Project Robot / manipulator design with 5 degrees of freedom

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Group:03

Table of Contents.

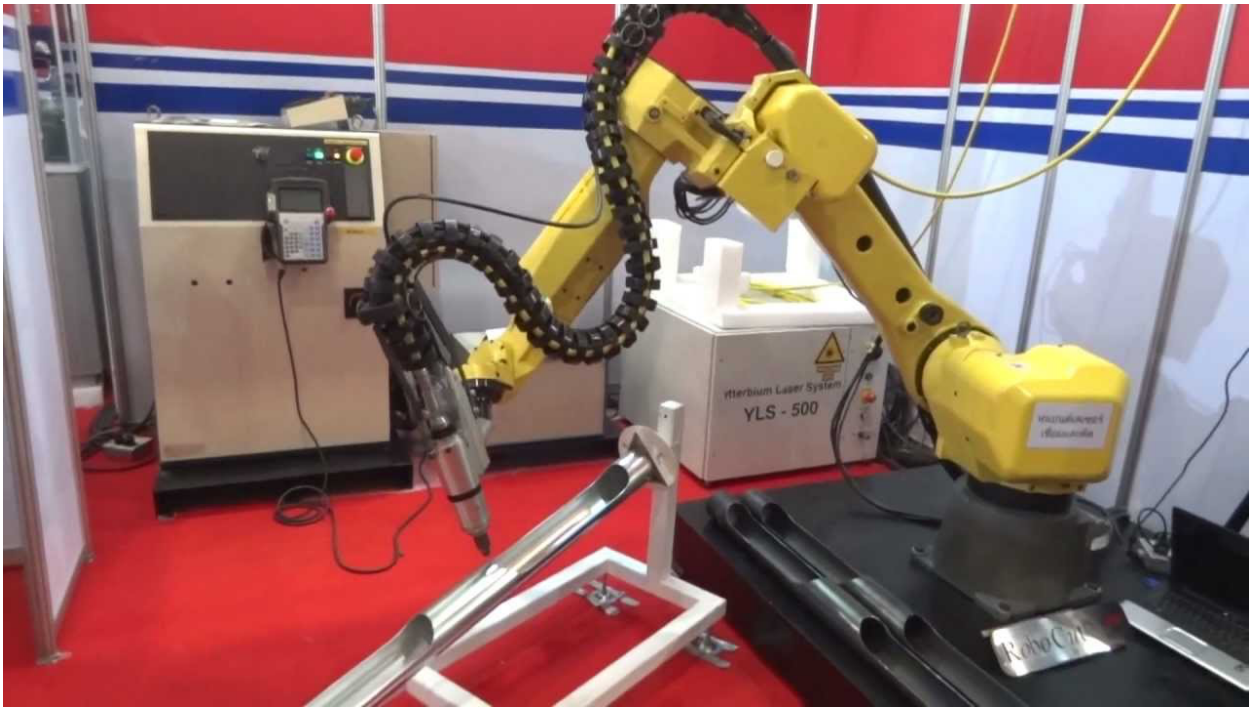
1.State of art

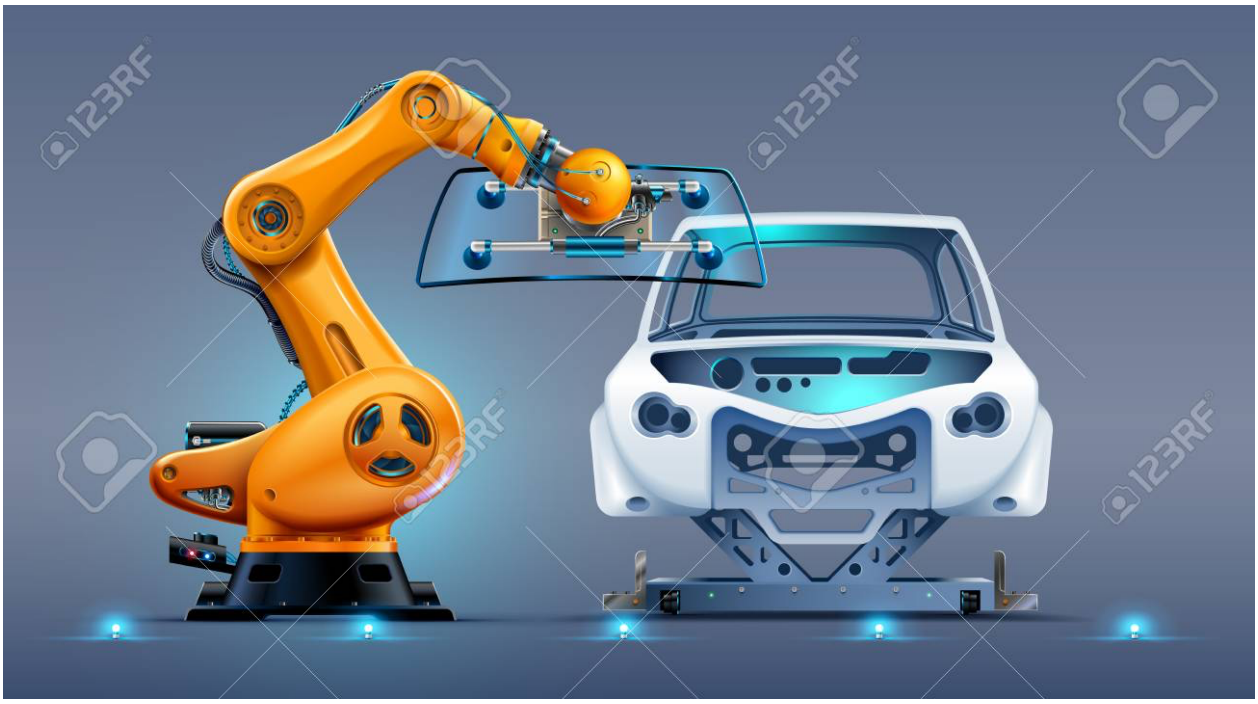
In this project I will construct robot arm (T050000)

