الجامعة الإسلامية العالمية ماليزيا

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

يونيبرسيتي إسلام انتارابڠسا مليسيا

KULIYYAH OF ENGINEERING (MECHATRONICS)

MCTE 4352

ROBOTICS

PROJECT FOR ROBOTICS

SECTION 1

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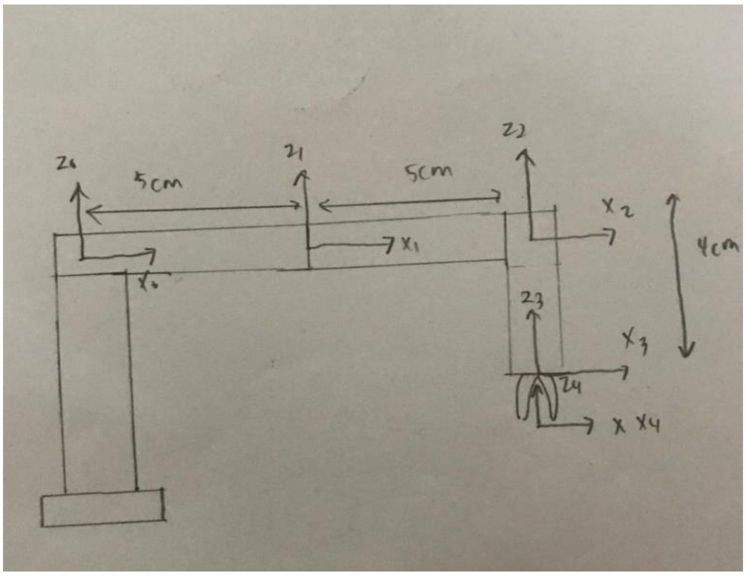
1. Introduction

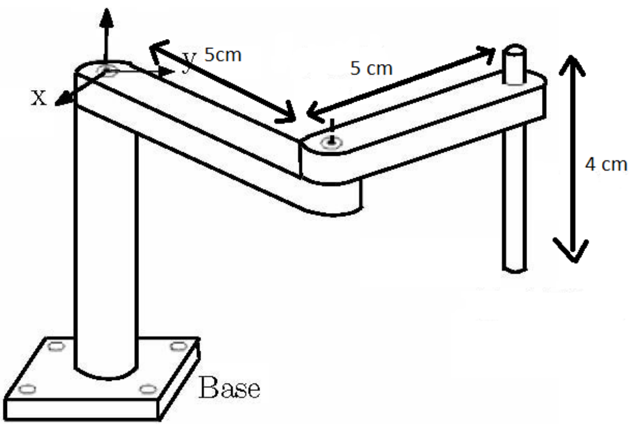
Scara robot stand for Selective Compliance Assembly Robot Arm and robotic arm with 4 links. This robot was developed by Hiroshi Makino, a professor at the University of Yamanashi. The robot really helpful for many types of assembly operations for example inserting a round pin in a round hole without binding. The main feature for this Scara robot is the jointed two-link arm layout similar to our human arms that enables the arm to extend out of the way into confined areas and then retract or fold up. This is useful for moving pieces from one cell to another of for enclosed process stations for loading and unloading. This Scara robot, which has a fully beltless structure, is the most distinctive feature. This achieves overwhelming high rigidity, high speed and high accuracy as the tip rotating axis is directly related to the speed reduction gear. This robot is used in a broad range of processes and applications such as electrical and electronic device manufacturing machinery and small precision computer parts that require precise assembly and large vehicle components to be assembled, treated and moved.

For this project, I have been asked to model own Scara robot using the Matlab. From the design of the model, the animation of movement using Matlab also will be shown in the video. The calculation for inverse and forward kinematics by using formula and using Matlab coding and will compare both of it.

