Robot Arm

K-mean Algorithm

```
function Y=my_kmeans(X,M)
    mx=mean(X);
    Y=rand(M,2)*0.1-0.05+ones(M,1)*mx;
    change =1; loop=0;
    while change > 10.^-6
        D = cross_distance(X,Y);
        [xx ind]=min(D');
        for i=1:M
            ind2=find(ind == i);
            Y_new(i,:) = mean(X( ind2,:));
        end
        change = sum(sum(abs(Y-Y_new)));
        Y=Y_new;
        loop = loop+1;
        fprintf('loop: %d change : %f\n',loop,change);
    end
    return
```

Cross_Distance

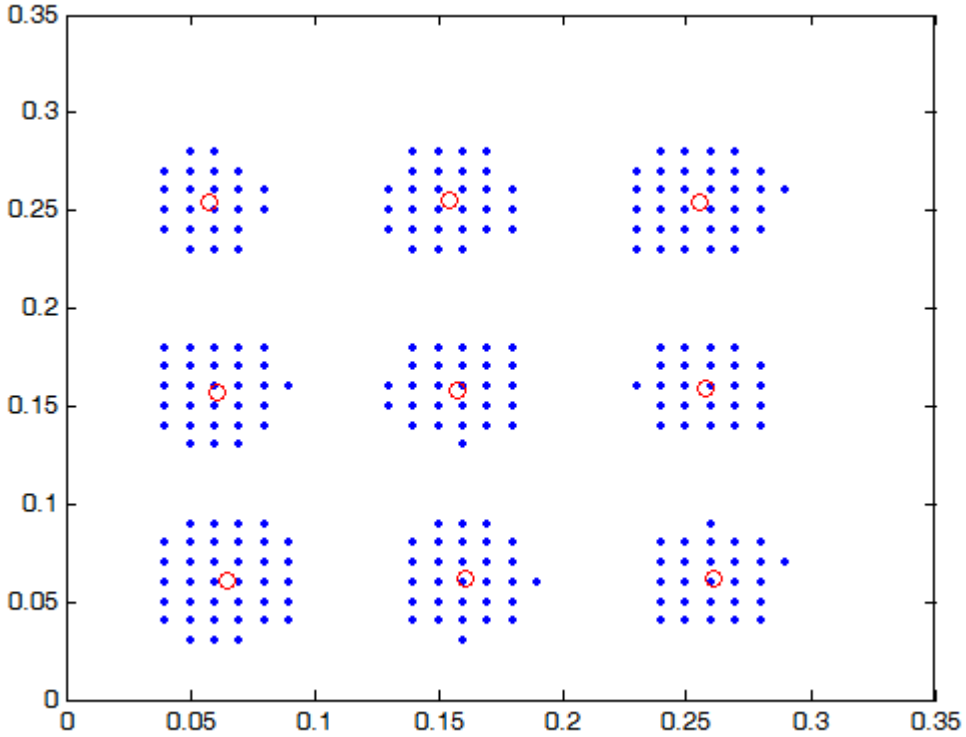
```
function D=cross_distance(X,Y)
M=size(Y,1);N=size(X,1);
A=sum(X.^2,2)*ones(1,M);
C=ones(N,1)*sum(Y.^2,2)';
B=X*Y';
D=sqrt(A-2*B+C);
```

Example

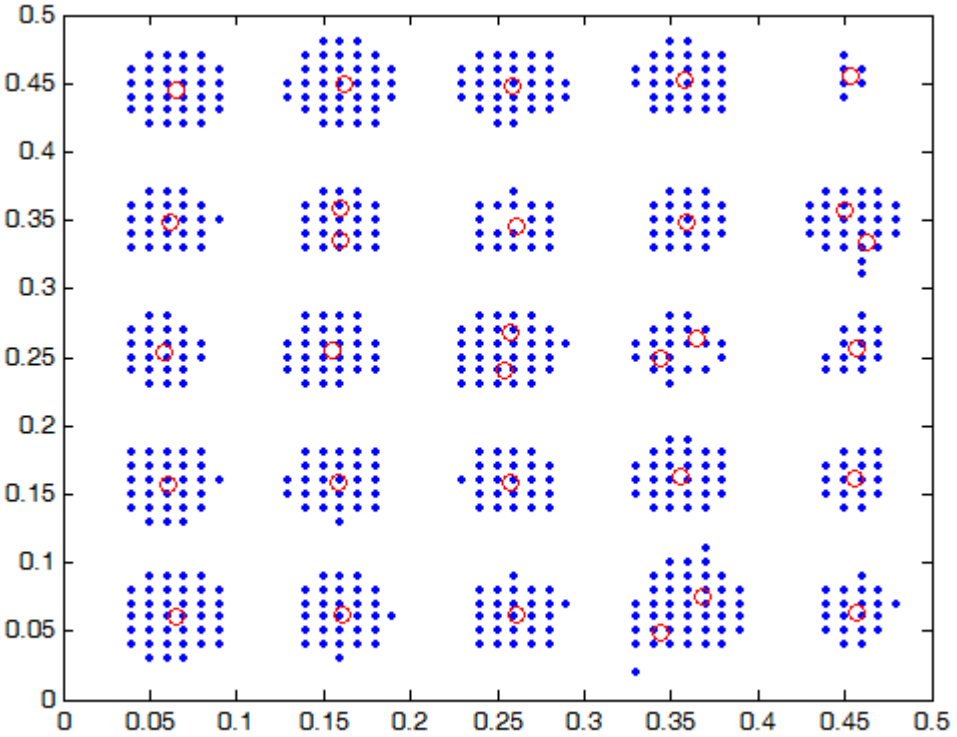
my_kmeans.m

data.zip

```
close all
load data_9.mat
plot(XX(:,1 ),XX(:,2 ), '. ');
s1=cputime;
y=my_kmeans(XX,9);
s2=cputime;
hold on
plot(y(:,1 ),y(:,2 ), 'ro');
s2-s1
```