One of the most common and typical robotic arms 5 degrees of freedom currently in factories. This mechanism is flexible and can be combined with automation to perform works quickly and easily which require 2-3 people to do.

With the ability of machines to be able to lift heavy objects, they are used in car factory, manufacturing materials or in freight.

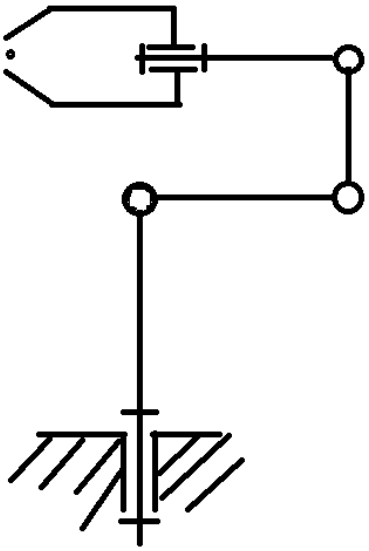
I have tried to find some similar mechanism in the factories and laboratories:





2.Mechanism.

Drawings of construction:



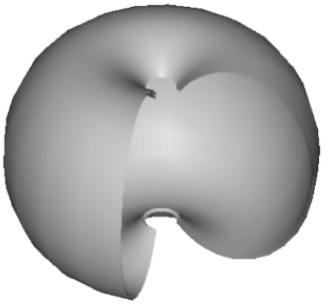
Degrees of freedom:

5 elements.

5 pair of class 1.

W= 6*5 - 5*5 = 5 degrees.

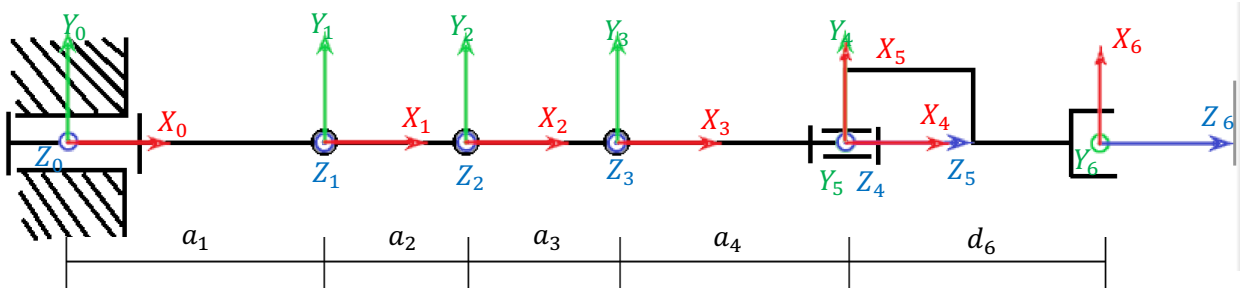
-Manipulators having three rotary joints are included in the group of anthropomorphic manipulators.



Work envelope

3.FOWARD KINEMATICS.

3.1 Mechanism



3.2 Kinematic table

System	θ_i	d_i	a_i	α_i
1	0	0	a_1	$\alpha_{1,var}$
2	$\theta_{2,var}$	0	a_2	0
3	$\theta_{3,var}$	0	a_3	0
4	$\theta_{4,var}$	0	a_4	0
5	90	0	0	90
6	$\theta_{6,var}$	d_6	0	0

3.3 Obtained Results

A1 =

[1, 0, 0, a1]

[0, cos(alpha1), -sin(alpha1), 0]

[0, sin(alpha1), cos(alpha1), 0]

[0, 0, 0, 1]

A2 =

[cos(theta2), -sin(theta2), 0, a2*cos(theta2)]

