Motion Planning

Spring 2017
Homework 1
2/17/2017

This part of the homework contains 2 page (including this cover page) and 6 questions. Total of points is 90. The coding assignment is a part of the website.

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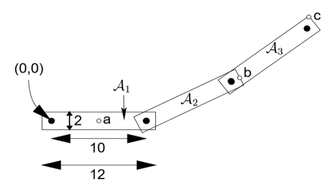
1. (15 points) For distinct values of yaw, pitch, and roll, it is possible to generate the same rotation. In other words, $R(\alpha, \beta, \gamma) = R(\alpha', \beta', \gamma')$ for some cases in which at least $\alpha = \alpha'$, $\beta = \beta'$, or $\gamma = \gamma'$. Characterize the sets of angles for which this occurs.

2. (15 points) Using rotation matrices, prove that 2D rotation is commutative but 3D rotation is not.

Figure 1:



3. (15 points) Consider the articulated chain of bodies shown in Figure 1. There are three identical rectangular bars in the plane, called A1, A2, A3. Each bar has width 2 and length 12.The distance between the two points of attachment is 10. The rst bar, A1,is attached to the origin. The second bar, A2, is attached to A1, and A3 is attached to A2. Each bar is allowed to rotate about its point of attachment. The conguration of the chain can be expressed with three angles, (θ1,θ2,θ3).The first angle, θ1, represents the angle between the segment drawn between the two points of attachment of A1 and the x-axis.The second angle, θ2, represents the angle between A2 and A1 (θ2=0 when they are parallel).The third angle, θ3,represents the angle between A3 and A2. Suppose the configuration is ($\pi/4$, $\pi/2$, -$\pi/4$).

   A. Use the homogeneous transformation matrices to determine the locations of points a, b, and c.

   B. Characterize the set of all congurations for which the final point of attachment (near the end of A3) is at (0,0) (you should be able to figure this out without using the matrices).

4. (15 points) Design combinations of robots and obstacles in workspace that lead to C-space obstacles resembling bug traps.

5. (15 points) In a high-dimensional grid, it becomes too costly to consider all 3^n-1 n-neighbors. It might not be enough to consider only 2^n 1-neighbors. Determine a scheme for selecting neighbors that are spatially distributed in a good way, but without requiring too many. For example,what is a good way to select 50 neighbors for a grid in $\mathbb{R}^{10}$?

6. (15 points) Explain the difference between searching an implicit, high-resolution grid and growing search trees directly on the C-space without a grid.