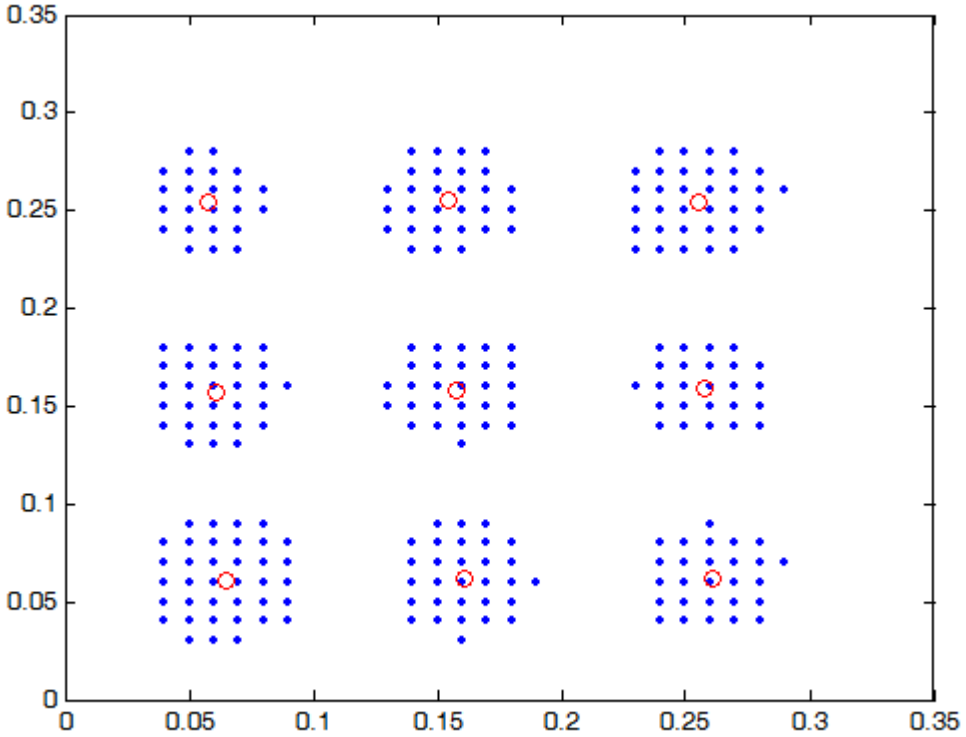

0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35

```
close all
load data_25.mat
plot(XX(:,1 ),XX(:,2 ), '. ');
s1=cputime;
y=my_kmeans(XX,30);
s2=cputime;
hold on
plot(y(:,1 ),y(:,2 ), 'ro');
s2-s1
```


0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5

Example

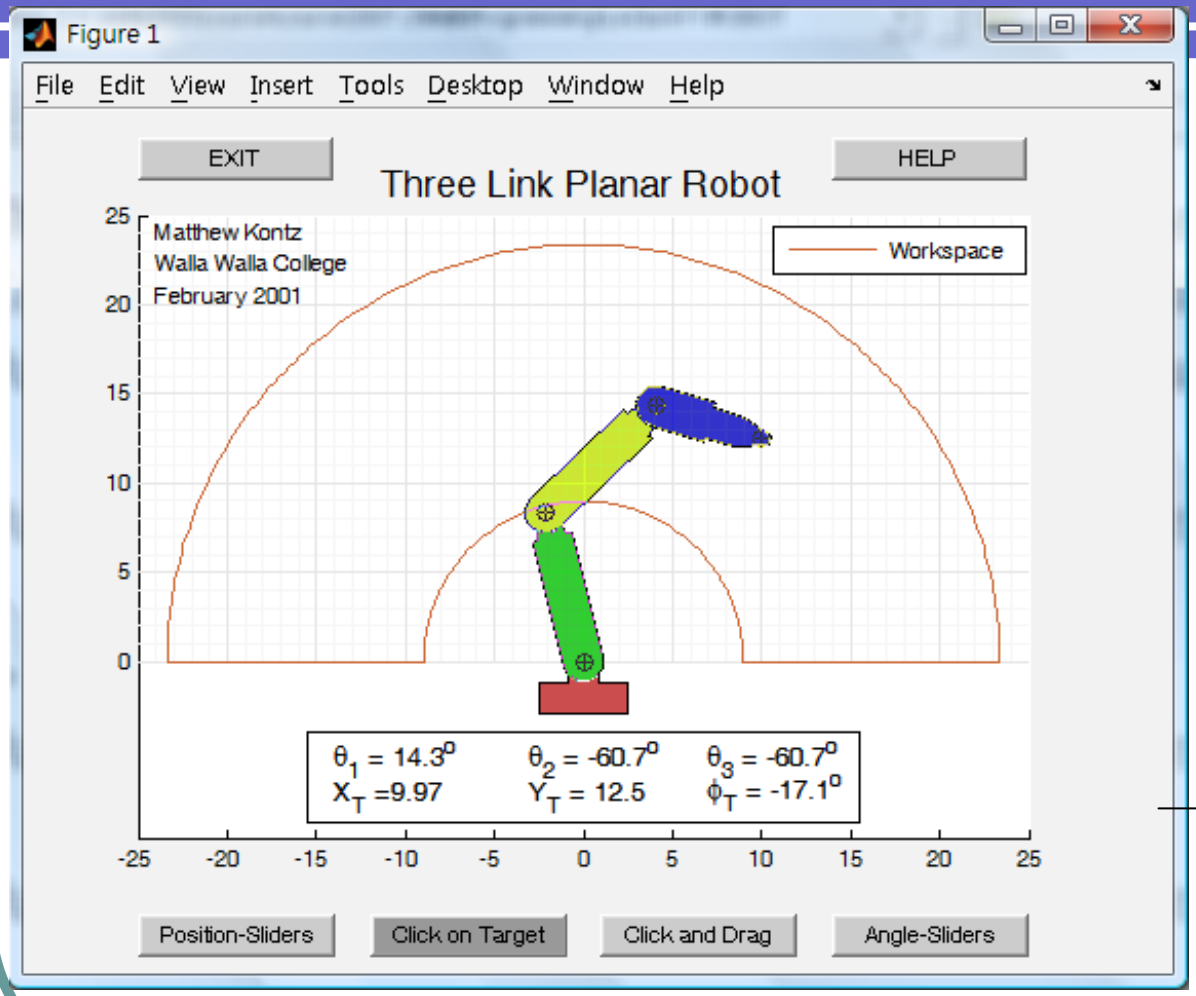
```
load data_9.mat
plot(XX(:,1 ),XX(:,2 ), '. ');
s1=cputime;
[ind,y]=kmeans(XX,9);
s2=cputime;
hold on
plot(y(:,1 ),y(:,2 ), 'ro');
s2-s1
```

