local planner.



4. For each θ_i & θ_j that are adjacent in the sequence:

   a) Identify $(x_k, y_k) \notin C_{obs}(\theta_i) \cup C_{obs}(\theta_j)$

   b.) Attempt to connect (x_k, y_k, θ_i) to (x_k, y_k, θ_j) by sweeping robot around reference point from θ_i to θ_j. Connect if no collisions.

5. For each new θ_i check for solution using a usual method.

6. If no solution:

   a. increase grid resolution and restart

   b. select next θ_i and continue (Go to step 3)

   c. give up.

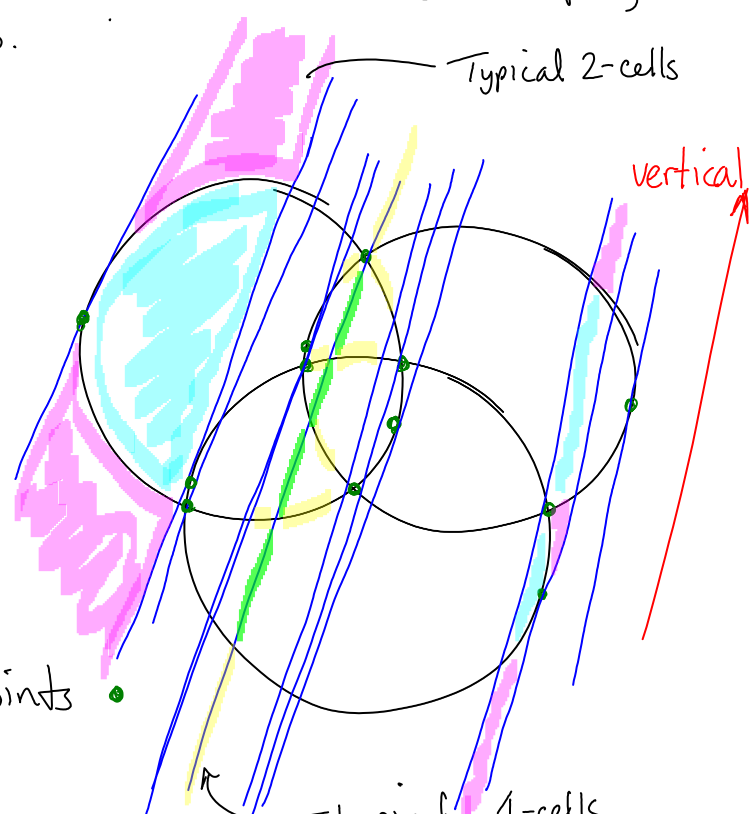
(6.9) Cylindrical algebraic cell decomposition into 0-cells, 1-cells, 2-cells.

12 critical points

≈100 2-cells

≈60 1-cells

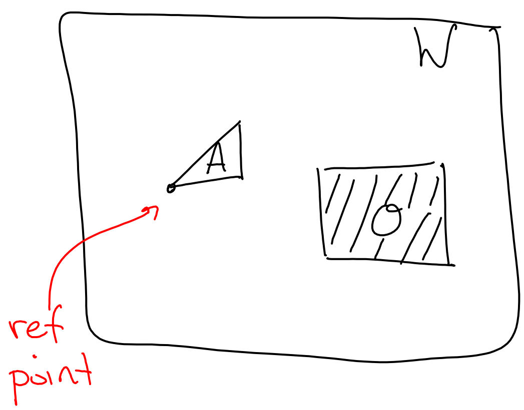
≈30 0-cells



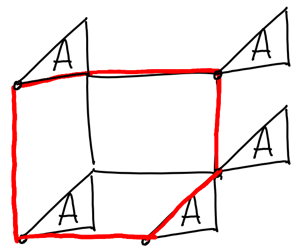
(6.11) How would one perform vertical decomposition of Cspace for a polygonal robot that can translate and scale (or shear) in the plane?