2. Modelling the Scara robot

2.1 Model with drawing





2.2 DH parameter

DH parameter	ai	αi	di	θi
0-1	5	0	0	Θ1
1-2	5	0	0	Θ2
2-3	0	0	4	0
3-4	0	0	0	0

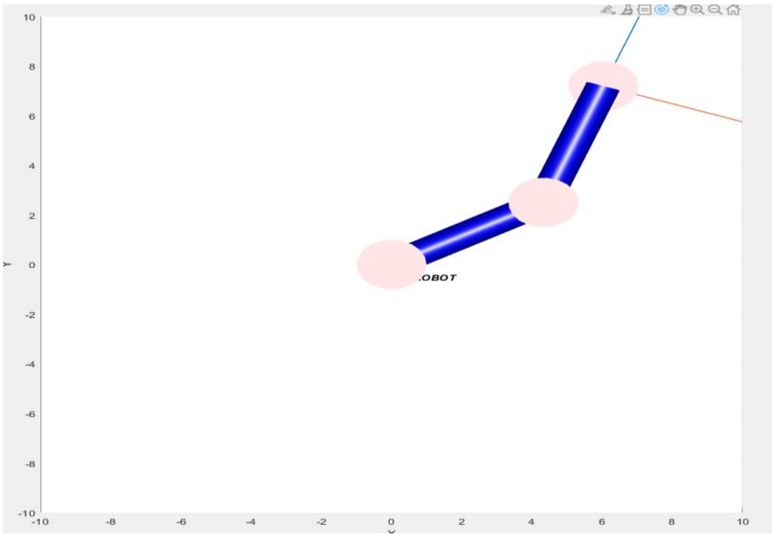
2.3 Modelling using Matlab

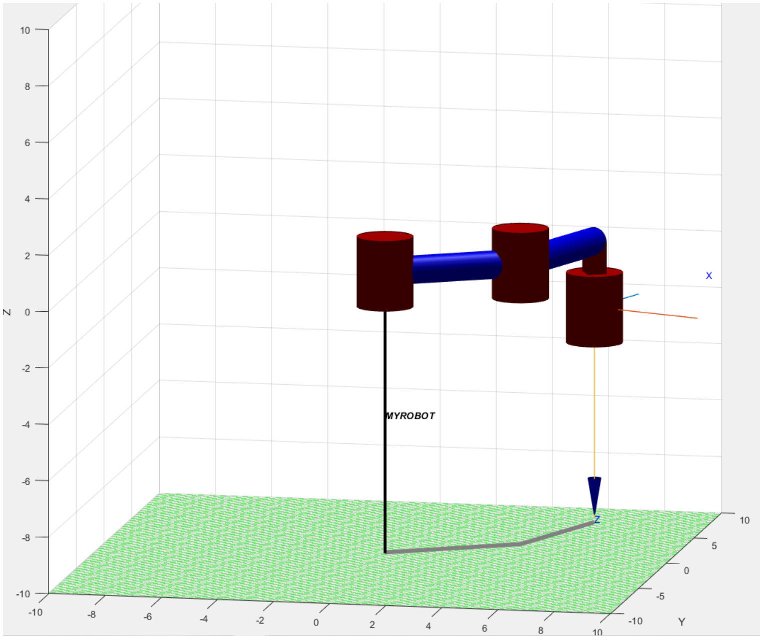
2.3.1 Coding

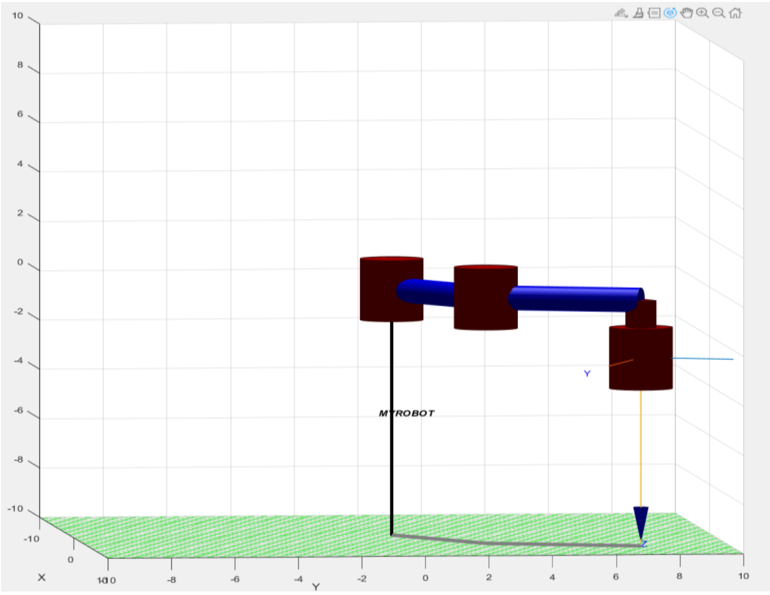
```
%Modelling the Scara robot
L1= Link('d',0,'a',5,'alpha',0); %For initialize DH variable
for link 1
L2= Link('d',0,'a',5,'alpha',pi); %For initialize DH variable
for link 2
L3= Link([0,4,0,0,1],'standard'); %For initialize DH variable
for Link 3 using the standard initialization because to use
primastic function
L3.qlim=[0 3]; %For prismatic function
L4= Link('d',0,'a',0,'alpha',0); %For initialize DH variable
for Link 4
Rbt= SerialLink([L1 L2 L3 L4],'name','MYROBOT'); %Function to
construct the Scara Robot
q1=deg2rad(30);q2=deg2rad(40);q3=2.34;q4=0; %To initialize the
theta
Rbt.plot([q1 q2 q3 q4],'workspace',[-10 10 -10 10 -10 10]);
%To plot the graph of the Scara Robot
Rbt; %To call the graph
```

```
%Modelling the Scara robot
L1= Link('d',0,'a',5,'alpha',0); %For initialize DH variable for link 1
L2= Link('d',0,'a',5,'alpha',pi); %For initialize DH variable for link 2
L3= Link([0,4,0,0,1],'standard'); %For initialize DH variable for Link 3 using the standard initialization because to use primastic function
L3.qlim=[0 3]; %For prismatic function
L4= Link('d',0,'a',0,'alpha',0); %For initialize DH variable for Link 4
Rbt= SerialLink([L1 L2 L3 L4],'name','MYROBOT'); %Function to construct the Scara Robot
q1=deg2rad(30);q2=deg2rad(40);q3=2.34;q4=0; %To initialize the theta
Rbt.plot([q1 q2 q3 q4],'workspace',[-10 10 -10 10 -10 10]); %To plot the graph of the Scara Robot
Rbt; %To call the graph
```