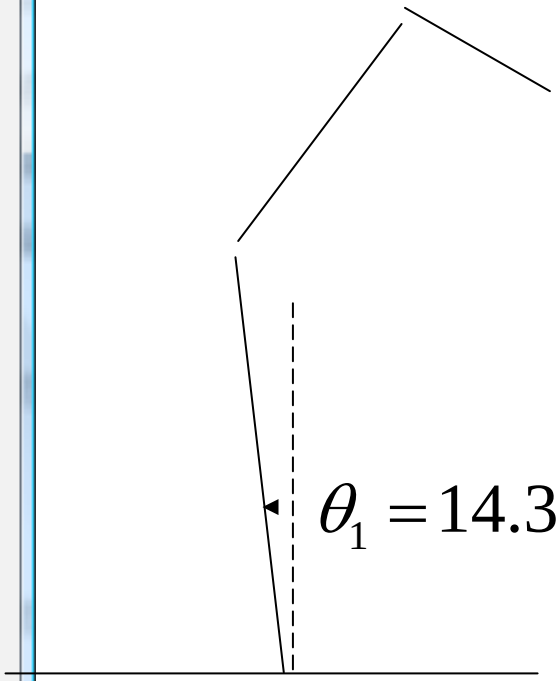

0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35

Example

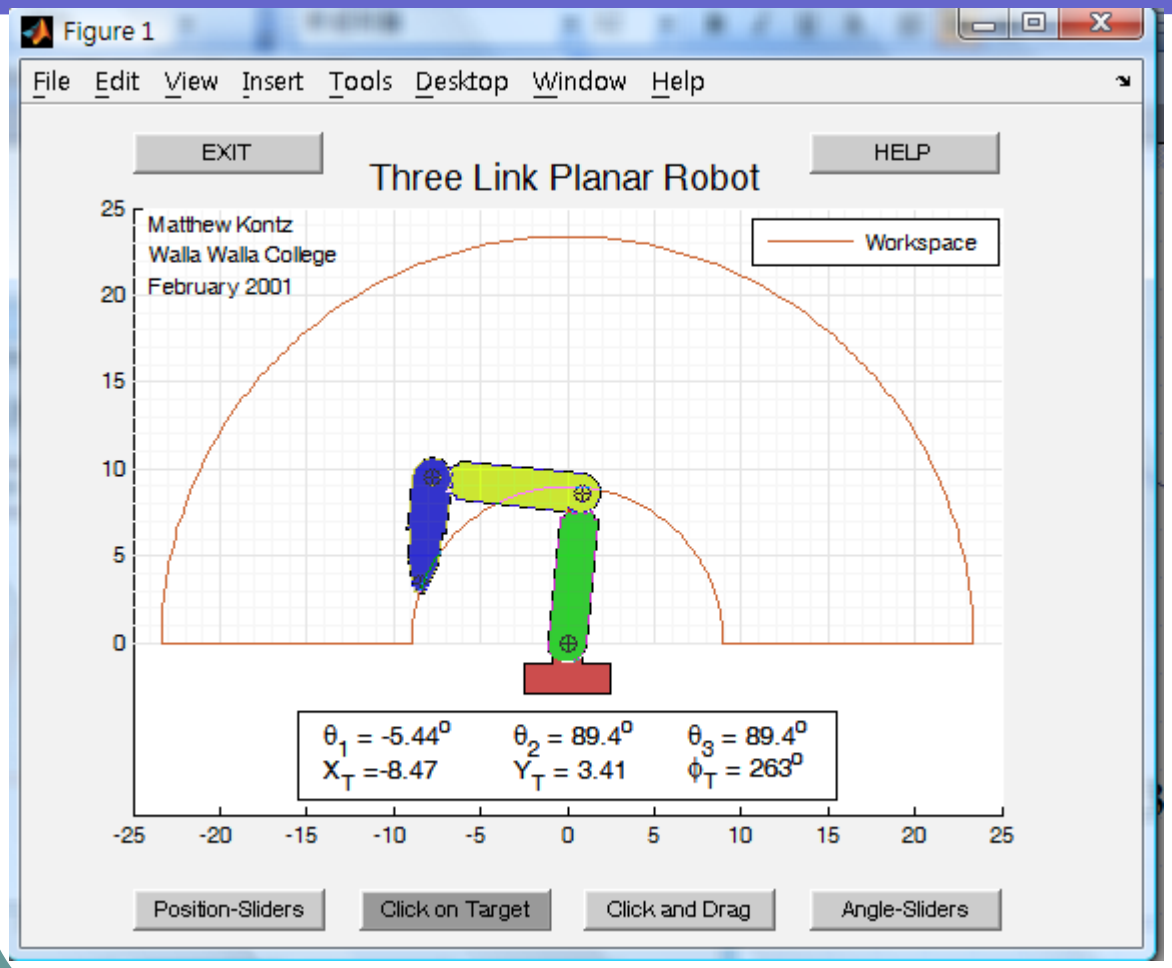
```
load data_25.mat
plot(XX(:,1 ),XX(:,2 ), '. ');
s1=cputime;
[ind,y]=kmeans(XX,25);
s2=cputime;
hold on
plot(y(:,1 ),y(:,2 ), 'ro');
s2-s1
```

http://www.mathworks.com/matlabcentral/fileexchange/loadFile.do?objectId=157&ojectType=File