Assume scaling is the same in both horizontal directions. $\therefore$ $\mathcal{C}$ space $= \underset{(x,y)}{\mathbb{R}^2} \times \underset{(s)}{\mathbb{R}^1}$

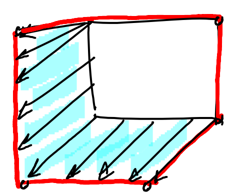
Example:



$\therefore$



C_{obs} w/ scale $s = 1$



Highlighted portion will stretch proportionally along arrows shown with changing s.

Also note $s = 0 \Rightarrow$ $C_{obs} = \mathcal{O}$, since $\mathcal{C} = \mathcal{W}$.

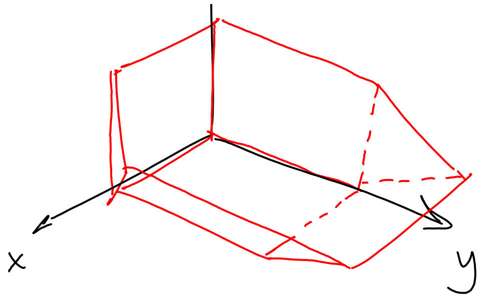
Build $\mathcal{C}$, $\mathcal{C}_{free}$, $\mathcal{C}_{obs}$

$\mathcal{C}_{obs}$ is a 3D polyhedron with base $= \mathcal{O}$ at $s = 0$.

Now choose $s = 1$ create $\mathcal{C}_{obs}$ for $s = 1$ and place above $s = 0$

Connect vertices to

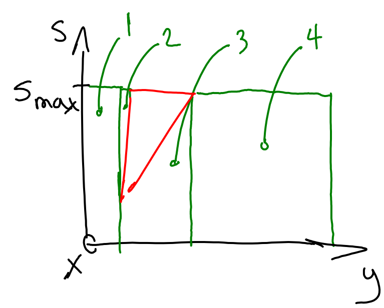
Create C_{obs}



This 3D solid is hard to visualize, but let's go w/ it.

Vertical Decomposition

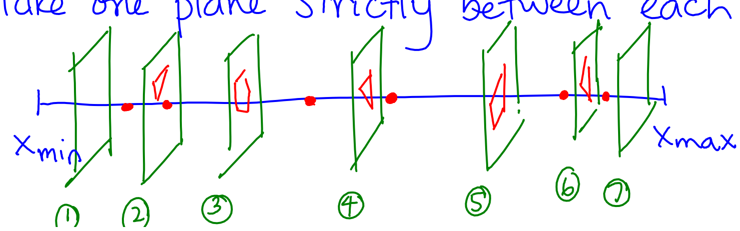
The vertical decomp should create polyhedra above & below the C_{obs} $\ni$ each polyhedron is bounded above by the plane at s_{max} or below by $s=0$. The other upper or lower bound is a full face of C_{obs}.

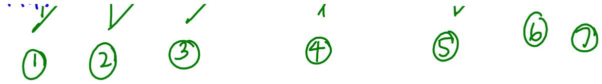


One approach: sweep a plane parallel to the (y,s)-plane to produce a series of critical planes where C_{obs} punches holes of varying polygonal shapes. Each value of x for which the shape changes serves as a bounding x value for 3-cells.

These critical events occur at every value of x for which C_{obs} has a vertex.

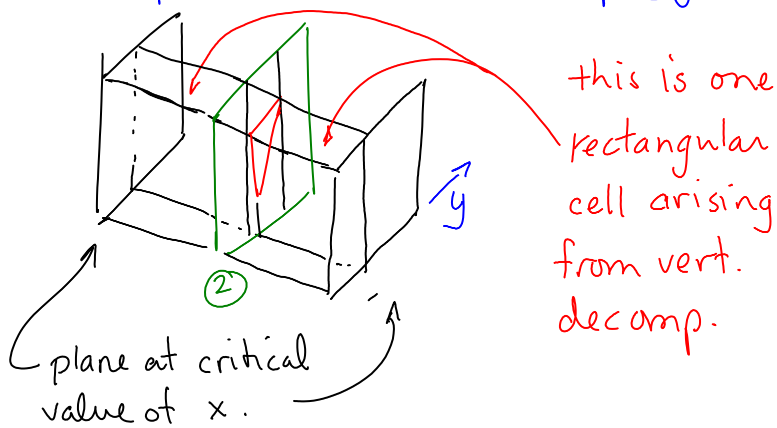
Next take one plane strictly between each





