Homework 1

Introduction to Robot Modeling

Deadline : September 25, 2022

Instructions

1. **Submit your assignment as your_directoryID_hw1.zip**
2. **Your submission must contain your code, instructions to run it, and the report as a PDF only**

1 Kinematics

1.1 Rear wheel drive modeling

Write a python program to plot the 2D trajectory of point O on a rear-wheel drive vehicle, given the initial pose (x_i, y_i, ϕ_i), drive speed ω, steering angle α, and duration T. Assume the all the wheels have a diameter of 0.5 m, chassis length to be 4 m, and distance between wheels is 1.5 m Fig. 1. Assume that none of the wheels slip and the drive speed is split among both the wheels as the following equation $\omega_{left} + \omega_{right} = 2\omega$. Please show all your work for the derivation of the state-space model.

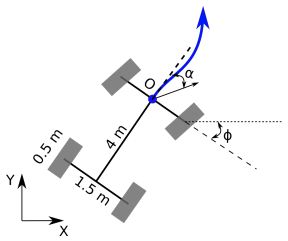

Figure 1: Rear Wheel Drive Model

1.2 Derive the kinematics equations for a 3-DOF manipulator using geometrical method

Consider a serial manipulator with 3 links connected by revolute joints as shown in Fig. 2 with the link lengths l_1, l_2, l_3.

1. Derive the (position and velocity) forward kinematics equations, given joint angles $\theta_1, \theta_2, \theta_3$ and joint velocities.
2. Derive (velocity) inverse kinematics equations in matrix format using geometrical method, given velocities of the end-effector $x-dot, y-dot, \phi-dot$ and joint angles $\theta_1, \theta_2, \theta_3$ (use python's SymPy library to take derivatives).

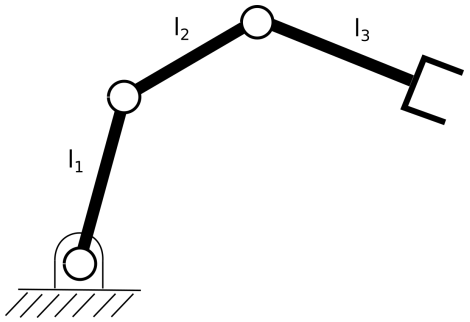

Figure 2: 3-link serial manipulator