MCE4101
Robotic Engineering

Assignment 3

Due: 7 Sept 2021

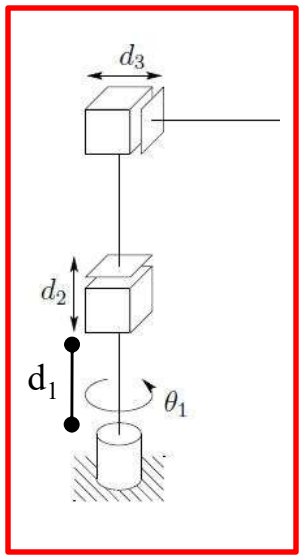
Todsavad T 6114215

Narong Aphiratsakun, D.Eng

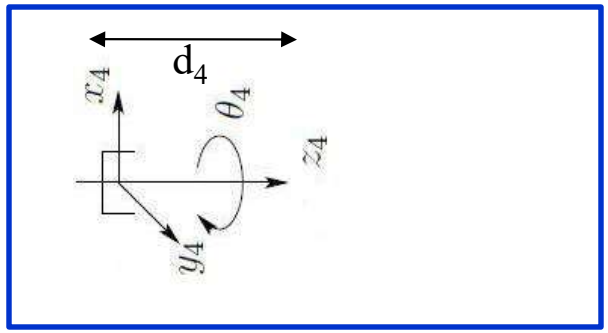
Assumption University

Faculty of Engineering

Assignment 3



RPP



1 DOF Wrist Mechanism

Q1. Obtain DH table for this mechanism with 1 DOF wrist.

Q2. Obtain forward kinematic equations for this mechanism with 1 DOF wrist. Attached your code and answer.

(a)

Links	θ	d	a	α
1	θ_1^*	d_1	0	0
2	0	d_2^*	0	-90°
3	0	d_3^*	0	0
4	θ_4^*	d_4	0	0

(b)

Assignment3Q1.m | Assignment3Q2.m

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%RPP + 1 DOF Wrist Mechanism
syms th1 th4
syms d1 d2 d3 d4
%%RPP
%%L = link([alpha A theta D])
A1 = link([0 0 th1 d1, 0]); %%0 is revolute (and default), 1 is prismatic
A2 = link([-pi/2 0 0 d2, 1]);
A3 = link([0 0 0 d3, 1]);
%%1DOF Wrist Mechanism
A4 = link([0 0 th4 d4, 0]);

RPP1DOF = robot({A1 A2 A3 A4});
RPP1DOFRobotequation = fkine(RPP1DOF,[th1 d2 d3 d4])
Pend = RPP1DOFRobotequation*[0;0;0;1]

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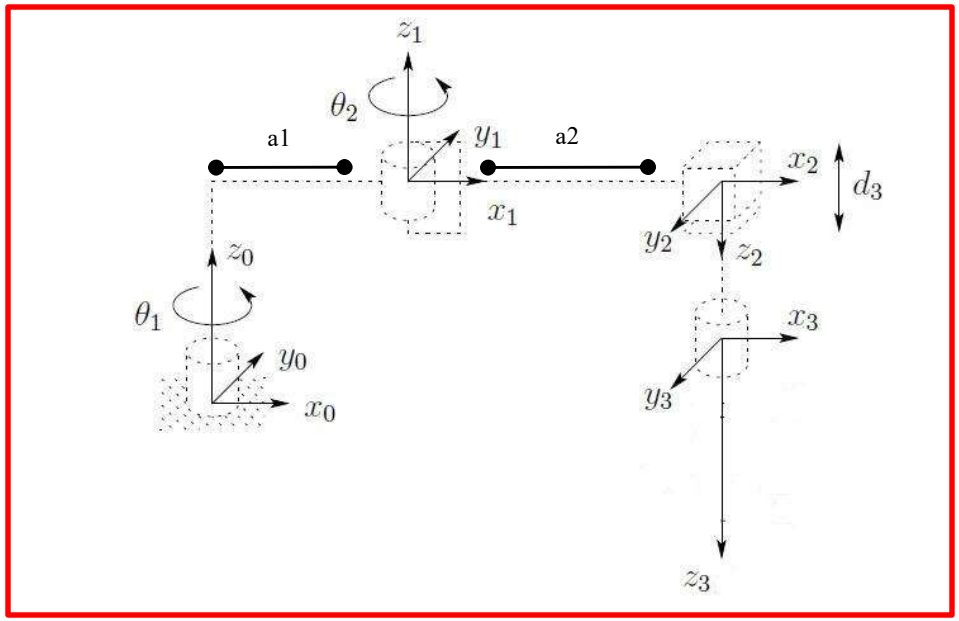
RPP1DOFRobotequation =

