ME766

Robot Motion Planning

Assignment 2

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Part A:-

MATLAB code :-

```matlab
clc;
clear;
tht_1=input("theta 1:");
tht_2=input("theta 2:");
tht_3=input("theta 3:");
l1 =1;
l2=1;
tht1=linspace(0,tht_1,10);
tht2=linspace(0,tht_2,10);
tht3=linspace(0,tht_3,10);


tht=[tht1; tht2; tht3]


for i= 1:length(tht1)
DH=[0 0 0 tht(1,i);
    l1 0 0 tht(2,i);
    l2 0 0 tht(3,i)]


a=DH(:,1);
alp=DH(:,2);
```

```matlab
d=DH(:,3);


T2=1;
T3=1;


for j=1:3
T=[  cosd(tht(j,i))                  -sind(tht(j,i))                    0
a(j);
    sind(tht(j,i))*cosd(alp(j))  cosd(tht(j,i))*cosd(alp(j)) -sind(alp(j))  -
sind(alp(j))*d(j);
    sind(tht(j,i))*sind(alp(j))  cosd(tht(j,i))*sind(alp(j))  cosd(alp(j))
cosd(alp(j))*d(j);
            0                                0                      0
1         ];


if(j<3)
    T2=T2*T;
end
    if(j<4)
        T3=T3*T;
    end


    end


x1=T2(1,4);
y1=T2(2,4);


x2=T3(1,4);
y2=T3(2,4);


x=[0 x1 x2];
y=[0 y1 y2];


figure(1);
hold on


plot(x,y,"-ro","LineWidth",0.5);
xlabel("X-coordinate(m)");
ylabel("Y-coordinate(m)");
grid on;
axis( [-2 2 -2 2]);
hold off
end
```
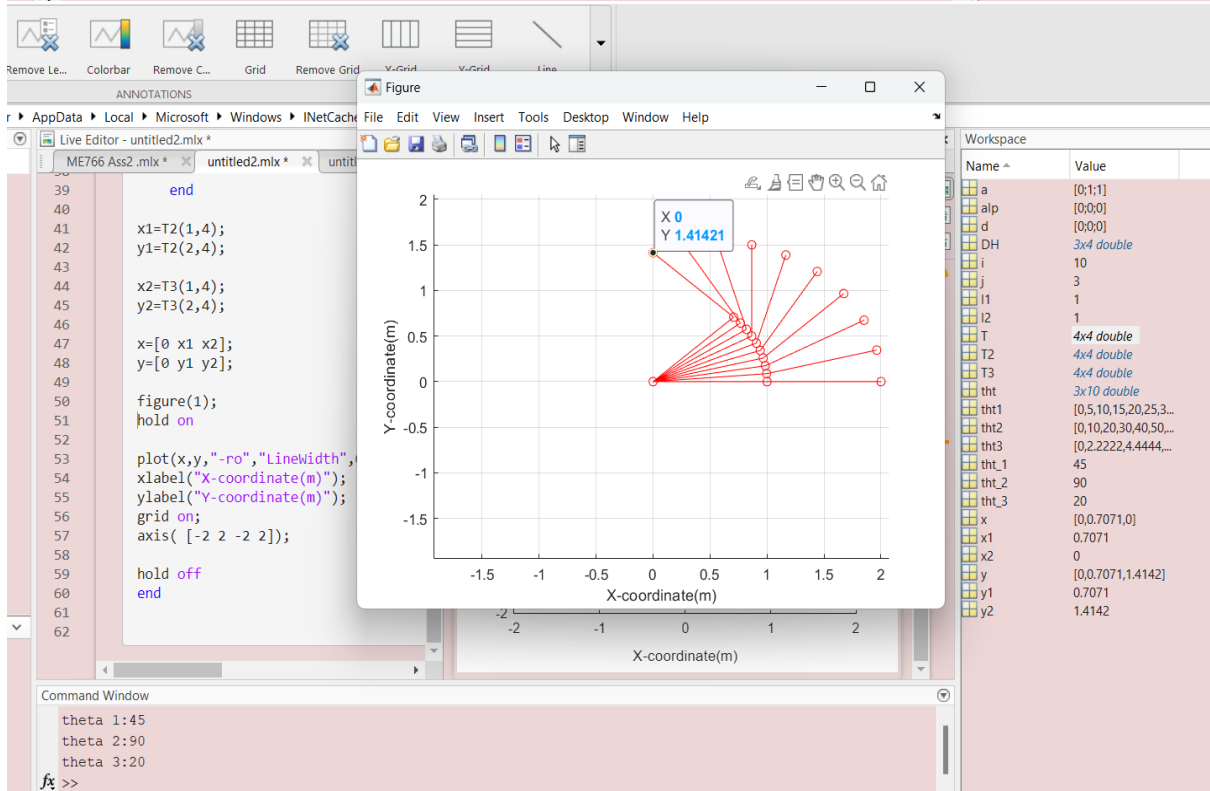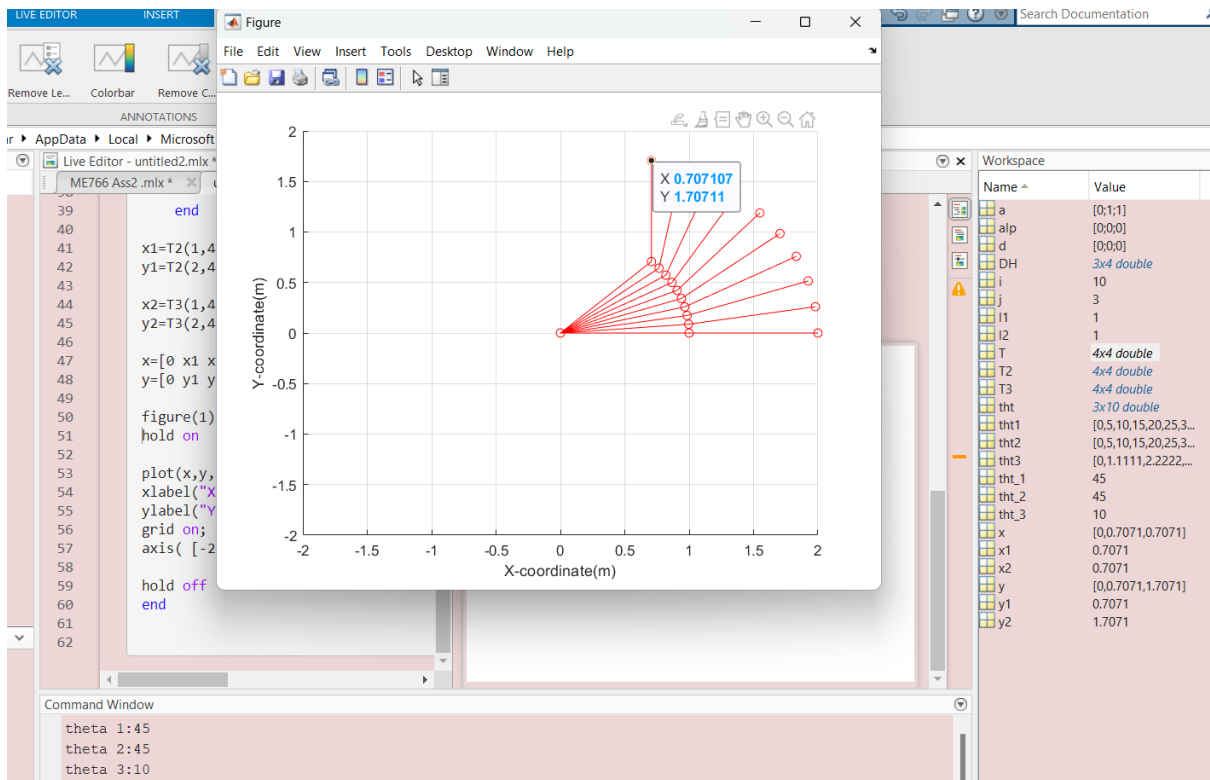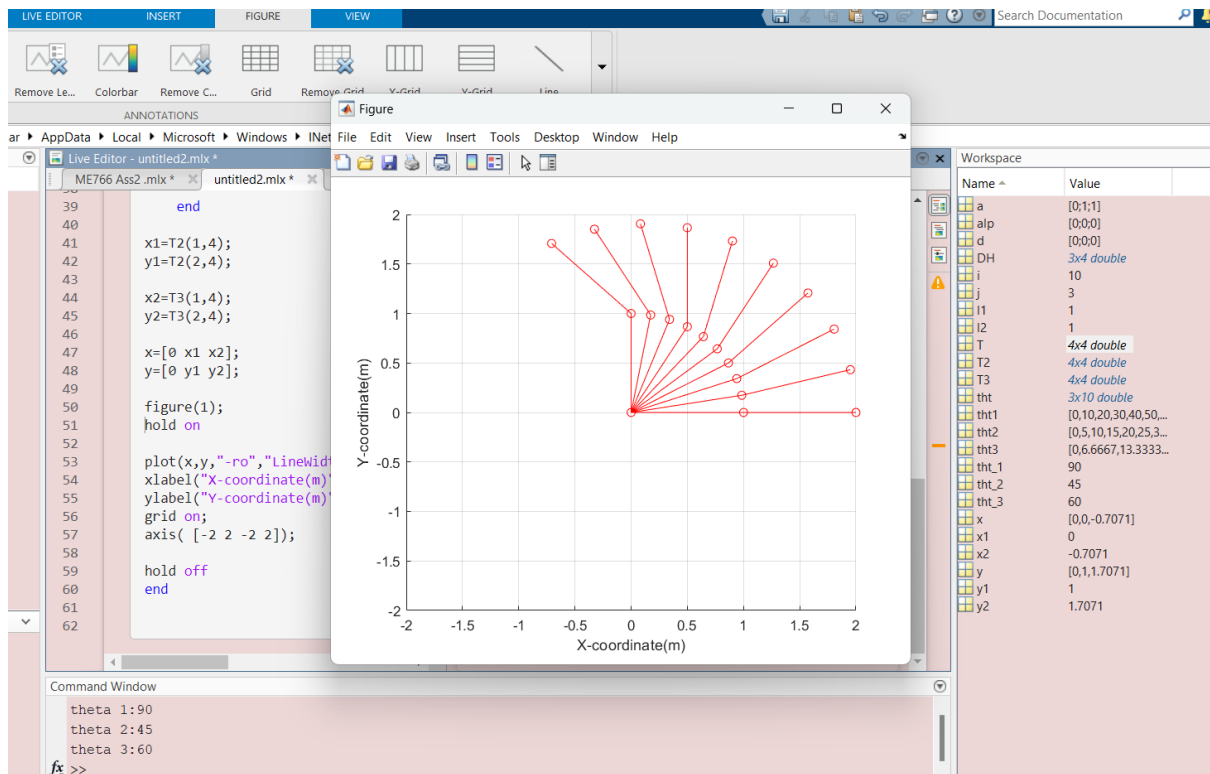
AppData ▸ Local ▸ Microsoft