Now perform vertical decomposition on each plane as in the case of $\mathcal{C}space \subset \mathbb{R}^2$ w/ $\mathcal{C}_{obs}$ = polygon

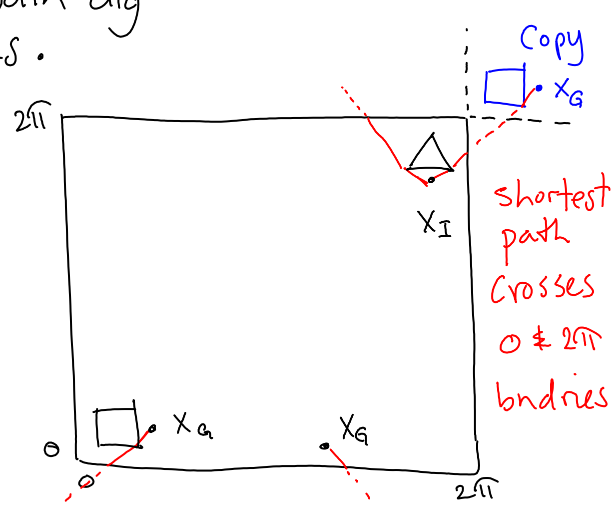
Generic plane ② shows that between two critical planes are 5 polyhedral 3-cells; one lying above the triangle, two below, one on its left, and one on its right.



Proceed analogously to vertical decomp in $\mathbb{R}^2$ to produce 3-cells and 2-cells. Place one point on the interior of each 2-cell & 3-cell. Connect points of the adjacent cells to form a topological graph, or roadmap.

(6.12) Develop shortest path alg on flattened torus.

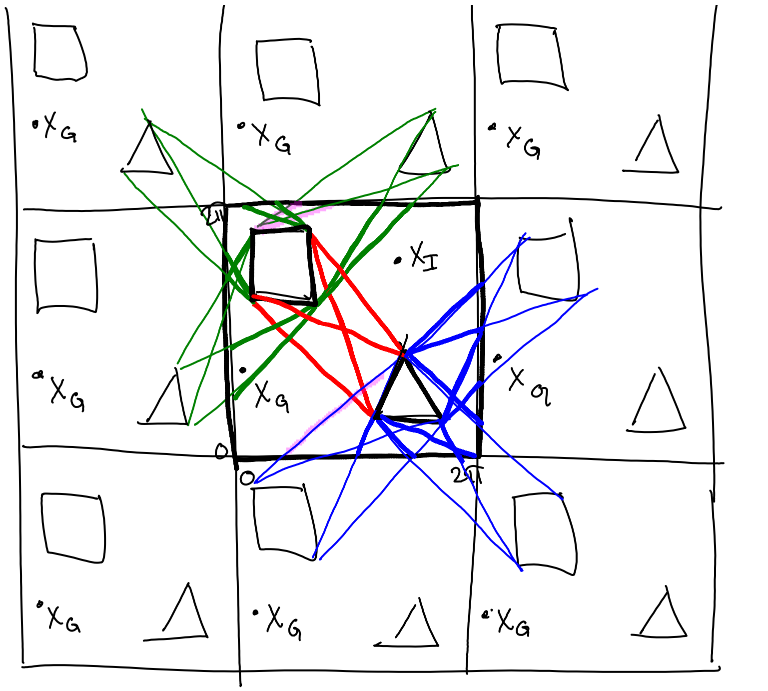
Be sure to handle identifications correctly.



1. Make ________

8 adjacent copies

2. Create visibility graph between △ & □ on all tiles.



3. Make 8 copies of x_G

4. Find shortest path to each of the 9 x_G's

5. Measure lengths of 9 paths. Keep shortest.