Kinematics and Dynamics of Mechatronic Systems

Table of Contents

3rd laboratory task

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Determine a Homogeneous Transformation matrix

```
clear all; clc

% declaration of symbols
syms th1 d1 th2 a3 th4 d5 q1 q2 q3
% Determination of a symbolic form of HT matrices – application of mA function
A1=mA(th1,d1,0,sym(pi/2));
A2=mA(th2,0,0,0);
A3=mA(0,0,a3,0);
A4=mA(th4,0,0,sym(pi/2));
A5=mA(sym(pi/2),d5,0,0);
```

multiplication of matrices to obtain the position of the links

```
T01=A1;
T05=A1*A2*A3*A4*A5;
```

Determining the constants and random values of joint coordinates in the ranges

input constants

```
d1_input = 0.4;
d5_input = 0.15;
% Random selection of the values of joint coordinates
th1_input = pi/2-pi*rand;
th2_input = pi/4-(pi/2)*rand;
```

```
a3_input=0.6-rand*0.4;
th4_input = pi/2-(pi)*rand;
```

Subtitute random generated ranges into the matrices

```
T01_real=subs(T01,{th1,d1},{th1_input,d1_input});
T05_real=subs(T05,{th1,d1,th2,a3,th4,d5},{th1_input,d1_input, th2_input, a3_input,
% Calculation of orientation of the 3rd link in relation to the 4th link
%
P_real = [T05_real(1,4); T05_real(2,4); T05_real(3,4)];
Pw = [T05_real(1,3);T05_real(2,3);T05_real(3,3)]*d5_input;
```

Defining origin and constant position of the 1st link

```
origin = [0 0 0];
joint1 = [T01(1,4) T01(2,4) T01(3,4)];
% Position of joint1 remains constant as it's only dependent from d1 constant vari
% joint2 position cannot be distinguished as it wouldn't be visible in the
% workspace visualization
```

Draw the workspace

```
x=[0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18];
y=[0.95 0.97 0.99 1.01 1.03 1.05 1.07 1.09 1.11 1.13];
z=[0.75 0.77 0.79 0.81 0.83 0.85 0.87 0.89 0.91 0.93];
path=[x; y; z];
figure(1);
plot3(x,y,z,'--r')
for i=1:10
    joint4=path(:,i)'
    joint3=joint4-Pw'
    joint1=[T01_real(1,4) T01_real(2,4) T01_real(3,4)]
    pts34=[joint4; joint3];
    pts13=[joint3; joint1];
    pts01=[joint1; origin];
    line(pts34(:,1), pts34(:,2),pts34(:,3));
    line(pts13(:,1), pts13(:,2),pts13(:,3));
    line(pts01(:,1), pts01(:,2),pts01(:,3));
end
```

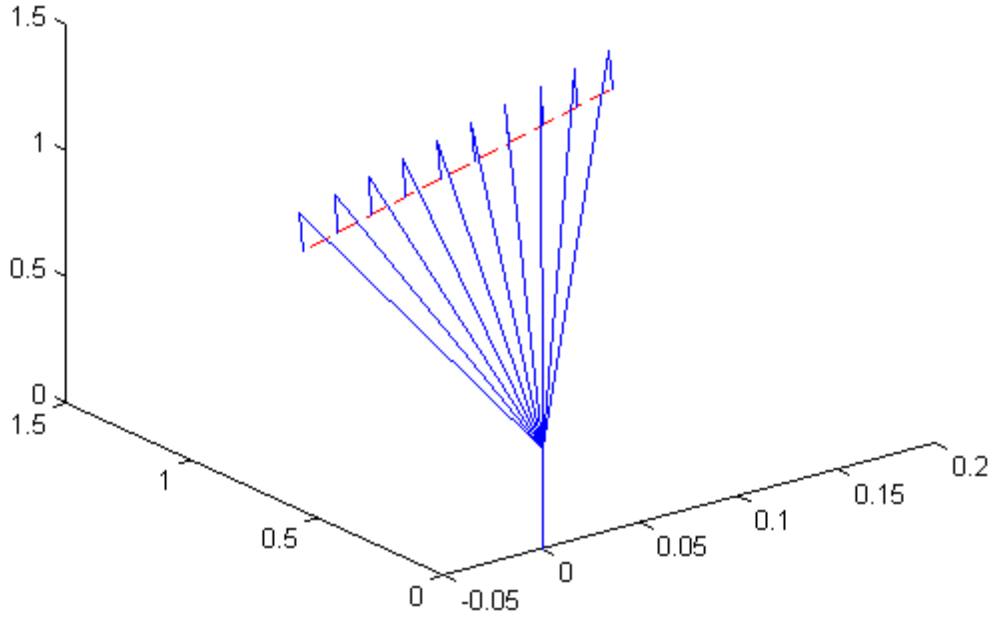
```
joint4 =

         0         0.95         0.75
```

```
joint3 =
```

```
         -0.00         0.95         0.90

joint1 =

            0            0         0.40

joint4 =

         0.02         0.97         0.77

joint3 =

         0.02         0.97         0.92

joint1 =

            0            0         0.40

joint4 =

         0.04         0.99         0.79

joint3 =

         0.04         0.99         0.94

joint1 =

            0            0         0.40

joint4 =

         0.06         1.01         0.81

joint3 =

         0.06         1.01         0.96

joint1 =

            0            0         0.40

joint4 =
```

```
    0.08    1.03    0.83

joint3 =

    0.08    1.03    0.98

joint1 =

     0       0      0.40

joint4 =

    0.10    1.05    0.85

joint3 =

    0.10    1.05    1.00

joint1 =

     0       0      0.40

joint4 =

    0.12    1.07    0.87

joint3 =

    0.12    1.07    1.02

joint1 =

     0       0      0.40

joint4 =

    0.14    1.09    0.89

joint3 =

    0.14    1.09    1.04
```

```
joint1 =

     0     0     0.40

joint4 =

    0.16    1.11    0.91

joint3 =

    0.16    1.11    1.06

joint1 =

     0     0     0.40

joint4 =

    0.18    1.13    0.93

joint3 =

    0.18    1.13    1.08

joint1 =

     0     0     0.40
```



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