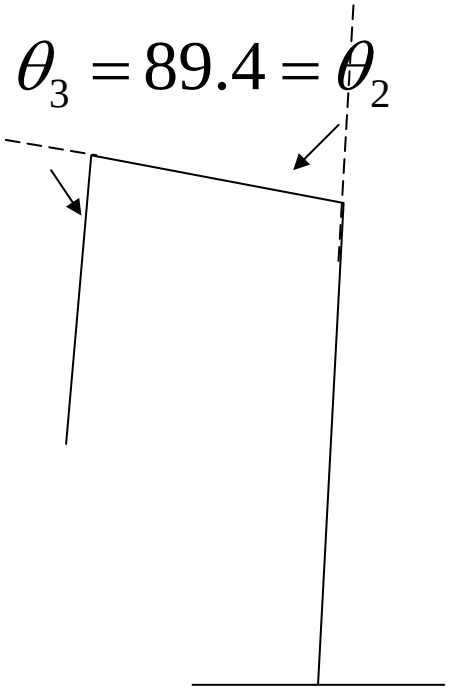




MATLAB Central - File detail - Robot Demo



$$\theta_3 = 89.4 = \theta_2$$



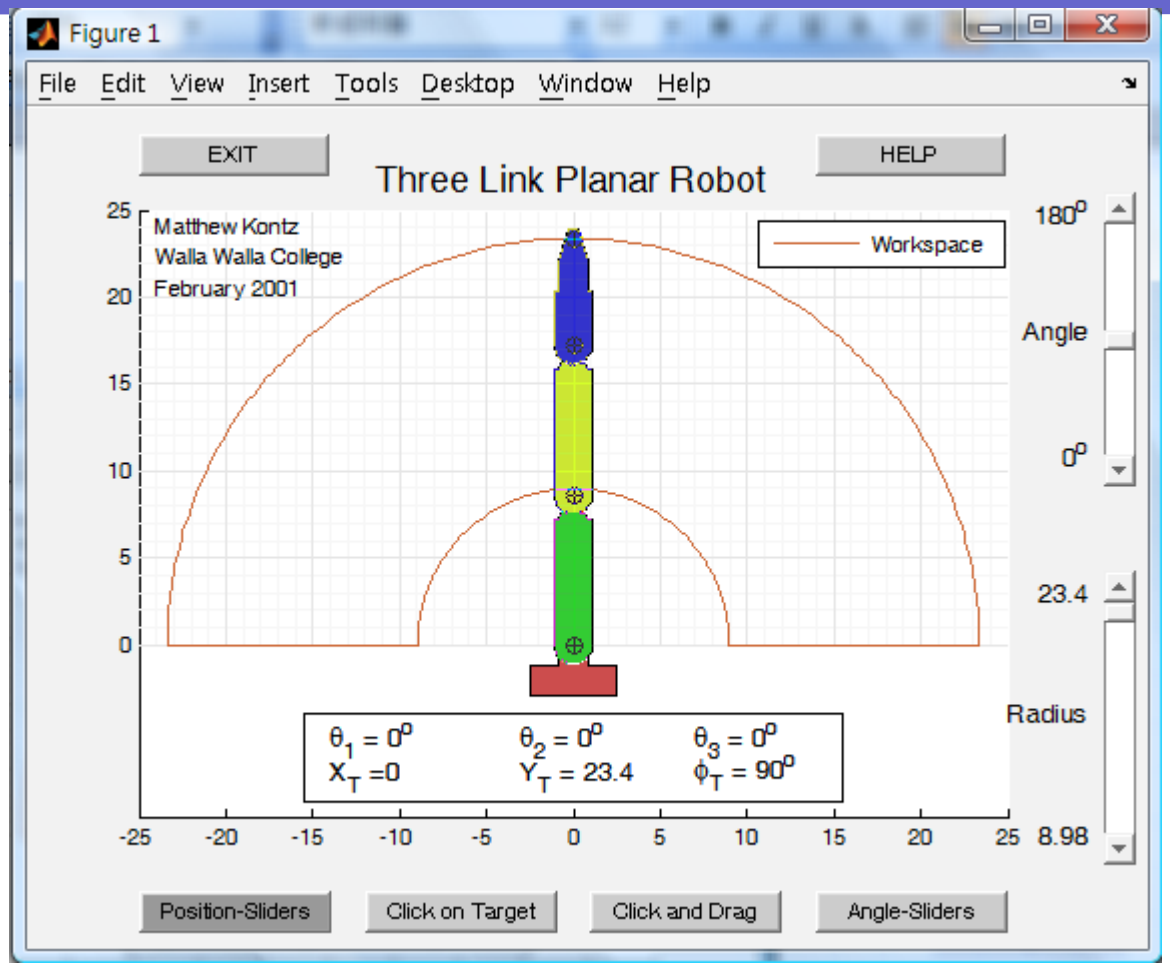
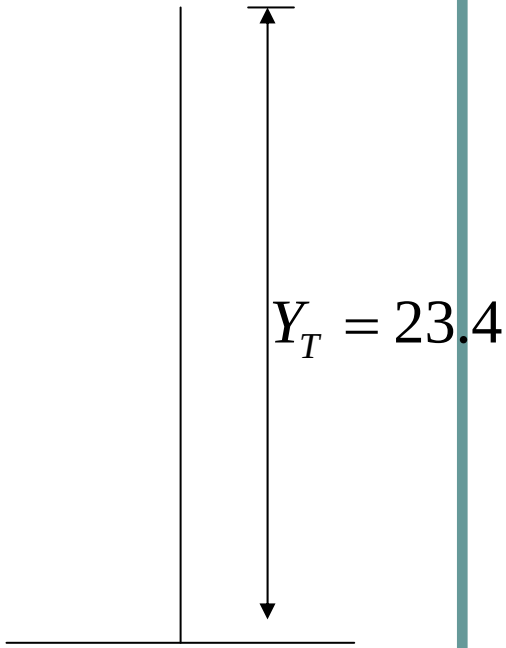


