3D Path Planning: Pruning with Constraint Satisfaction (7A)

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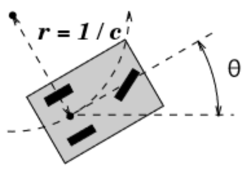
1 Non-Holonomic Constraints

A non-holonimic system is one in which there is a continuous closed circuit of the governing parameters, by which the system may be transformed from any given state to any other state. The vehicles are known to be non-holonomic,i.e, they are subjected to non-holonomic constraints as velocity.

Figure 1: Car Steering



$$\frac{\mathbf{d}}{\mathbf{dt}}\begin{pmatrix} x \\ y \\ \theta \end{pmatrix} = \begin{pmatrix} \cos\theta & 0 \\ \sin\theta & 0 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} v \\ v\,c \end{pmatrix}$$

So the equations for a car are:-
q(x,y,θ)
$dx = v * \cos(\phi) * \cos(\theta)$
$dy = v * \cos(\phi) * \sin(\theta)$
$d\theta = (v/L) * \sin(\phi)$
$distance(p, q) = \sqrt{(p.x - q.x)^2 + (p.y - q.y)^2 + A * min[(p.\theta - q.\theta)^2), (p.\theta - q.\theta + 2\pi)^2, (p.\theta - q.\theta - 2\pi)^2]}.$

Here
L is the length of the car.
A = L*L.

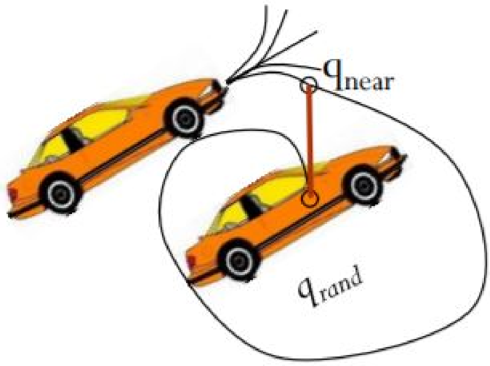
After finding the nearest node (vn) of the randomized configuration (q), we have to find the optimal input(v, ϕ) to get the new node (qn) closest to q. This is a optimization problem, defined as following:-

distance(qn,q) = $\sqrt{(qn.x - q.x)^2 + (qn.y - q.y)^2 + A * min^2[(qn.\theta - q.\theta), (qn.\theta - q.\theta + 2\pi), (qn.\theta - q.\theta - 2\pi)}$
$Where,$
$qn.x = vn.x + v * dt * \cos(\phi) * \sin(vn.\theta)$

$qn.y = vn.y + v * dt * \cos(\phi) * \sin(vn.\theta)$
$qn.\theta = vn.\theta + v * dt * \sin(\phi)$

2 Effect of Non-Holonomic Constraints on Voronoi Bias

Hard to define the distance metric as due to consideration of mixing velocity, position, rotation etc. Euclidean distance might not be optimal distance metric.



Configurations are close according to Euclidian metric, but actual distance is large.

References

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