[ cos(d4)*cos(th1), -sin(d4)*cos(th1), -sin(th1), - d3*sin(th1) - d4*sin(th1)]
[ cos(d4)*sin(th1), -sin(d4)*sin(th1),  cos(th1),   d3*cos(th1) + d4*cos(th1)]
[          -sin(d4),           -cos(d4),         0,                       d1 + d2]
[                 0,                  0,         0,                            1]


Pend =

 - d3*sin(th1) - d4*sin(th1)
   d3*cos(th1) + d4*cos(th1)
                       d1 + d2
                             1
```

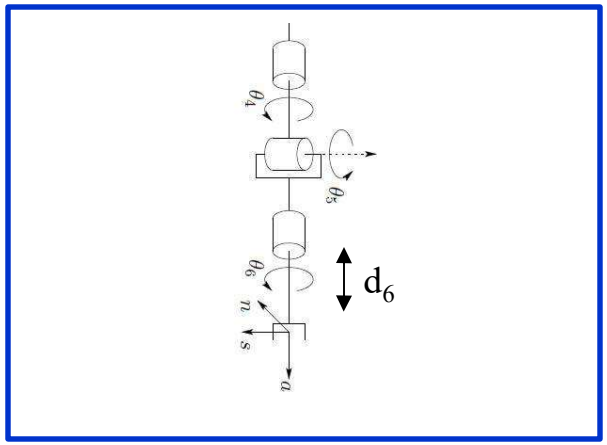
Assignment 3



RRP

Q3. Obtain DH table for this mechanism with 3 DOF wrist. d6 is wrist offset.

Q4. Obtain forward kinematic equations for this mechanism with 3 DOF wrist. Attached your code and answer.



3 DOF Wrist Mechanism

(a)

Links	θ	d	a	α
1	θ_1^*	0	a_1	0
2	θ_2^*	0	a_2	-180°
3	0	d_3^*	0	0
4	θ_4^*	0	0	-180°
5	θ_5^*	0	0	180°
6	θ_6^*	d_6	0	180°

(b)

ment3Q1.m | Assignment3Q2.m | +

```
%RRP + 3 DOF Wrist Mechanism
syms th1 th2 th4 th5 th6
syms d1 d2 d3 d4 d5 d6
syms a1 a2
%%RRP
%%L = link([alpha A theta D])
A1 = link([0 a1 th1 0, 0]); %%0 is revolute (and default), 1 is prismatic
A2 = link([pi a2 th2 0, 0]);
A3 = link([0 0 0 d3, 1]);
%%3DOF Wrist Mechanism
A4 = link([-pi/2 0 th4 0, 0]);
A5 = link([pi/2 0 th5 0, 0]);
A6 = link([0 0 th6 d6, 0]);

RRP3DOF = robot({A1 A2 A3 A4 A5 A6});
RRP3DOFRobotequation = fkine(RRP3DOF ,[th1 th2 d3 th4 th5 th6])
Pend = RRP3DOFRobotequation*[0;0;0;1]
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RPP3DOFRobotequation =

[sin(th6)*(cos(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1)) - sin(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2))) + cos(th5)*cos(th6)*(cos(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2)) + sin(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1))), cos(th6)*(cos(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1)) - sin(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2))) - cos(th5)*sin(th6)*(cos(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2)) + sin(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1))), sin(th5)*(cos(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2)) + sin(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1))), a1*cos(th1) + a2*cos(th1)*cos(th2) - a2*sin(th1)*sin(th2) + d6*sin(th5)*(cos(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2)) + sin(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1)))]

[cos(th5)*cos(th6)*(cos(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1)) - sin(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2))) - sin(th6)*(cos(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2)) + sin(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1))), - cos(th6)*(cos(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2)) + sin(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1))) - cos(th5)*sin(th6)*(cos(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1)) - sin(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2))), sin(th5)*(cos(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1)) - sin(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2))), a1*sin(th1) + a2*cos(th1)*sin(th2) + a2*cos(th2)*sin(th1) + d6*sin(th5)*(cos(th4)*(cos(th1)*sin(th2) + cos(th2)*sin(th1)) - sin(th4)*(cos(th1)*cos(th2) - sin(th1)*sin(th2)))]

[cos(th6)*sin(th5), -sin(th5)*sin(th6), -cos(th5), - d3 - d6*cos(th5)]

[0,0,0,1]