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```
39            end
40
41    x1=T2(1,4
42    y1=T2(2,4
43
44    x2=T3(1,4
45    y2=T3(2,4
46
47    x=[0 x1 x
48    y=[0 y1 y
49
50    figure(1)
51    hold on
52
53    plot(x,y,
54    xlabel("X
55    ylabel("Y
56    grid on;
57    axis( [-2
58
59    hold off
60    end
61
62
```

X 0.707107
Y 1.70711

Y-coordinate(m)

X-coordinate(m)

Command Window
```
theta 1:45
theta 2:45
theta 3:10
```

Workspace

Name ▲	Value
a	[0;1;1]
alp	[0;0;0]
d	[0;0;0]
DH	3x4 double
i	10
j	3
l1	1
l2	1
T	4x4 double
T2	4x4 double
T3	4x4 double
tht	3x10 double
tht1	[0,5,10,15,20,25,3...
tht2	[0,5,10,15,20,25,3...
tht3	[0,1.1111,2.2222,...
tht_1	45
tht_2	45
tht_3	10
x	[0,0.7071,0.7071]
x1	0.7071
x2	0.7071
y	[0,0.7071,1.7071]
y1	0.7071
y2	1.7071

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```
39            end
40
41    x1=T2(1,4);
42    y1=T2(2,4);
43
44    x2=T3(1,4);
45    y2=T3(2,4);
46
47    x=[0 x1 x2];
48    y=[0 y1 y2];
49
50    figure(1);
51    hold on
52
53    plot(x,y,"-ro","LineWidth",
54    xlabel("X-coordinate(m)");
55    ylabel("Y-coordinate(m)");
56    grid on;
57    axis( [-2 2 -2 2]);
58
59    hold off
60    end
61
62
```

