Motion planning for Six Degree Of Freedom Mechanical Arm model

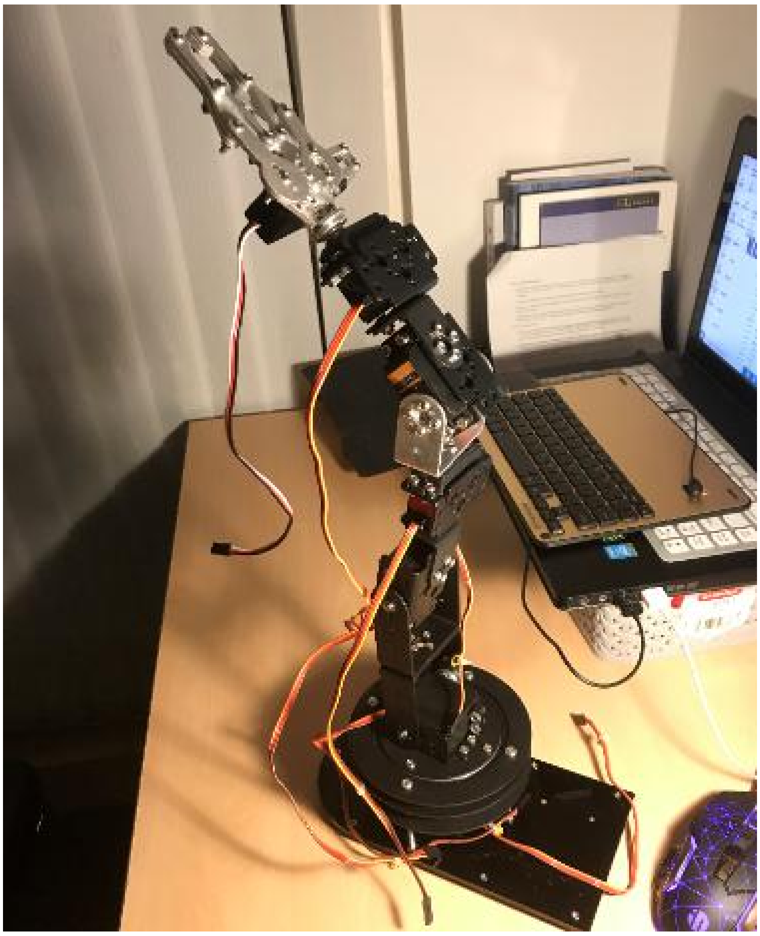
(Kinematics and Inverse Kinematics Implement by C and Simulation On Matlab)

Project materials Introduction

Mechanical arm

Before we introduce Kinematics implement, I would like to introduce more details about the mechanical arm I used in this project.

This is a very simple and mini 6 DOF mechanical arm. This type of mechanical arm is easy to modify and assemble, cause this arm is make up of some simple and original basic components. And you can find those components on amazon or Taobao easily. I modified this mechanical arm into six degree of freedom which is more convenient for me to deduce and learn the kinematics algorithm.
As Picture shows,



The full length of modified mechanical arm is 33.5cm, and the weight is about 1.5 KG. The mechanical arm is driven by 7 PWM Signal Digit Servos. (One servo for end paw part and six servos for the arm part). The type of servo motor is LD-20MG whose torque is 20kg.cm. These servos are controlled by PWM signal (Driven circuit board will be introduced later), and servos' rotation range is from 0 degree to 180 degree.`

Create Link frames for mechanical arm

The next step is creating Link frames for mechanical arm.

In order to describe the location of each link relative to its neighbor links, we should define a frame attached for each link. The link frames are named by the link number they are attached. Such as, frame{i} is attached to link i.

Create Frames for arm links

1. Find joint axis and built Z axis for frame{i}

   The Joint axis is consider as a frame's Z-axis, called Zi. Such as joint axis {i} is Z-axis of frame{i}.

2. Find origin points

If joint axis {i} and joint axis{ i + 1} are paralleled. The origin point is located at the intersection point of common perpendicular and axis {i}.

If joint axis {i} and joint axis {i+1} are intersected in the space. The intersection point on the axis{i} is origin point of frame{i}.

