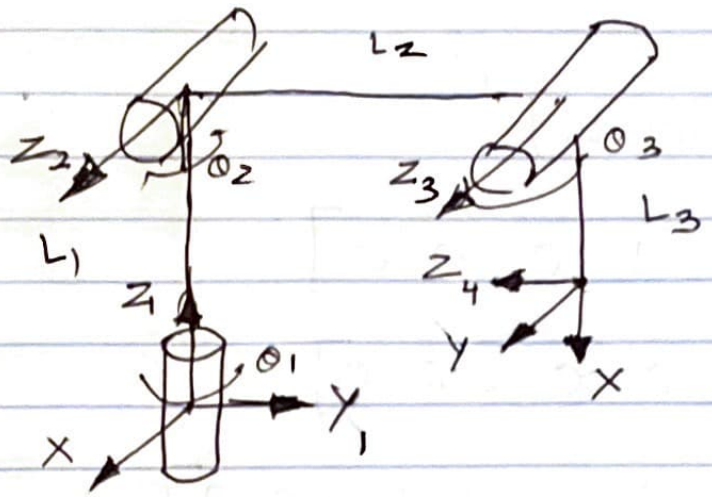
HW-3
RBE-501 - Robot Dynamics
Prasanna Vijay Naty

Q1



$L_1 = 0.2$
$L_2 = 0.3$
$L_3 = 0.4$

Calculating Body ~~Twist~~ Frame Screw axes.

$B_i = [\omega_i \; v_i]^T$.

~~B_1 [ ]~~

$B_1 = [-1 \; 0 \; 0 \; 0 \; -0.3 \; 0]$

$B_2 = [0 \; 1 \; 0 \; -0.3 \; 0 \; -0.4]$

$B_3 = [0 \; 1 \; 0 \; 0 \; 0 \; -0.4]$

Calculating the home configuration

M

$$\therefore \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0.3 \\ -1 & 0 & 0 & -0.2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Calculating the Screw Axis for Space frame

