ME 570: Robot Motion Planning

Homework 2 Report

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**Problem 1: Rotations**

Question 1.1 \_report\_ – Geometric Reasoning of the Rotation Matrices

This rotation matrix rotates the and -axes counterclockwise around the -axis

A picture containing chart

Description automatically generated

This rotation matrix rotates the and -axes counterclockwise around the -axis

Chart

Description automatically generated with low confidence

This rotation matrix rotates the and -axes counterclockwise around the -axis

Chart

Description automatically generated

This rotation matrix reflects the and -axes across the -axis and then rotates them counterclockwise.

Diagram

Description automatically generated

**Problem 2: Free Configuration Space for a Two-Link Manipulator**

Question 2.1 \_report\_ – Coordinate Transformations

1. The coordinates of the point given in , denoted as :  
     
    where and is the simple rotation matrix
2. The coordinates of the point given in denoted as :  
     
   : To compute this, we need to perform   
     
   : Plugging this into the above, converting form   
     
      
    **where** **and**   
     
   Also important is is, again, the simple rotation matrix:  
      
     
   We now have:

Question 2.1 \_code\_ – TwoLink.kinematic\_map()

Question 2.1 \_optional\_ – TwoLink.kinematic\_map(i)

Question 2.2 \_code\_ – TwoLink.is\_collision()

Question 2.2 \_report\_ – TwoLink.plot\_collision()

Question 2.2 \_optional\_ – TwoLink.free\_space()

**Problem 3: Grids, Function Handles, and Evaluating Functions on Grids**

Question 3.1 \_code\_ – Grid.eval()

**Problem 4: Charts for the Circle Using Rotations**

Question 4.1 \_report\_ – Show that is a rotation

Question 4.1 \_optional\_ – Two Charts for a Circle

Question 4.2 \_optional\_ – Generate Vectors and

**Problem 5: Charts for the Torus Using Rotations**

Question 5.1 \_code\_ – Torus.phi()

Question 5.1 \_report\_ – Create Atlas for Torus

Question 5.2 \_report\_ – Torus.plot\_charts()

Question 5.2 \_optional\_ – Plot All Charts Simultaneously

Question 5.3 \_report\_ – Explain the Atlas for the Torus

Question 5.4 \_report\_ – Compute the Tangent   of the curve

Question 5.2 \_code\_ – Torus.phi\_push\_curve()

Question 5.5 \_report\_ – Torus.plot\_charts\_curves

**Problem 6: Jacobians and End Effector Velocities**

Question 6.1 \_report\_ – Expression for as a function of

Question 6.1 \_optional\_ – Find the Jacobian from Previous Question

Question 6.1 \_code\_ – TwoLink.jacobian()

Question 6.2 \_report\_ – Find for Set of Values

Question 6.3 \_report\_ – me570\_hw2.torus\_twolink\_plot\_jacobian()

Question 6.4 \_report\_ – Relationship between \_report 5.5\_ and \_report 6.3\_