2.3.2 Matlab robotic plot

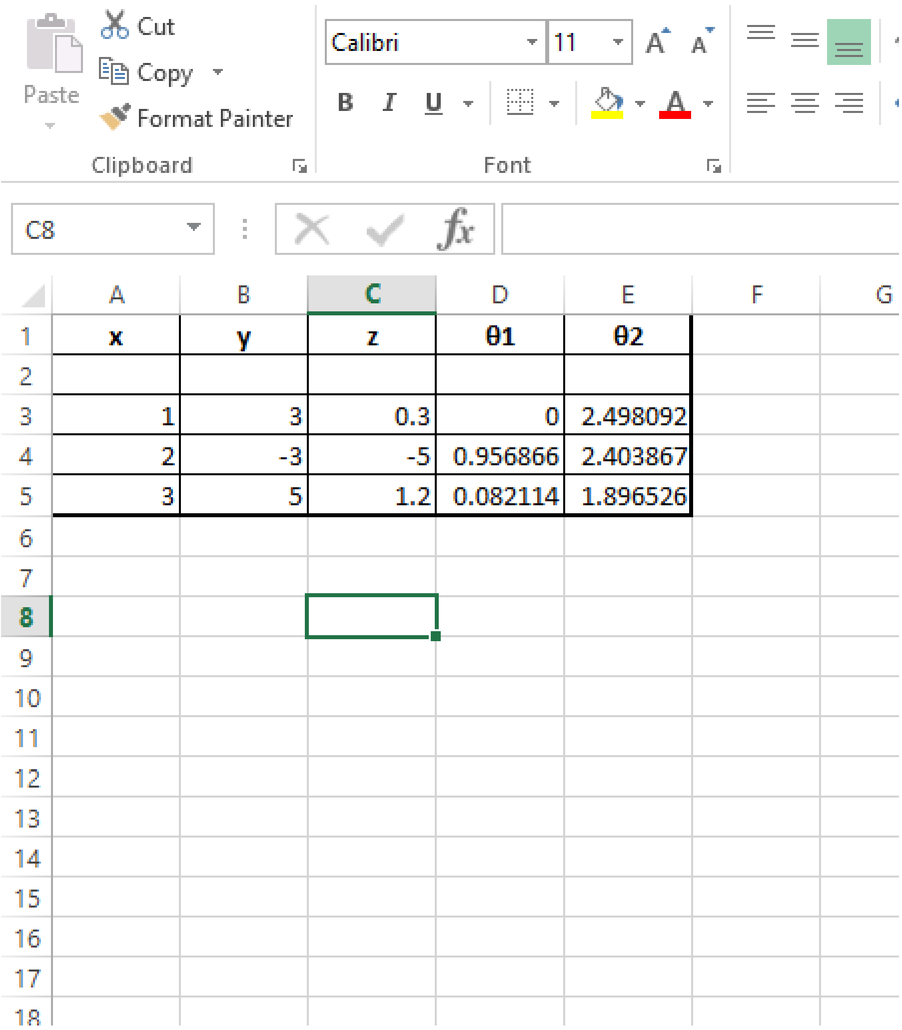






2. Inverse and forward kinematic

2.1 Calculation using Excel



	x	y	z	θ1	θ2
1	x	y	z	θ1	θ2
2					
3	1	3	0.3	0	2.498092
4	2	-3	-5	0.956866	2.403867
5	3	5	1.2	0.082114	1.896526