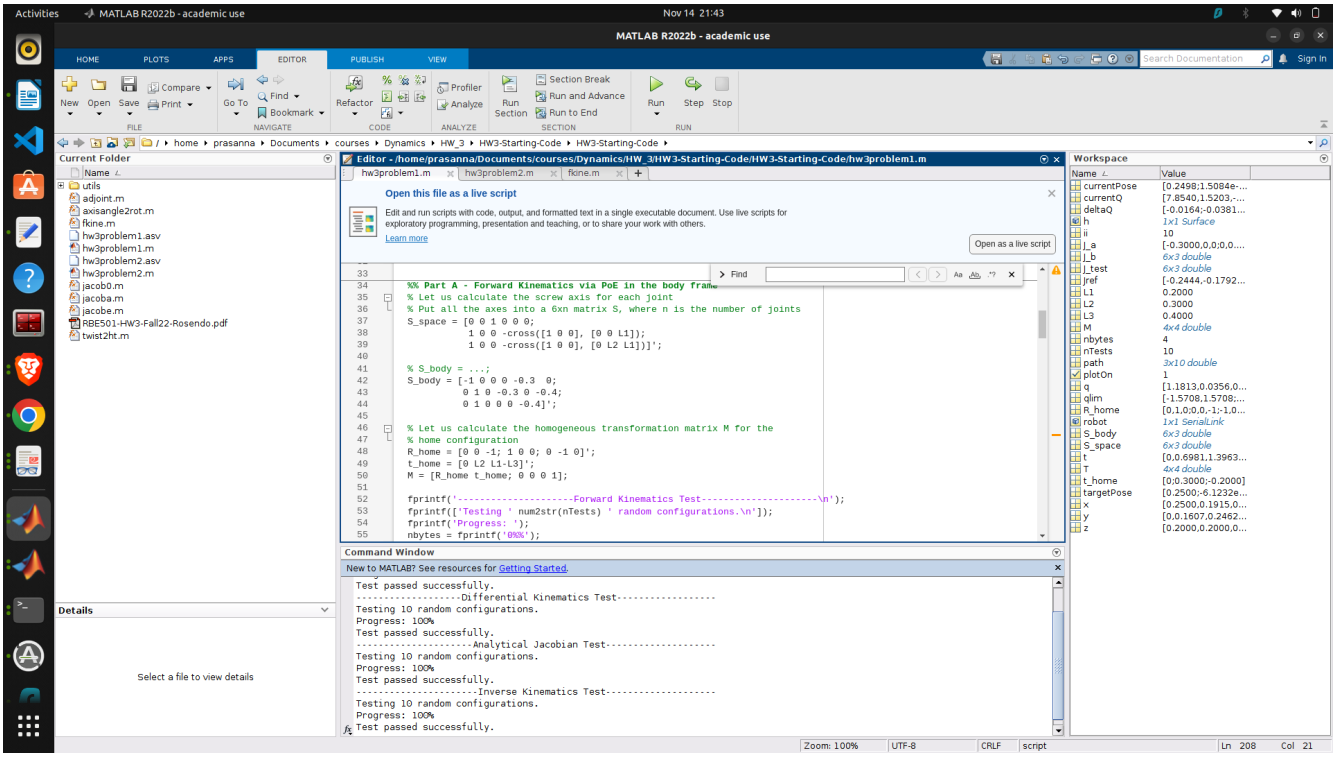
$$S_i = [\omega_i \; v_i]^T$$

$$S_1 = [0 \; 0 \; 1 \; 0 \; 0 \; 0]$$

$$S_2 = [1 \; 0 \; 0 \; 0 \; 0.2 \; 0]$$

$$S_3 = [1 \; 0 \; 0 \; 0 \; 0.4 \; -0.3]$$

Problem 1:


Activities
MATLAB R2022b - academic use
Nov 14 21:43
MATLAB R2022b - academic use
HOME
PLOTS
APPS
EDITOR
PUBLISH
VIEW
Current Folder
Name
utils
adjoint.m
axisangle2rot.m
fkine.m
hw3problem1.asv
hw3problem1.m
hw3problem2.asv
hw3problem2.m
jacob0.m
jacoba.m
jacobe.m
RBE501-HW3-Fall22-Rosendo.pdf
twist2ht.m
Details
Select a file to view details
Editor - /home/prasanna/Documents/courses/Dynamics/HW_3/HW3-Starting-Code/HW3-Starting-Code/hw3problem1.m
hw3problem1.m
hw3problem2.m
fkine.m
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Learn more
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%% Part A - Forward Kinematics via PoE in the body frame
% Let us calculate the screw axis for each joint
% Put all the axes into a 6xn matrix S, where n is the number of joints
S_space = [0 0 1 0 0 0;
1 0 0 -cross([1 0 0], [0 0 L1]);
1 0 0 -cross([1 0 0], [0 L2 L1])]';
% S_body = ...;
S_body = [-1 0 0 0 -0.3 0;
0 1 0 -0.3 0 -0.4;
0 1 0 0 0 -0.4]';
% Let us calculate the homogeneous transformation matrix M for the
% home configuration
R_home = [0 0 -1; 1 0 0; 0 -1 0]';
t_home = [0 L2 L1-L3]';
M = [R_home t_home; 0 0 0 1];
fprintf('--------------------Forward Kinematics Test--------------------\n');
fprintf(['Testing ' num2str(nTests) ' random configurations.\n']);
fprintf('Progress: ');
nbytes = fprintf('0%%');
Command Window
New to MATLAB? See resources for Getting Started.
Test passed successfully.
------------------Differential Kinematics Test----------------
Testing 10 random configurations.
Progress: 100%
Test passed successfully.
--------------------Analytical Jacobian Test-------------------
Testing 10 random configurations.
Progress: 100%
Test passed successfully.
--------------------Inverse Kinematics Test--------------------
Testing 10 random configurations.
Progress: 100%
Test passed successfully.
Workspace
Name
Value
currentPose [0.2498;1.5084e-...
currentQ [7.8540,1.5203,-...
deltaQ [-0.0164;-0.0381...
h 1x1 Surface
ii 10
J_a [-0.3000,0,0;0,0....
J_b 6x3 double
J_test 6x3 double
Jref [-0.2444,-0.1792...
L1 0.2000
L2 0.3000
L3 0.4000
M 4x4 double
nbytes 4
nTests 10
path 3x10 double
plotOn 1
q [1.1813,0.0356,0...
qlim [-1.5708,1.5708;...
R_home [0,1,0;0,0,-1;-1,0...
robot 1x1 SerialLink
S_body 6x3 double
S_space 6x3 double
t [0,0.6981,1.3963...
T 4x4 double
t_home [0;0.3000;-0.2000]
targetPose [0.2500;-6.1232e...
x [0.2500,0.1915,0...
y [0,0.1607,0.2462...
z [0.2000,0.2000,0...
Zoom: 100%
UTF-8
CRLF
script
Ln 208
Col 21