3. Find X axis for frame{i}

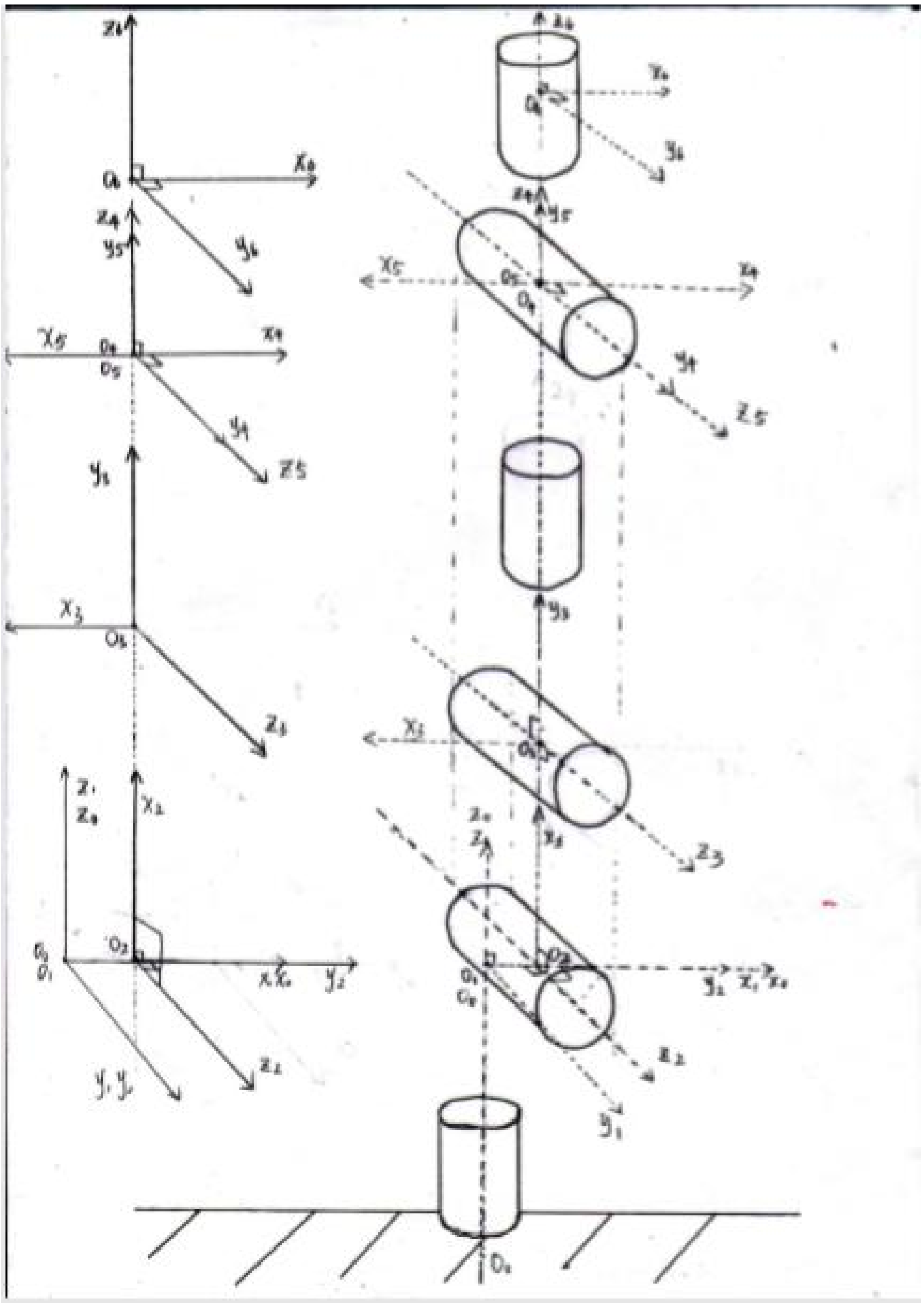
Assign the X axis pointing along with common perpendicular from link{i} to link {i +1}, if the axis intersect, assign X{i} to be normal to the plane containing the two axes.

4. Find Y axis for frame{i}

Assign the Y axis to complete a right hand coordinate system.

5. Assign frame{0} to match {1} when the first joint variable is zero. For end frame{N}, choose an origin location and X{n} direction freely, but generally so as to cause as many linkage parameters as possible to become zero.

According to the standard processes above, we can create frames for my mechanical arm model. As picture shows below:



Create Link parameters for link frames

There are four basic parameters to describe the relationship between two neighboring links. The definition of mechanisms by means of these quantities is convention usually called the Denavit-Hartenberg notion.

Four Link Description Parameters

Link length: a {i-1}: distance of (zi-1, Zi) along Xi-1
Link twist αi-1: angle of (Zi-1, Zi) about Xi-1
Link offset di: distance of (xi-1, xi) along zi

Link angle θ_i: angle of (x_{i-1}, x_i) about z_i

We can according this convention to find four parameters for each link joint, So the DH table shows as below:

i	a_{i-1} (cm)	α_{i-1}	d_i (cm)	θ_i
1	0.00	0	0	0
2	1.25	pi/2	0	pi/2
3	10.5	0	0	pi/2
4	0.00	pi/2	13.0	-pi
5	0.00	pi/2	0	pi
6	0.00	pi/2	10.0	-pi