[sin(theta2), cos(theta2), 0, a2*sin(theta2)]

[0, 0, 1, 0]

[0, 0, 0, 1]

A3 =

[cos(theta3), -sin(theta3), 0, a3*cos(theta3)]

[sin(theta3), cos(theta3), 0, a3*sin(theta3)]

[0, 0, 1, 0]

[0, 0, 0, 1]

A4 =

[cos(theta4), -sin(theta4), 0, a3*cos(theta4)]

[sin(theta4), cos(theta4), 0, a3*sin(theta4)]

[0, 0, 1, 0]

[0, 0, 0, 1]

A5 =

[0 0 1 0]

[1 0 0 0]

[0 1 0 0]

[0 0 0 1]

A6 =

[cos(theta6), -sin(theta6), 0, 0]

[sin(theta6), cos(theta6), 0, 0]

[0, 0, 1, d6]

[0, 0, 0, 1]

T06 =

[-sin(theta2+theta3+theta4)*cos(theta6), sin(theta2+theta3+theta4)*sin(theta6), cos(theta2+theta3+theta4), a1+a3*cos(theta2+theta3)+a2*cos(theta2)+a3*cos(theta2+theta3+theta4)+ d6*cos(theta2+theta3+theta4)]

[cos(theta2+theta3+theta4)*cos(alpha1)*cos(theta6)-sin(alpha1)*sin(theta6), -sin(alpha1)*cos(theta6)-cos(theta2+theta3 +theta4)*cos(alpha1)*sin(theta6), sin(theta2+theta3+theta4)*cos(alpha1), cos(alpha1)*(a3*sin(theta2+theta3)+a2*sin(theta2)+a3*sin(theta2+theta3+theta)+d6*sin(theta2+theta3+theta4))]

[cos(alpha1)*sin(theta6)+cos(theta2+theta3+theta4)*sin(alpha1)*cos(theta6), cos(alpha1)*cos(theta6)-cos(theta2+theta3+theta4)*sin(alpha1)*sin(theta6), sin(theta2+theta3+theta4)*sin(alpha1), sin(alpha1)*(a3*sin(theta2+theta3)+a2*sin(theta2)+a3*sin(theta2+theta3+theta4)+d6*sin(theta2+theta3+theta4))]

[0, 0, 0, 1]

5.APPENDIX.

5.1 MATLAB CODE

```
clear all
close all
clc
syms a1 a2 a3 a4 ;
syms d6;
syms alpha1 theta2 theta3 theta4 theta6;
%system 1
Tranx_a1=[1 0 0 a1;0 1 0 0;0 0 1 0;0 0 0 1];
Rotx_alpha1=[1 0 0 0;0 cos(alpha1) -sin(alpha1) 0; 0 sin(alpha1) cos(alpha1)
0;0 0 0 1];


%system 2
Rotz_theta2=[cos(theta2) -sin(theta2) 0 0;sin(theta2) cos(theta2) 0 0;0 0 1
0; 0 0 0 1];
Tranx_a2=[1 0 0 a2;0 1 0 0;0 0 1 0;0 0 0 1];


%system 3
Rotz_theta3=[cos(theta3) -sin(theta3) 0 0;sin(theta3) cos(theta3) 0 0;0 0 1
0; 0 0 0 1];
Tranx_a3=[1 0 0 a3;0 1 0 0;0 0 1 0;0 0 0 1];


%system 4
Rotz_theta4=[cos(theta4) -sin(theta4) 0 0;sin(theta4) cos(theta4) 0 0;0 0 1
0; 0 0 0 1];
Tranx_a4=[1 0 0 a3;0 1 0 0;0 0 1 0;0 0 0 1];


%system 5
Rotz_90=[0 -1 0 0;1 0 0 0;0 0 1 0;0 0 0 1];
Rotx_90=[1 0 0 0;0 0 -1 0;0 1 0 0;0 0 0 1];


%system 6
Rotz_theta6=[cos(theta6) -sin(theta6) 0 0;sin(theta6) cos(theta6) 0 0;0 0 1
0; 0 0 0 1];
Tranz_d6=[1 0 0 0;0 1 0 0;0 0 1 d6;0 0 0 1];

%Danavit-Hartenberg Notations
A1=Tranx_a1*Rotx_alpha1;    A1=simplify(A1)
A2=Rotz_theta2*Tranx_a2;    A2=simplify(A2)
A3=Rotz_theta3*Tranx_a3;    A3=simplify(A3)
A4=Rotz_theta4*Tranx_a4;    A4=simplify(A4)
A5=Rotz_90*Rotx_90          %A5=simplify(A5)
A6=Rotz_theta6*Tranz_d6;    A6=simplify(A6)
```

```
%Forward kinematic for each joint
T01=A1;
T02=T01*A2;
T03=T02*A3;
T04=T03*A4;
T05=T04*A5;
T06=T05*A6;
T06=simplify(T06)
```