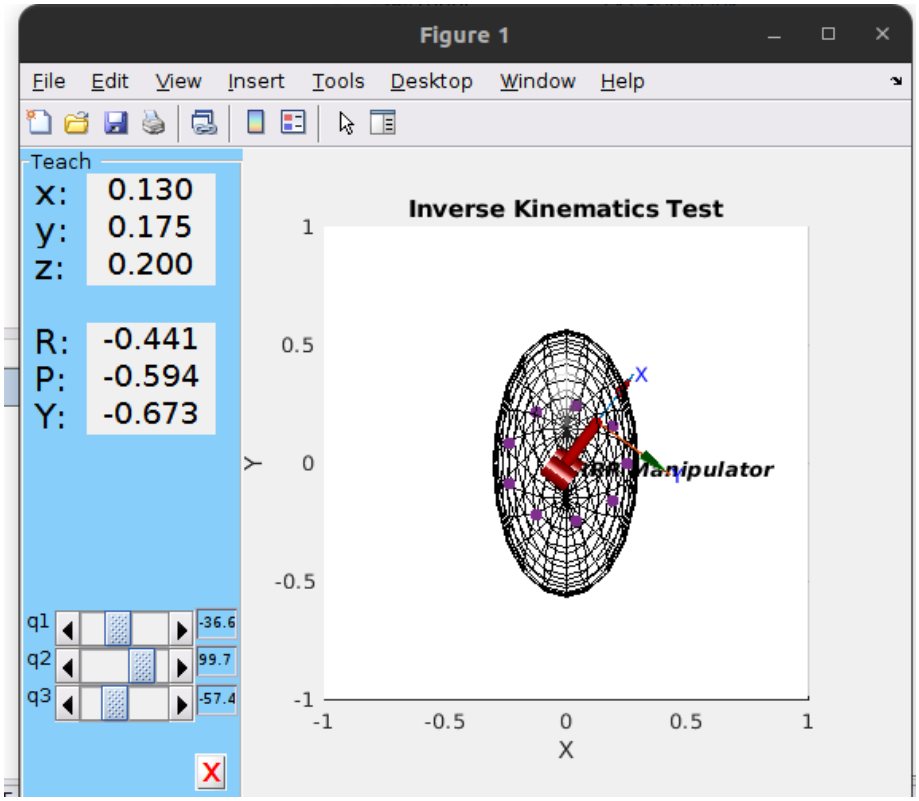
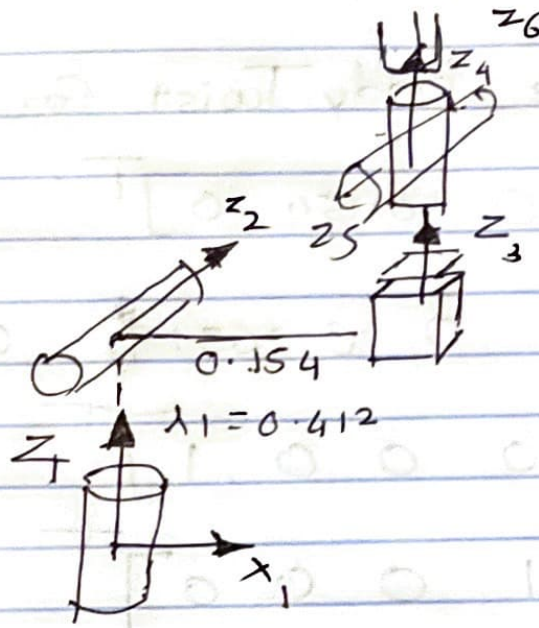


