Tutorial 5: Inverse Kinematics

These questions are from the Practice Exercises of the Modern Robotics book. The solutions can be found on the book website. Please try your best before referring to the solutions.

Question 1: Newton-Raphson root finding

Perform three iterations of (approximate) iterative Newton-Raphson root finding on the scalar function $x_d - f(\theta)$ in *Figure 1*, starting from θ^0. (A general vector function $f(\theta)$ could represent the forward kinematics of a robot, and x_d could represent the desired configuration in coordinates. The roots of $x_d - f(\theta)$ are the joint vectors θ satisfying $x_d - f(\theta) = 0$, i.e., solutions to the inverse kinematics problem.) Draw the iterates θ^1, θ^2 and θ^3 on the θ axis and illustrate clearly how you obtain these points.

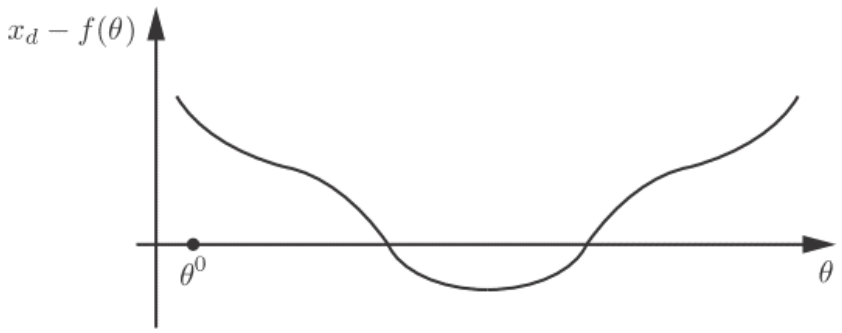

Figure 1. A scalar function $x_d - f(\theta)$ of θ.

Question 2: RRP robot arm

The spatial RRP open chain of *Figure 2* is shown in its zero position. Use analytic methods to solve the inverse kinematics when the end-effector configuration is described by

$$T = \begin{bmatrix} 0 & 1 & 0 & 2L \\ 0 & 0 & -1 & 0 \\ -1 & 0 & 0 & -3L \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

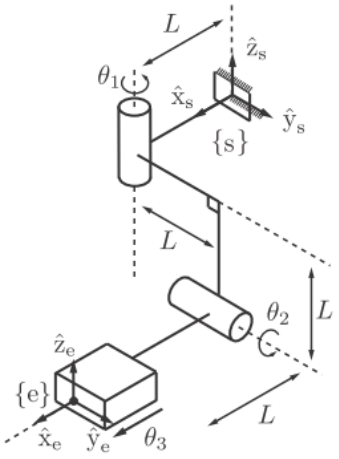

Figure 2. An RRP Robot.