ME5493: Robotics, HW 9
Homework due on 12-10-2017, Topics: Modeling using urdf and xacro using ROS

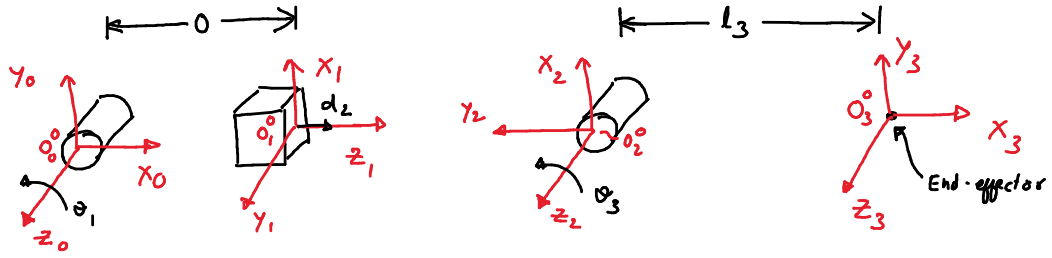
Instructions: You will submit this HW through `https://github.com/` (a free code hosting website). Please make an account and create the folder hw9 in your account. Within this folder make subfolders for each question. Submit all your code and other text/figure files as indicated in the questions below.

1. For the 3 link manipulator with revolute-prismatic-revolute (RPR) joint the link length $\ell_3 = 1$ m. (Note: The '0' in the figure below indicates a length of zero). Create a folder *hw9_1* in your github account and submit you work in that folder.

   (a) Create a urdf or xacro model with the following joint limits $-1.57 \leq \theta_1 \leq 1.57$, $0 \leq d_2 \leq 0.2$, and $0 \leq \theta_3 \leq 3.14$. Also, attach a body to the end-effector.

   (b) Create a *display.launch* file that invokes the *joint_state_publisher* and outputs the model using *rviz*. Once you launch the model, use the sliders on the *joint_state_publisher* to set, $\theta_1 = 0.785$, $d_2 = 0.1$, and $\theta_3 = 1.57$. Take a screenshot without changing the viewpoint and submit the screenshot, *view_hw9q1.jpg or png*.

   (c) Write a C++ file that sets the above angles for the manipulator and outputs the end-effector position (only x-,y-, z-position). Compare the output with that obtained using D-H formula. Submit both, output from ROS and that from D-H formula in a text file called *compare_hw9q1.txt* on github.



Link i	a_i	α_i	d_i	θ_i
1	0	$\pi/2$	0	θ_1
2	0	$-\pi/2$	d_2	0
3	l_3	0	0	θ_3

a_i, α_i : $X_i \rightarrow z_{i-1}$ & z_i
d_i, θ_i : $z_{i-1} \rightarrow x_{i-1}$ & x_i

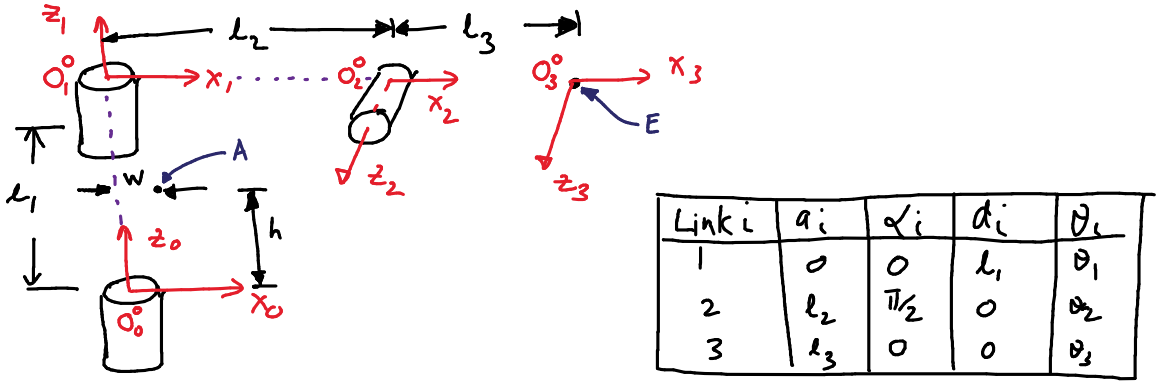
Figure 1: Manipulator with revolute-prismatic-revolute (RPR) joint.

2. For the 3 link manipulator with revolute-revolute-revolute (RRR) joint the link length $\ell_1 = 1$ and $\ell_2 = \ell_3 = 0.5$ m. Create a folder *hw9_2* in your github account and submit you work in that folder.

   (a) Create a urdf or xacro model with the following joint limits $-1.57 \leq \theta_1, \theta_2 \leq 1.57$ and $0 \leq \theta_3 \leq 3.14$. Also, attach a body to the end-effector.

   (b) Create a *display.launch* file that invokes the *joint_state_publisher* and outputs the model using *rviz*. Once you launch the model, use the sliders on the *joint_state_publisher* to set, $\theta_1 = 0.3$, $\theta_2 = 0.5$, and $\theta_3 = 0.7$. Take a screenshot without changing the viewpoint and submit the screenshot, *view_hw9q2.jpg or png*.

   (c) Write a C++ file that sets the above angles for the manipulator and outputs the end-effector position (only x-,y-, z-position). Compare the output with that obtained using D-H formula. Submit both, output from ROS and that from D-H formula in a text file called *compare_hw9q2.txt* on github.



Link i	a_i	α_i	d_i	θ_i
1	0	0	l_1	θ_1
2	l_2	$\pi/2$	0	θ_2
3	l_3	0	0	θ_3

Figure 2: Manipulator with revolute-revolute-revolute (RRR) joints.