Figure 1
File
Edit
View
Insert
Tools
Desktop
Window
Help
Teach
x: 0.130
y: 0.175
z: 0.200
R: -0.441
P: -0.594
Y: -0.673
q1
q2
q3
-36.6
99.7
-57.4
Inverse Kinematics Test
1
0.5
0
-0.5
-1
-1
-0.5
0
0.5
1
X
Y
X
Manipulator

Problem 1:
Procedure:

1. Initially we calculated all the values necessary for the Jacobian and inverse which are the home configuration and screw axes in both frames that is space and body .
2. In the given problem we assign axes as shown and then calculate the axes S using the axisangle2rot function.
3. Then we calculate the twist using the twist2ht function.
4. We calculate adjoint function.
5. Later we calculate the forward kinematics using the S,M,q values.
6. Then we can calculate analytical,space and body Jacobian, using S,q that we got initially.
7. We use Newton Raphson Method for getting to the target position from the initial position and plot the manipulability ellipsoid for each current position as shown in the figure.

Q2



Let start with calculating Space twist S for each joint.

$$S_i = [w_i, v_i]^T$$

$$S_1 = [0\ 0\ 1\ 0\ 0\ 0]^T$$

$$S_2 = [0\ 1\ 0\ -0.412\ 0\ 0]^T$$

$$S_3 = [0\ 0\ 0\ 0\ 0\ 1]^T$$

$$S_4 = [0\ 0\ 1\ 0.154\ 0\ 0]^T$$

$$S_5 = [1\ 0\ 0\ 0\ 0.412 + q_3^*\ -0.154]^T$$

$$S_6 = [0\ 0\ 1\ 0.154\ 0\ 0]^T.$$

where $w \neq v = -\bar{w} \times$ distance between two frames.

Now let calculate Body Twist for the same.

$B_i = [w_i, v_i]^T$

$$B_1 = [0 \quad 0 \quad 1 \quad 0 \quad -0.154 \quad 0]^T$$

$$B_2 = [-1 \quad 0 \quad 0 \quad 0 \quad -0.263 + q_3^* \quad 0]^T$$

$$B_3 = [0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 1]^T$$

$$B_4 = [0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0]^T$$

$$B_5 = [0 \quad 1 \quad 0 \quad 0.263 \quad 0 \quad 0]^T$$

$$B_6 = [0 \quad 0 \quad 1 \quad 0 \quad 0 \quad 0]^T$$

Now lets calculate the home configuration

$$M = \begin{bmatrix} 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0.154 \\ 0 & 0 & 1 & 0.412 + 0.263 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0.154 \\ 0 & 0 & 1 & 0.675 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Problem 2:

Procedure:

1. Initially we calculated all the values necessary for the Jacobian and inverse which are the home configuration and screw axes in both frames that is space and body .
2. In the given problem we assign axes as shown and then calculate the axes S using the axisangle2rot function.
3. Then we calculate the twist using the twist2ht function.
4. We calculate adjoint function.
5. Later we calculate the forward kinematics using the S,M,q values.
6. Then we can calculate analytical,space and body Jacobian, using S,q that we got initially.