Example: C-space

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C-space = space of all configurations of a robot

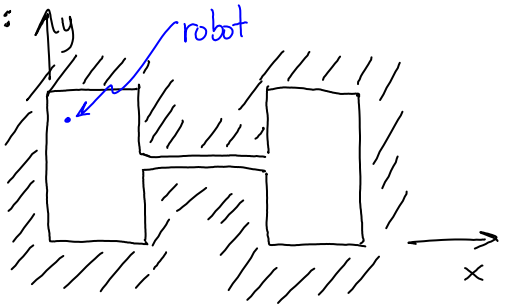
In C-space, the robot is a point

C-Obstacle = configurations corresponding to penetration

C-free = C-space − Closure(C-obstacle)

C-contact = C-space − Cobstacle − C-free

Some examples to work out:



(A) Robot is a particle in the plane.

Workspace is dumbell-shaped region

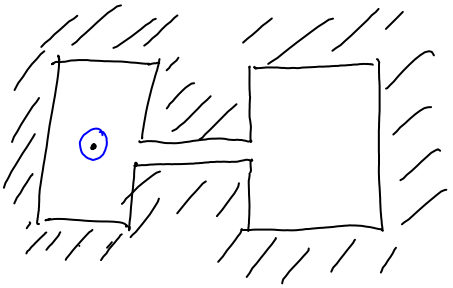
What is the C-space?

What is C-obstacle?

What is C-free?

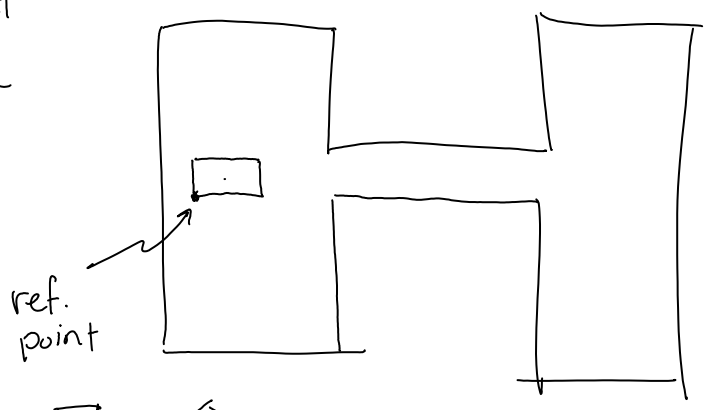
What is C-contact?

(B) Same workspace as (A), but robot is a disk of diameter greater than narrow gap. Use center of disc as reference point, i.e. think in terms of where the reference pt. can be without penetration.

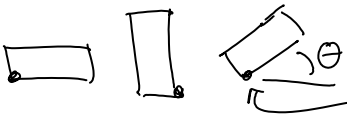


What is the C-space?
What is C-obstacle?
What is C-free?
What is C-contact?

(C.) Same as A, B, but robot is a rectangle that can fit thru the gap.



Consider 3 rectangle orientations:



(x, y) of ref. pt.

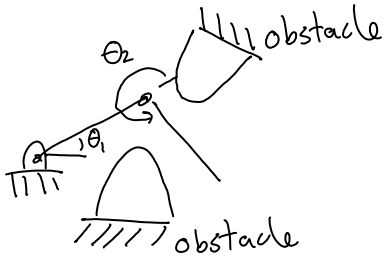
Configuration of robot is (x, y, θ)

Sketch the boundary of C-free for each of the 3 orientations.

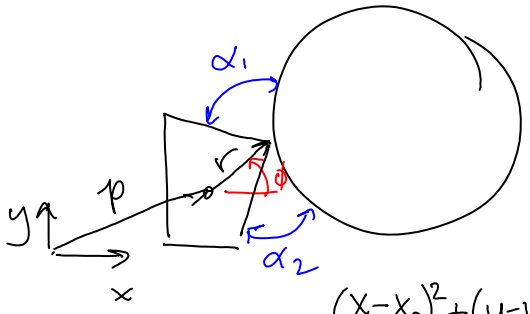
How many components does C-free have?

(D) Same questions.

Note that θ_1 cannot move freely.



(E) Determine equations defining C-obstacle facets.



$(x-x_0)^2+(y-y_0)^2-1=0$

$$p=\begin{bmatrix} p_x \\ p_y \end{bmatrix}$$

$$p+r=\begin{bmatrix} p_x+d\cos\phi \\ p_y+d\sin\phi \end{bmatrix}$$

C-facet:

$$(p_x+d\cos\phi-x_0)^2+(p_y+d\sin\phi-y_0)^2-1=0$$

$$\alpha_1(p_x,p_y,\phi,x_0,y_0)\geq 0$$

$$\alpha_2(p_x,p_y,\phi,x_0,y_0)\geq 0$$