2.2 Matlab Coding

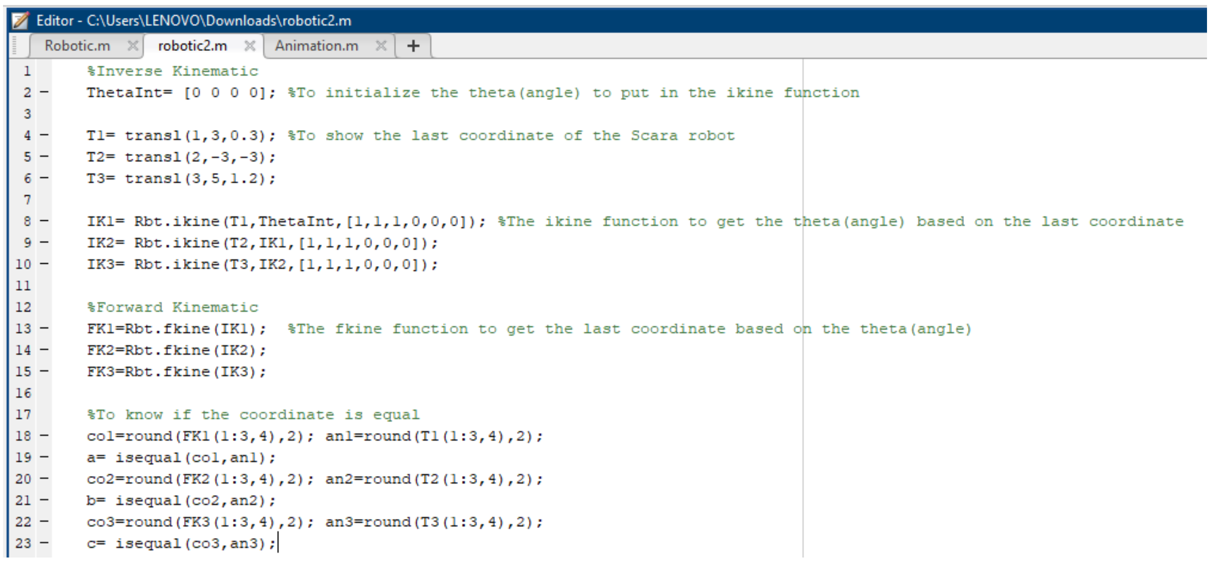
```
%Inverse Kinematic
ThetaInt= [0 0 0 0]; %To initialize the theta(angle) to put in the ikine function

T1= transl(1,3,0.3); %To show the last coordinate of the Scara robot
T2= transl(2,-3,-5);
T3= transl(3,5,1.2);

IK1= Rbt.ikine(T1,ThetaInt,[1,1,1,0,0,0]); %The ikine function to get the theta(angle) based on the last coordinate
IK2= Rbt.ikine(T2,IK1,[1,1,1,0,0,0]);
IK3= Rbt.ikine(T3,IK2,[1,1,1,0,0,0]);

%Forward Kinematic
FK1=Rbt.fkine(IK1);  %The fkine function to get the last coordinate based on the theta(angle)
FK2=Rbt.fkine(IK2);
FK3=Rbt.fkine(IK3);

%To know if the coordinate is equal
co1=round(FK1(1:3,4),2); an1=round(T1(1:3,4),2);
a= isequal(co1,an1);
co2=round(FK2(1:3,4),2); an2=round(T2(1:3,4),2);
b= isequal(co2,an2);
co3=round(FK3(1:3,4),2); an3=round(T3(1:3,4),2);
c= isequal(co3,an3);
```



3. Result

From the Matlab coding, for the inverse kinematic, first assume the initial angle of the Scara robot and the last coordinate of the robot. By using the Ikine function, the final angle of the Scara robot is get when it reach the last coordinate. Then for the forward kinematics, using the angle of Scara robot given, we can get the last coordinate of the Scara robot. The result of inverse kinematic and forward kinematic of the Scara robot is proven correct.

```
Command Window
>> IK1

IK1 =

    0.0000    2.4981   -0.3000         0

>> IK2

IK2 =

    0.2191   -2.4039    3.0000         0

>> IK3

IK3 =

    1.9786   -1.8965   -1.2000         0
```

This picture above show result of the three angle of the Scara robot from three assumption last coordinate of the Scara robot.

```
Command Window
>> a

a =

  logical

   1

>> b

b =

  logical

   1

>> c

c =

  logical

   1
```

This picture above show the proven result of the equality of the last coordinate of the robot from the inverse and forward kinematics.

4. Animation Matlab Coding

```
%Animation is from robotdemo
t=[0:0.07:3]';
pause(0.1);
Anim1=jtraj(ThetaInt,IK1,t);
Rbt.plot(Anim1,'workspace',[-15 15 -15 15 -10 10]);
pause(0.1);
Anim2=jtraj(IK1,IK2,t);
Rbt.plot(Anim2,'workspace',[-15 15 -15 15 -10 10]);
pause(0.1);
Anim3=jtraj(IK2,IK3,t);
Rbt.plot(Anim3,'workspace',[-15 15 -15 15 -10 10]);
```