X 0
Y 1.41421

Y-coordinate(m)

X-coordinate(m)

Command Window
```
theta 1:45
theta 2:90
theta 3:20
fx >>
```

Workspace

Name ▲	Value
a	[0;1;1]
alp	[0;0;0]
d	[0;0;0]
DH	3x4 double
i	10
j	3
l1	1
l2	1
T	4x4 double
T2	4x4 double
T3	4x4 double
tht	3x10 double
tht1	[0,5,10,15,20,25,3...
tht2	[0,10,20,30,40,50,...
tht3	[0,2.2222,4.4444,...
tht_1	45
tht_2	90
tht_3	20
x	[0,0.7071,0]
x1	0.7071
x2	0
y	[0,0.7071,1.4142]
y1	0.7071
y2	1.4142

NOTE:-Inputs are in the respective image

Part B:-

MATLAB code :-

```
clc;
clear;
%link dimesions;
l1=15;
l2=10;
l1_dimension=[0,1;0,-1;15,-1;15,1];
l2_dimension=[0,1;0,-1;10,-1;10,1];

hold on;
figure(1);
axis([-50 50 -50 50]);
daspect([1 1 1]);
l1_arm=fill(l1_dimension(:,1),l1_dimension(:,2),[0.4940 0.1840 0.5560]);
```

```matlab
l2_arm=fill(l2_dimension(:,1),l2_dimension(:,2),[0.6350 0.0780 0.1840]);


%obstacles

%circle
x_pos=25;
y_pos=-20;
r=10;
t=linspace(1,360,360);

x_component=x_pos+ r*cosd(t);
y_component=y_pos+ r*sind(t);


% rectangle
rectangle= [-10 10;-10 30;-40 30;-40 10];

% triangle
triangle = [-10 -30;-30 -30;-15 -15];

obs1= polyshape(x_component,y_component);
obs2=polyshape(rectangle(:,1),rectangle(:,2));
obs3=polyshape(triangle(:,1),triangle(:,2));
% coloring the Obstacles
fill(x_component,y_component,'r');
fill(rectangle(:,1),rectangle(:,2),'m')
fill(triangle(:,1),triangle(:,2),'g');
hold off;

%you can set resoulution of C-Space,
resolution1=10;
resolution2=10;

for tht1=0:resolution1:360
for tht2=0:resolution2:360
 x1=l1*cosd(tht1);
 y1=l1*sind(tht1);

 x2=x1+cosd(tht1+tht2);
 y2=y1+sind(tht1+tht2);

rotated_arm1=l1_dimension*[cosd(tht1) sind(tht1);-sind(tht1) cosd(tht1)];

rotated_arm2=l2_dimension*[cosd(tht1+tht2) sind(tht1+tht2);-sind(tht1+tht2)...
cosd(tht1+tht2)];

set(l1_arm,'xdata',rotated_arm1(:,1),'ydata',rotated_arm1(:,2));
set(l2_arm,'xdata',x2+rotated_arm2(:,1),'ydata',y2+rotated_arm2(:,2));

arm1=polyshape(rotated_arm1(:,1),rotated_arm1(:,2));
```

```matlab
arm2=polyshape(x2+rotated_arm2(:,1),y2+rotated_arm2(:,2));

% check if arm hits any obstacle

hold on
figure(6);
xlabel('theta1')
ylabel('theta2')
title('C-Space');
if(overlaps(arm1,obs1)||overlaps(arm2,obs1))
plot(tht1,tht2,'ro');
elseif(overlaps(arm1,obs2)||overlaps(arm2,obs2))
    plot(tht1,tht2,'mo');
elseif(overlaps(arm1,obs3)||overlaps(arm2,obs3))
    plot(tht1,tht2,'go');
else
    plot(tht1,tht2,'yo');
end
axis([0 360 0 360]);
pause(0.00001);
end
end
```

