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# Devon Quaternik

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%ELEN337
%HW 3 Problem 3

%DH Parameters
DR=180/pi;
syms the1 the2 the3
l1=4;
l2=3;
l3=2;
a1 = [0 0 0]';
a = [0 l1 l2]';
d = [0 0 0]';
theta = [the1 the2 the3]';

t01=[cos(the1) -sin(the1) 0 0; sin(the1) cos(the1) 0 0; 0 0 1 0; 0 0 0
    1];
t12=[cos(the2) -sin(the2) 0 l1; sin(the2) cos(the2) 0 0; 0 0 1 0; 0 0
    0 1];
t23=[cos(the3) -sin(the3) 0 l2; sin(the3) cos(the3) 0 0; 0 0 1 0; 0 0
    0 1];
t3h=[1 0 0 l3; 0 1 0 0; 0 0 1 0; 0 0 0 1];

t03=t01*t12*t23
t0h=t03*t3h

%part i
thet1=0;
thet2=0;
thet3=0;
t01=[cos(thet1) -sin(thet1) 0 0; sin(thet1) cos(thet1) 0 0; 0 0 1 0; 0
    0 0 1];
t12=[cos(thet2) -sin(thet2) 0 l1; sin(thet2) cos(thet2) 0 0; 0 0 1 0;
    0 0 0 1];
t23=[cos(thet3) -sin(thet3) 0 l2; sin(thet3) cos(thet3) 0 0; 0 0 1 0;
    0 0 0 1];
t3h=[1 0 0 l3; 0 1 0 0; 0 0 1 0; 0 0 0 1];

t03=t01*t12*t23
t0h=t03*t3h

%part ii
thet1=10*DR;
thet2=20*DR;
thet3=30*DR;
t01=[cos(thet1) -sin(thet1) 0 0; sin(thet1) cos(thet1) 0 0; 0 0 1 0; 0
    0 0 1];
t12=[cos(thet2) -sin(thet2) 0 l1; sin(thet2) cos(thet2) 0 0; 0 0 1 0;
    0 0 0 1];
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t23=[cos(thet3) -sin(thet3) 0 12; sin(thet3) cos(thet3) 0 0; 0 0 1 0;
0 0 0 1];
t3h=[1 0 0 13; 0 1 0 0; 0 0 1 0; 0 0 0 1];

t03=t01*t12*t23
t0h=t03*t3h

%part iii
thet1=90*DR;
thet2=90*DR;
thet3=90*DR;
t01=[cos(thet1) -sin(thet1) 0 0; sin(thet1) cos(thet1) 0 0; 0 0 1 0; 0
0 0 1];
t12=[cos(thet2) -sin(thet2) 0 11; sin(thet2) cos(thet2) 0 0; 0 0 1 0;
0 0 0 1];
t23=[cos(thet3) -sin(thet3) 0 12; sin(thet3) cos(thet3) 0 0; 0 0 1 0;
0 0 0 1];
t3h=[1 0 0 13; 0 1 0 0; 0 0 1 0; 0 0 0 1];

t03=t01*t12*t23
t0h=t03*t3h

t03 =

[ cos(the3)*(cos(the1)*cos(the2) - sin(the1)*sin(the2)) -
sin(the3)*(cos(the1)*sin(the2) + cos(the2)*sin(the1)), -
cos(the3)*(cos(the1)*sin(the2) + cos(the2)*sin(the1)) -
sin(the3)*(cos(the1)*cos(the2) - sin(the1)*sin(the2)), 0, 4*cos(the1)
+ 3*cos(the1)*cos(the2) - 3*sin(the1)*sin(the2)]
[ cos(the3)*(cos(the1)*sin(the2) + cos(the2)*sin(the1)) +
sin(the3)*(cos(the1)*cos(the2) - sin(the1)*sin(the2)),
cos(the3)*(cos(the1)*cos(the2) - sin(the1)*sin(the2)) -
sin(the3)*(cos(the1)*sin(the2) + cos(the2)*sin(the1)), 0, 4*sin(the1)
+ 3*cos(the1)*sin(the2) + 3*cos(the2)*sin(the1)]
[
0,
0, 1,
0]
[
0,
0, 0,
1]

t0h =

[ cos(the3)*(cos(the1)*cos(the2) - sin(the1)*sin(the2)) -
sin(the3)*(cos(the1)*sin(the2) + cos(the2)*sin(the1)), -
cos(the3)*(cos(the1)*sin(the2) + cos(the2)*sin(the1)) -
sin(the3)*(cos(the1)*cos(the2) - sin(the1)*sin(the2)), 0,
4*cos(the1) + 3*cos(the1)*cos(the2) - 3*sin(the1)*sin(the2)]

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+ 2*cos(the3)*(cos(the1)*cos(the2) - sin(the1)*sin(the2)) -
2*sin(the3)*(cos(the1)*sin(the2) + cos(the2)*sin(the1))]
[ cos(the3)*(cos(the1)*sin(the2) + cos(the2)*sin(the1)) +
sin(the3)*(cos(the1)*cos(the2) - sin(the1)*sin(the2)),
cos(the3)*(cos(the1)*cos(the2) - sin(the1)*sin(the2)) -
sin(the3)*(cos(the1)*sin(the2) + cos(the2)*sin(the1)), 0,
4*sin(the1) + 3*cos(the1)*sin(the2) + 3*cos(the2)*sin(the1)
+ 2*cos(the3)*(cos(the1)*sin(the2) + cos(the2)*sin(the1)) +
2*sin(the3)*(cos(the1)*cos(the2) - sin(the1)*sin(the2))]
[
0,

0, 1,

0]

[
0,

0, 0,

1]

```

t03 =

```

1      0      0      7
0      1      0      0
0      0      1      0
0      0      0      1

```

t0h =

```

1      0      0      9
0      1      0      0
0      0      1      0
0      0      0      1

```

t03 =

```

0.6642  -0.7476      0  -1.2422
0.7476   0.6642      0   2.4811
0         0      1.0000      0
0         0         0      1.0000

```

t0h =

```

0.6642  -0.7476      0   0.0861
0.7476   0.6642      0   3.9762
0         0      1.0000      0
0         0         0      1.0000

```

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```
t03 =

    0.7911    -0.6117         0    -3.6598
    0.6117     0.7911         0    -2.1018
         0         0     1.0000         0
         0         0         0     1.0000
```

```
t0h =

    0.7911    -0.6117         0    -2.0777
    0.6117     0.7911         0    -0.8783
         0         0     1.0000         0
         0         0         0     1.0000
```

## Check with the robotics toolbox

```
%initialize links with 0 params for thetas
link1 = link([0, d(1), a(1),al(1),0,0], 'mod')
link2 = link([0, d(2), a(2),al(2),0,0], 'mod')
link3 = link([0, d(3), a(3),al(3),0,0], 'mod')

%create robot
rrr=robot({link1, link2, link3}, 'Plan3R');

%create poses
pose1=[0 0 0]*DR
pose2=[10 20 30]*DR;
pose3=[90 90 90]*DR;

%find transformation matrices for given pose
t031 = fkine(rrr,pose1);
t032 = fkine(rrr,pose2);
t033 = fkine(rrr,pose3);

%Th0 matrices
t0h1 = t031*th3
t0h2 = t032*th3
t0h3 = t033*th3

%link function does not seem to accept any data type I can figure out.
Constantly gives errors even when typecasting. I am not able to find
good documentation on this function and cannot seem to get it to work

Undefined function 'link' for input arguments of type 'double'.

Error in matlabexercise3 (line 64)
link1 = link([0, d(1), a(1),al(1),0,0], 'mod')
```

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