EE594 Industrial Robotics and Automation

Assignment- 1

March/April 2022

Consider the RHINO robot system shown in the figures below:

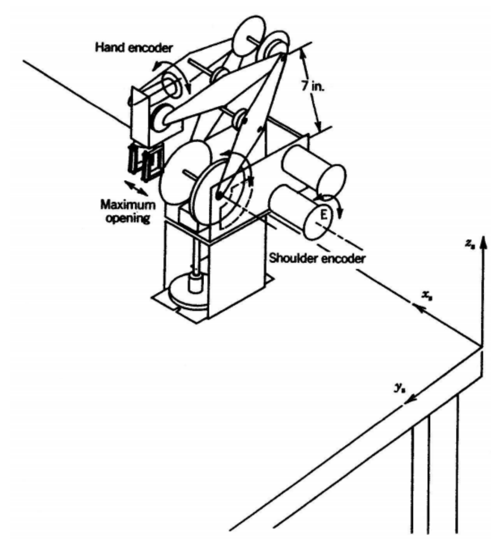

Fig. 01: RHINO Robot description

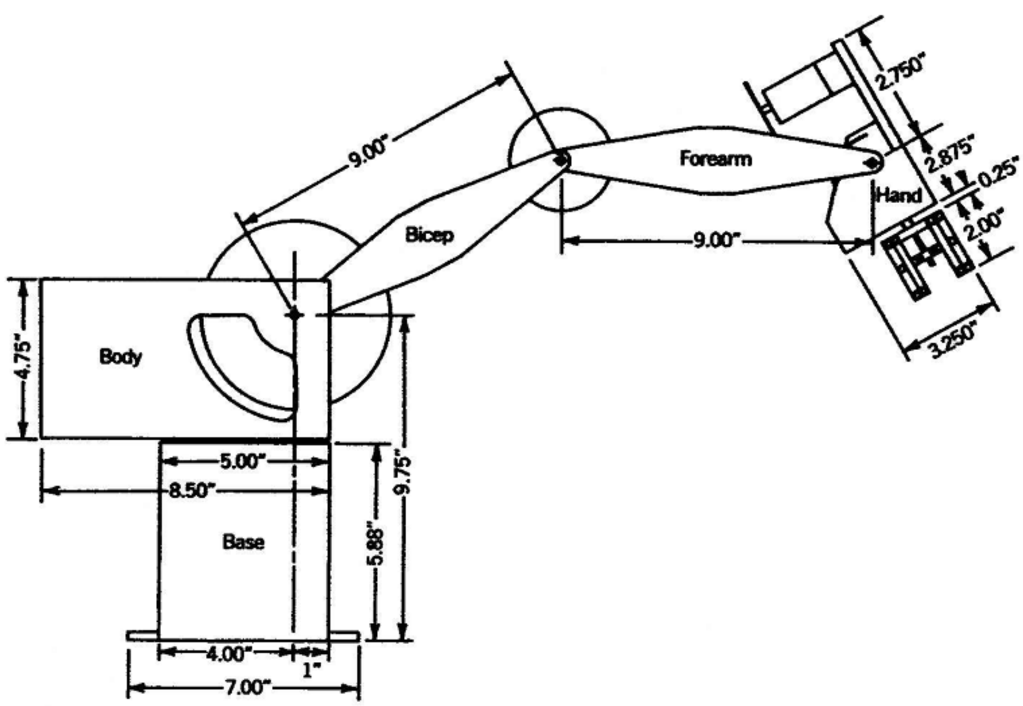

Fig. 02: RHINO Robot dimensions

For this assignment you will use the MATLAB Robotics Toolbox created by Peter Corke (http://petercorke.com/wordpress/toolboxes/robotics-toolbox).

1 Obtain the DH parameters for the 5-link RHINO robot manipulator shown in the figures 01 and 02 (use SI units). Then create the Links and connect them serially to form the Robotic manipulator.

2 The home (idle) position (Fig. 03, **H**) and orientation of the manipulator end-effector is XYZ (-0.146, 0, 0.409) and RPY (0, -90, -180) respectively. First, set the robotic manipulator to the home position (XYZ in meters and Roll, Pitch, Yaw in degrees).

