Homework 1

Introduction to Robot Modeling
Deadline : September 23, 2023

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 simple bicycle, given the initial pose (x_i, y_i, ϕ_i), rear wheel drive angular speed ω, steering angle $\alpha = 0.5*sin(\pi t)$, and duration T (assume values for the initial pose, ω and T). Assume the all the wheels have a diameter of 0.5 m and distance between wheels is 1.5 m (Fig.1). Assume that none of the wheels slip, and there is no tilt (roll) to the bicycle and its always perfectly vertical. Please show all your work for the derivation of the state-space model.

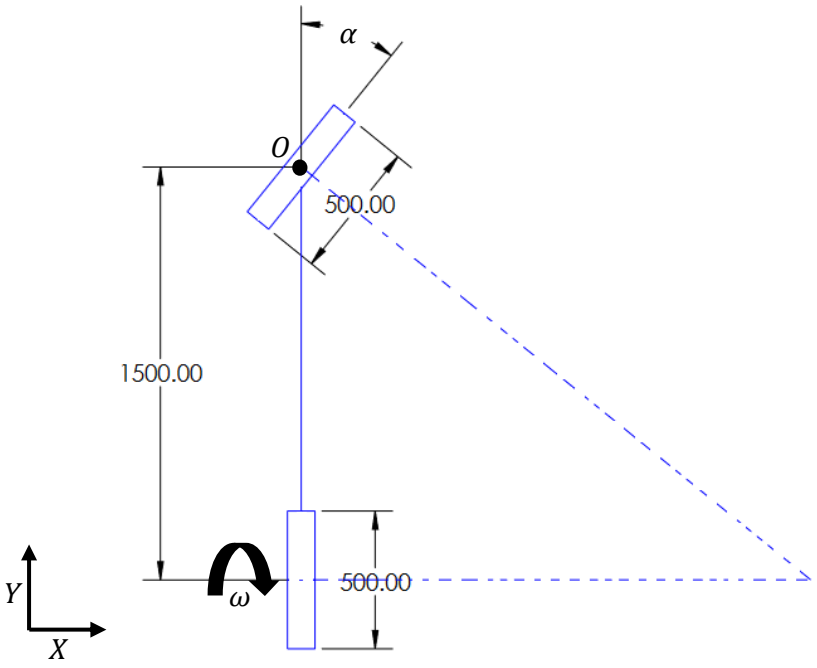

Fig 1: Rear Wheel Drive Bicycle top view

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

Consider a robot with 3 links connected by revolute and prismatic joints as shown in Fig.2 with the link lengths l1 (variable), l2, l3 and angles θ1, θ2 (fixed), θ3

1. Derive the (position and velocity) forward kinematics equations, given joint positions θ1, l1, θ3 and joint velocities θ1_dot, l1_dot, θ3_dot
2. Derive (velocity) inverse kinematics equations in matrix format using geometrical method, given velocities of the end-effector x−dot, y−dot, φ−dot and joint positions θ1, l1, θ3 (use python's SymPy library to take derivatives).

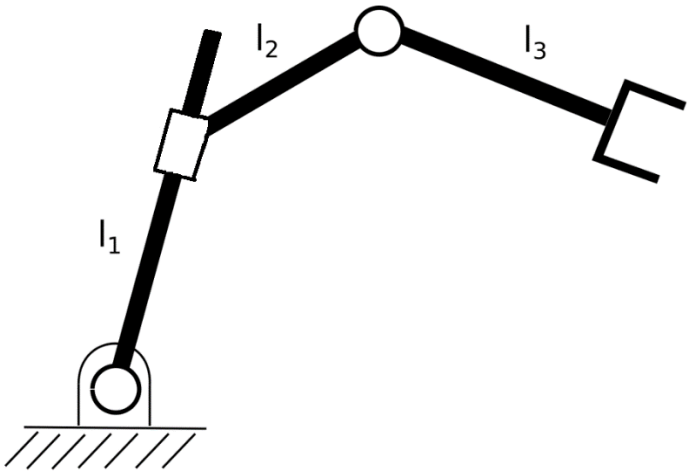

Figure 2: 3-link planar robot