Figure 1
File Edit View Insert Tools Desktop Window Help
EXIT
Three Link Planar Robot
HELP
Matthew Kontz
Walla Walla College
February 2001
Workspace
180°
Angle
0°
23.4
Radius
8.98
θ1 = 0°
X_T =0
θ2 = 0°
Y_T = 23.4
θ3 = 0°
φ_T = 90°
Position-Sliders
Click on Target
Click and Drag
Angle-Sliders


$Y_T = 23.4$

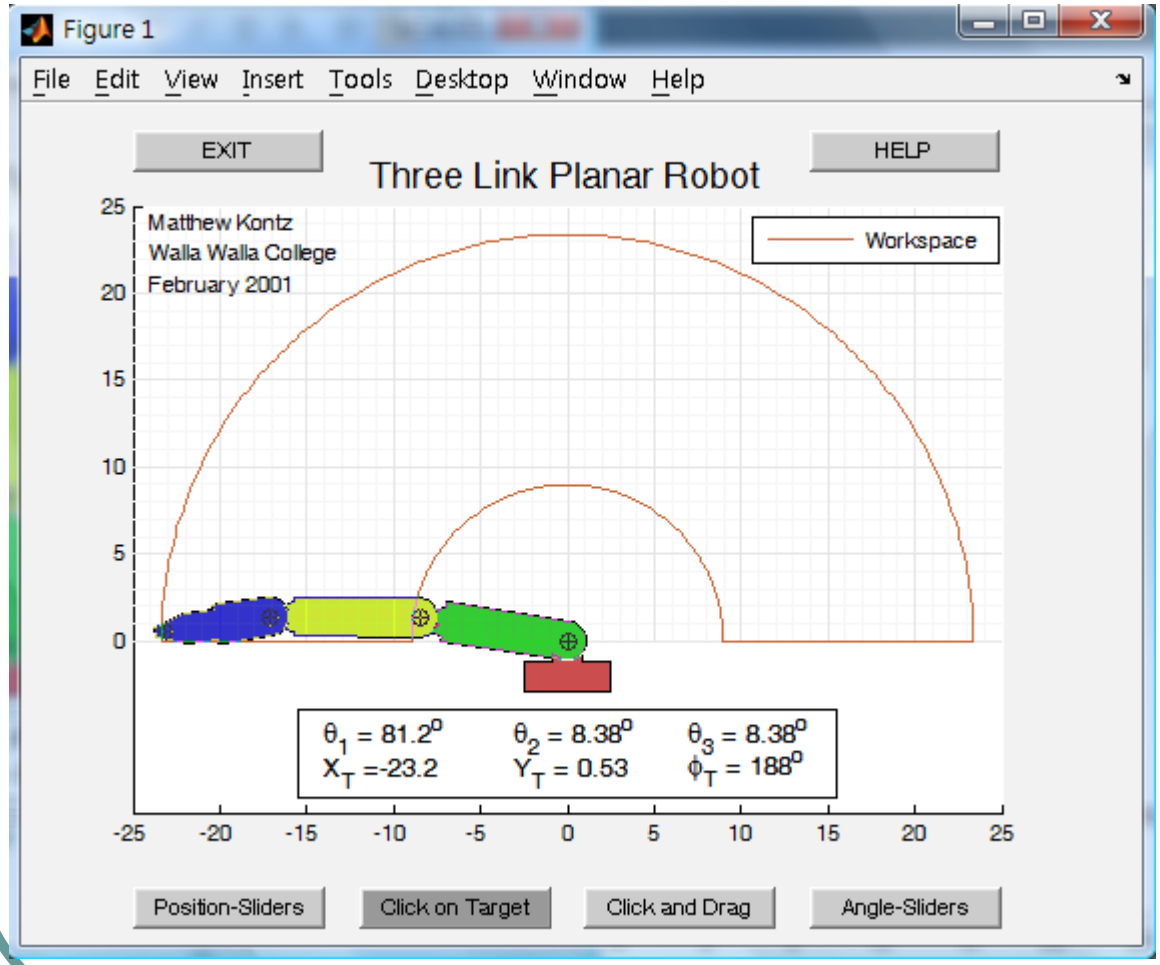
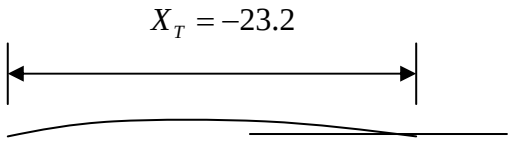


Figure 1
File Edit View Insert Tools Desktop Window Help
EXIT
Three Link Planar Robot
HELP
Matthew Kontz
Walla Walla College
February 2001
Workspace
θ1 = 81.2°
θ2 = 8.38°
θ3 = 8.38°
XT =-23.2
YT = 0.53
ϕT = 188°
Position-Sliders
Click on Target
Click and Drag
Angle-Sliders