3 Your task is to pick an object located at **A** (see the Fig. 03), then moves it along a straight line (constrained) to position **B** and need to place it at **D**. However, there is a wall in between **B** and **D**. Therefore, move the object via position **C** (above the wall). After placing the object, set the manipulator back to the home position (**H**). Position and orientation of the end- effector at each location is given below;

```
A- XYZ (-0.17,    AY,     AZ),   RPY (-180,   0,   60)
B- XYZ (0.181, 0.313, 0.345),  RPY (-125,  26,  106)
C- XYZ (0.420, 0.000, 0.540),  RPY (   0,  70,    0)
D- XYZ (0.237, -0.338, 0.100,  RPY ( 180,   0, -125)
```

where Ay = 0.30 for **odd EN** numbers and 0.20 for **even EN** numbers;
Az = 0.010+ EN/420*0.40 (**EN** is XX of your registration number, E/16/**XX**)

Generate trajectories (in joint space) to move the manipulator from H to A, then A to B, B to D via C and finally, back to H. Following commands will be useful; *ikcon, ikunc, fkine, jtraj, ctraj, transl, rpy2tr, d2r.*
(Note: you do not need to simulate pick and place operations)

4 Visualize the end-effector of the manipulator moving along the trajectories generated above. Save the figure frames when the end-effector at each of the following locations A, B, C, D and H. You can use the following Matlab code snippet for visualizing the Robot (stick diagram) movement.

```
EET = zeros(4,4);
t   = 0: 0.04: 2;
for i = 1:1:length(t)
    EET = Robot.fkine(trajectory1(i,:));
    EEp(i,:)= EET(1:3,4);
    plot2(EEp(i,:),'r.')
    Robot.plot(trajectory1(i,:))
    plot2(EEp,'b')
end
```

"Robot" is the manipulator created in 1 and the "trajectory1" is one of the trajectories generated in 3. "t" is the time points used in computing the trajectory.
(Note: you do not need to create the wall and the box as in Fig. 03)

5 Generate a movie from the simulation. You can save separate frames into a folder and combine using an encoder like “ffmpeg” (https://www.ffmpeg.org/download.html).

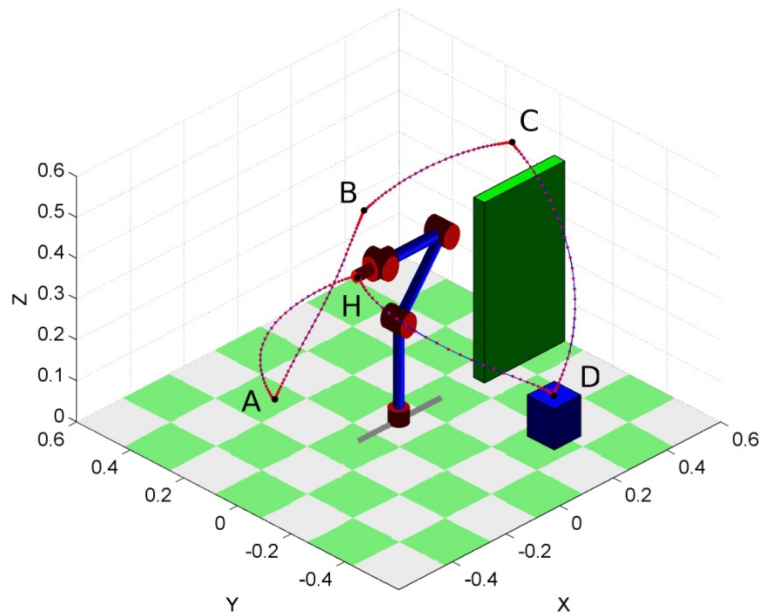

Fig. 03: Trajectories generated during the manipulator task

Add the following line just after the last plot2 command in the above snippet to generate frames,

```
saveas(gcf,['./frameDIR/filename' num2str(i) '.png']);
```

and combine them using,

```
ffmpeg -r 10 -i filename%d.png movie.avi
```

at the command prompt within the frame directory (“frameDIR”).

NOTE: If you need further information about the RHINO robot, you may refer to the RHINO robot manipulator in the Control, Robotics and Automation laboratory in the Dept. of Electrical & Electronic Engineering.

DEADLINE FOR SUBMISSION OF ANSWERS: April 30th 11:59 pm

You must submit the Matlab code, five figures in 4 (Last figure should look-like Fig. 03 without the wall and the box) compiled into a single word page, an animation (avi file) showing the robot end-effector moving from H to A-B-C-D and back to H.