

Homework 1

Introduction to Robotics

September 22, 2014

1. What are the degrees of freedom of a standard, hand-pushed lawnmower? Why are you still able to mow your entire lawn? *1pt*
2. What are the maximum degrees of freedom for objects driving on the plane? *1pt*
3. (a) Write out the entries of a rotation matrix ${}^A_B R$ assuming basis vectors X_A, Y_A, Z_A , and X_B, Y_B, Z_B . *1pt*
(b) Express $\hat{X}_B = [0, 1, 0]^T$ in frame $\{A\}$. *1pt*
(c) Write out the entries of rotation matrix ${}^B_A R$. *1pt*
(d) Verify that your solution for ${}^A\hat{X}_B = {}^A_B R[0, 1, 0]^T$ indeed reduces to $[0, 1, 0]^T$ when re-expressed in coordinate system $\{B\}$. Tip: Express multiplications as scalar products and remember that the scalar product of orthogonal vectors is 0 and that of parallel vectors is 1. *1pt*
4. Consider a tri-cycle with two independent standard wheels in the rear and the steerable front-wheel. Chose a suitable coordinate system and use θ as the steering wheel angle and wheel-speed $\dot{\omega}$. Provide forward and inverse kinematics. *2pt*