$X_T = -23.2$

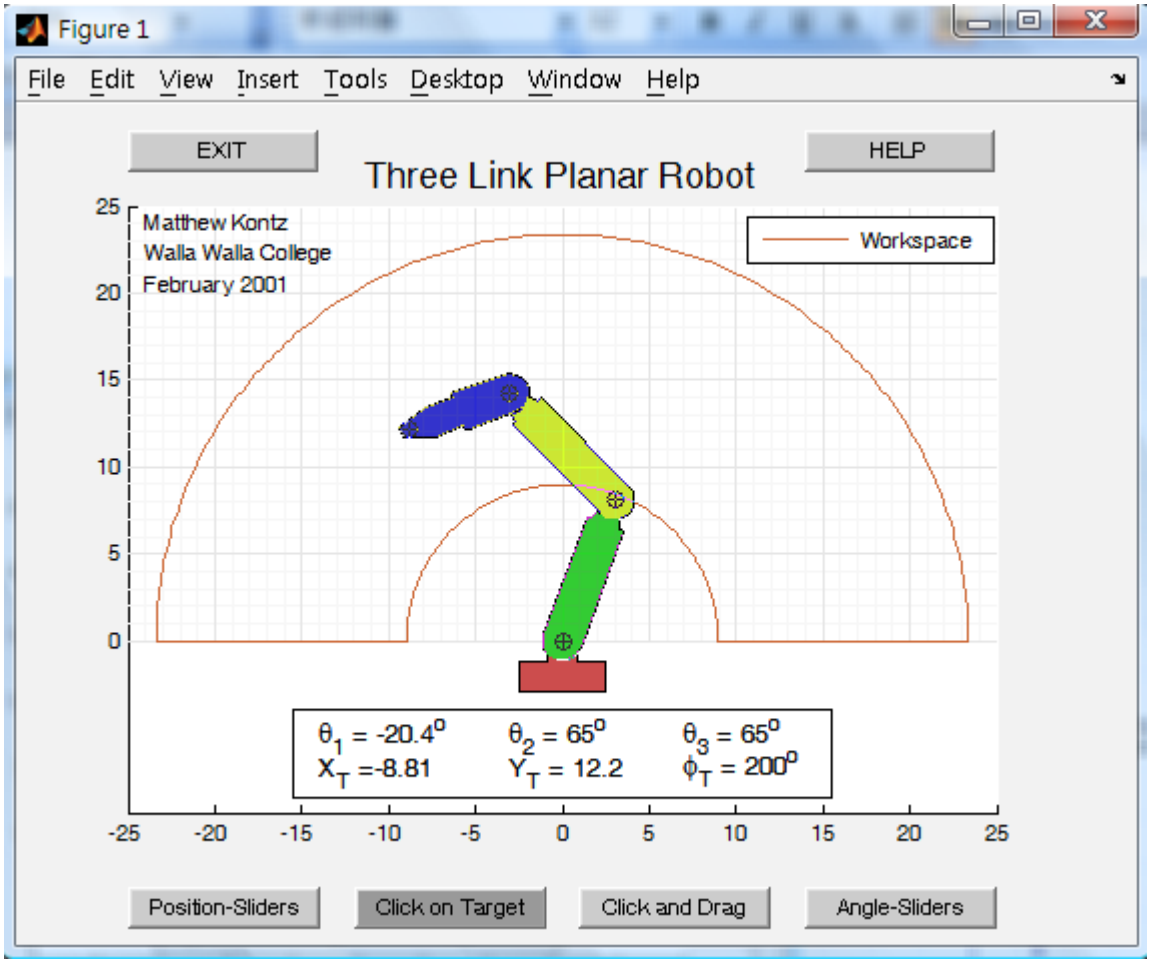
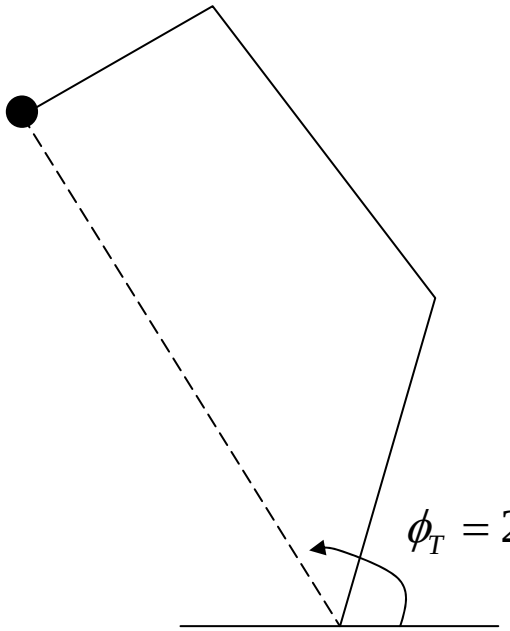


Figure 1
File Edit View Insert Tools Desktop Window Help
EXIT
Three Link Planar Robot
HELP
Matthew Kontz
Walla Walla College
February 2001
Workspace
θ1 = -20.4°
θ2 = 65°
θ3 = 65°
XT =-8.81
YT = 12.2
ϕT = 200°
Position-Sliders
Click on Target
Click and Drag
Angle-Sliders