C-Space:-
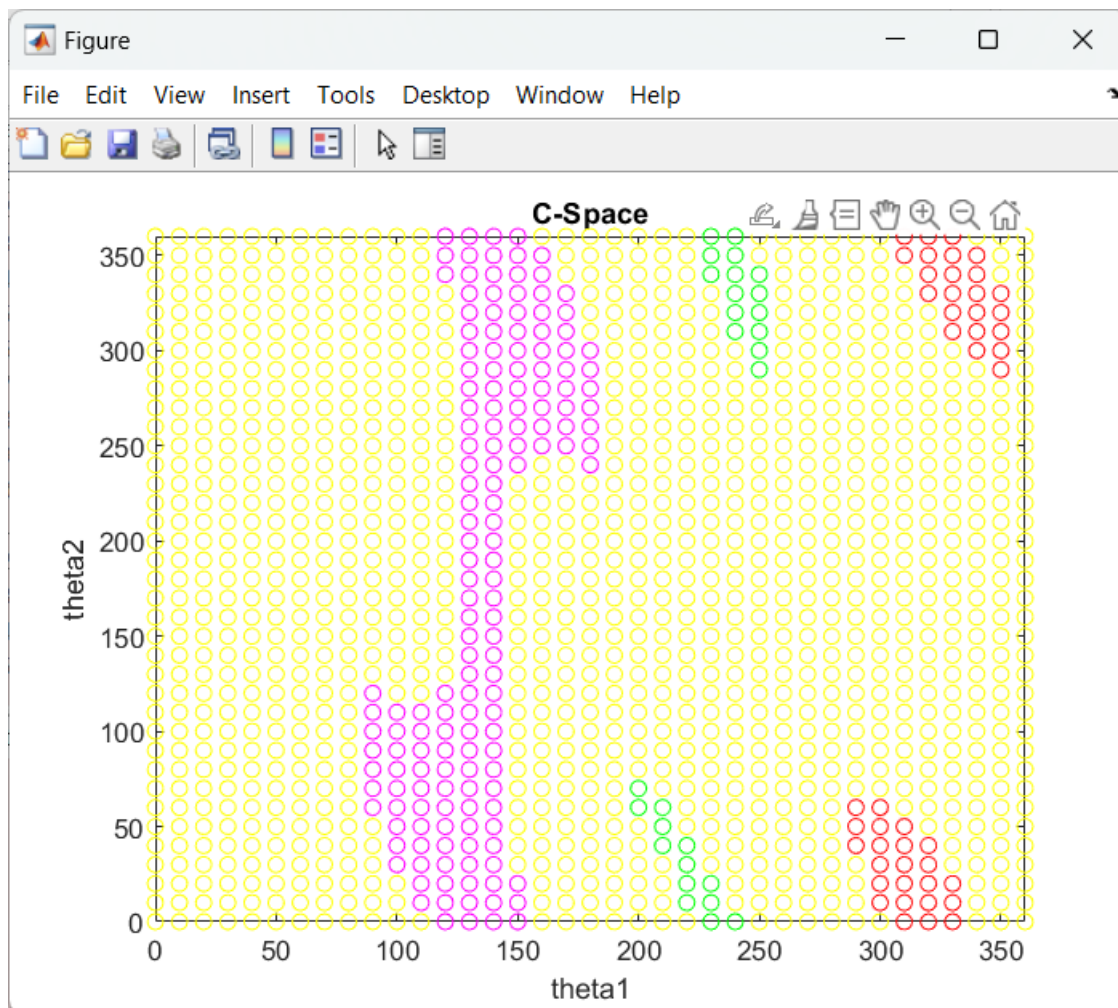
Snapshot of Robot arm at some position:-