CMPSCI 403: Introduction to Robotics: Perception, Mechanics, Dynamics, and Control

HW 02

Due Online, Wednesday, Sept. 15th, 11:30 PM

All questions refer to the robot arm sketched in the figure below. You should use MATLAB to perform intermediate symbolic computations. Answer the questions below with text, mathematical statements, and supporting sketches where appropriate. Include a commented copy of your MATLAB code.

1. How many degrees of freedom (n) does this mechanism possess?
2. Where would you attach motors to control the position of the end effector in the plane?
3. Based on your choice, define joint position vectors $q \in \mathbb{R}^n$ and derive forward kinematic equations that relate the inputs (motor angles) to the outputs (end effector position in Cartesian coordinate, i.e. $p = (x, y)$).
4. Obtain the Jacobian matrix $J(q) = \frac{dp}{dq}$ symbolically in MATLAB.
5. Use this Jacobian to relate output forces (F_x, F_y) at the tip of the arm to statically equivalent input torques (τ_1, τ_2).

Assumptions and tips:

- You should define fixed parameters as necessary.
- You can assume that the linkage is a parallelogram.
- Consider using MATLAB functions: `syms, eval, jacobian`
- You may want to read the MATLAB Symbolic Computation Toolbox Tutorial before getting started: `http://www.mathworks.com/help/symbolic/performing-symbolic-computations.html`