$(X_T = -8.81, Y_T = 12.2)$


$\phi_T = 200^o$

Forward Kinematics

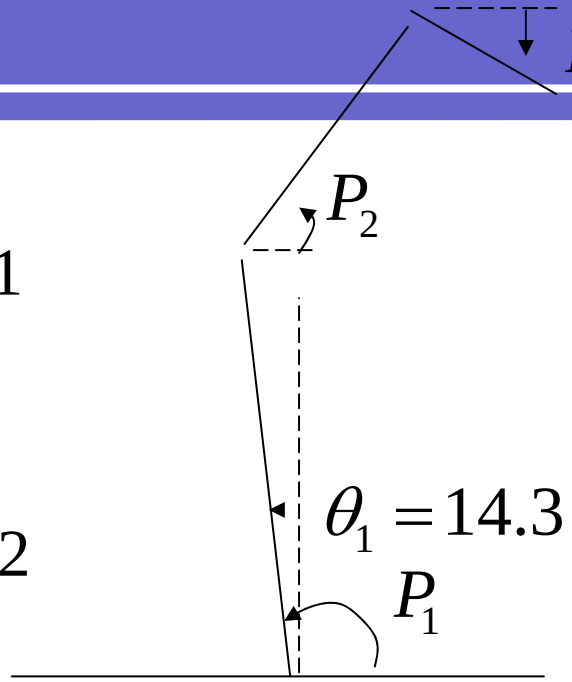
Angle between matlab and frame 1

$$P_1 = \frac{\pi}{2} + \frac{\pi}{180}\theta_1$$

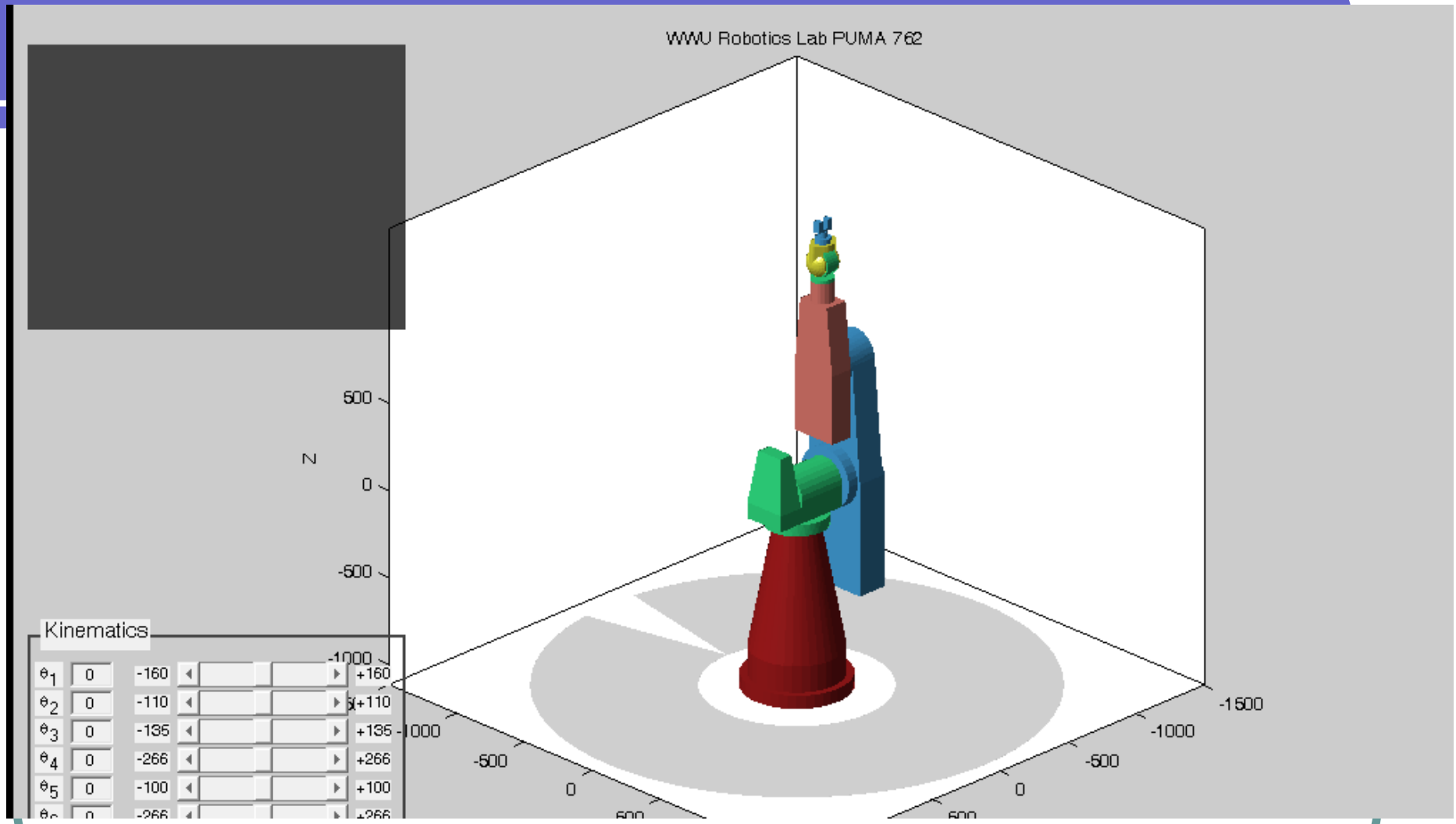
Angle between matlab and frame 2

$$P_2 = P_1 + \frac{\pi}{180}\theta_2$$

$$P_3 = P_2 + \frac{\pi}{180}\theta_3$$



http://www.learnaboutrobots.com/forwardKinematics.htm


WWU Robotics Lab PUMA 762
Kinematics
θ1 0 -160 +160
θ2 0 -110 +110
θ3 0 -135 +135
θ4 0 -266 +266
θ5 0 -100 +100
500
0
-500
-1000
-1500
-1000
-500
0
500

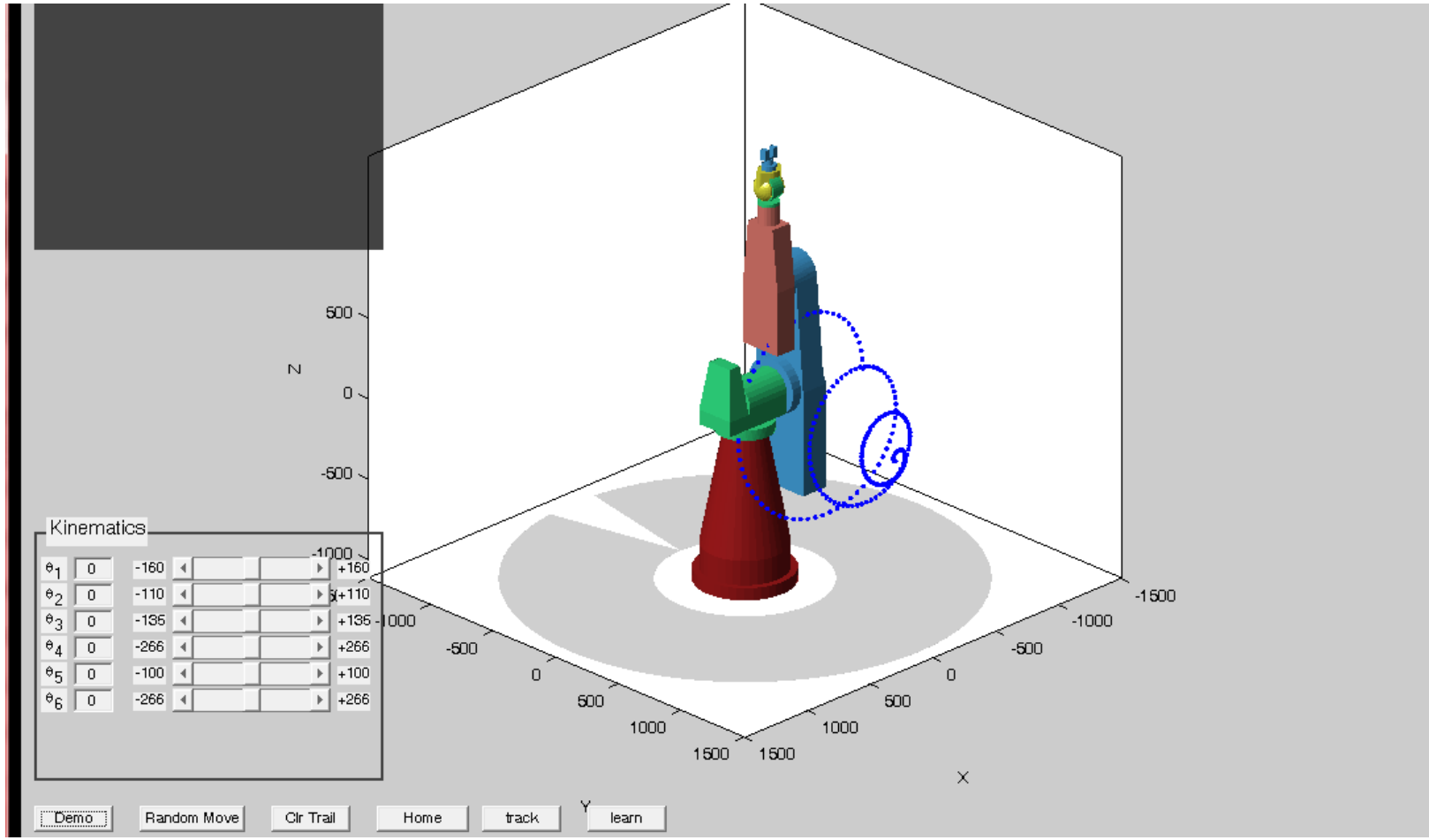
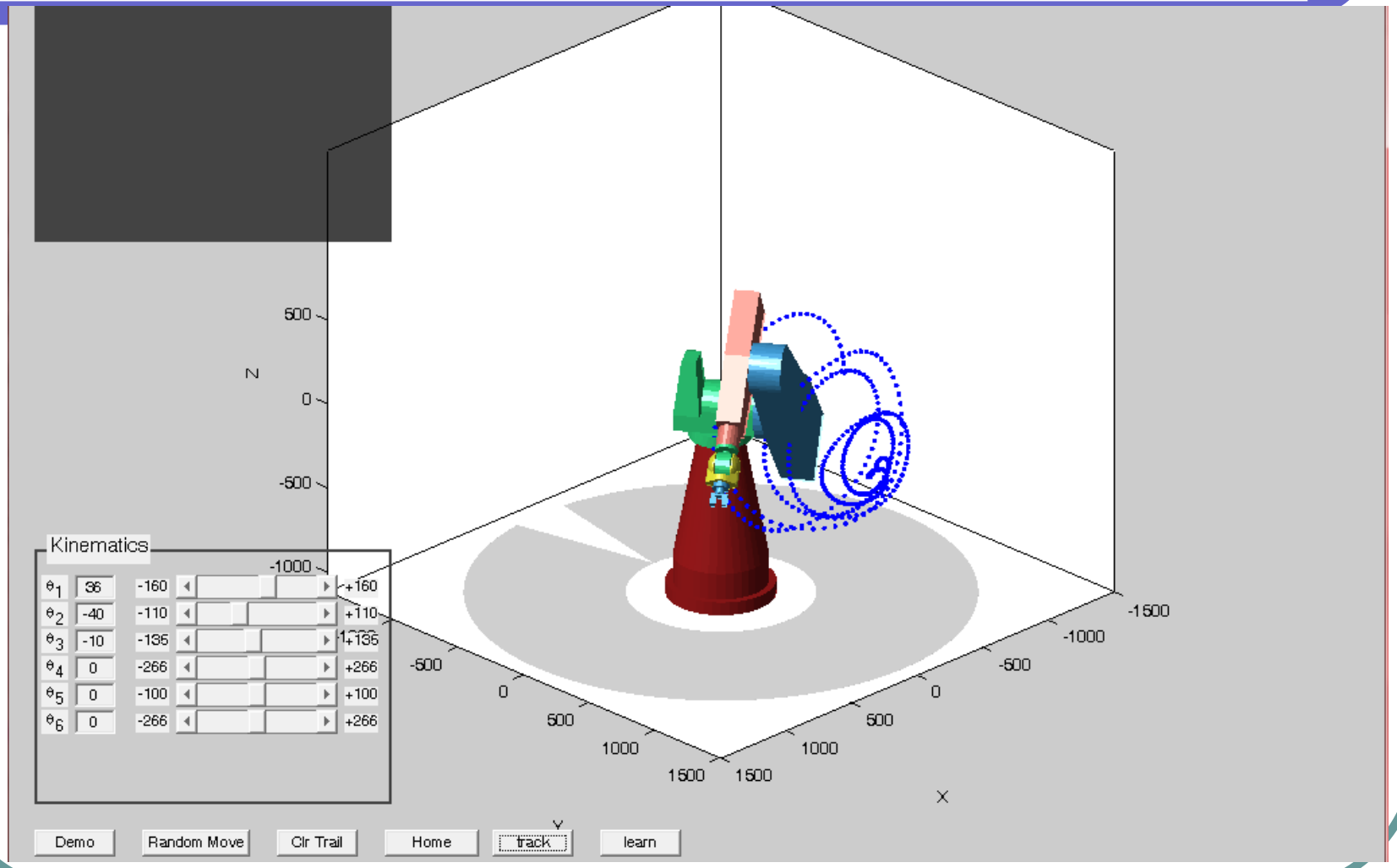
PUMA Robot Matlab/Servo To Go software

MATLAB Central File Exchange - 3D Puma Robot Demo

puma3d.m

gen_path.m

Demo 3d robot arm movement



3D Motion Tracking