

Robotic system development



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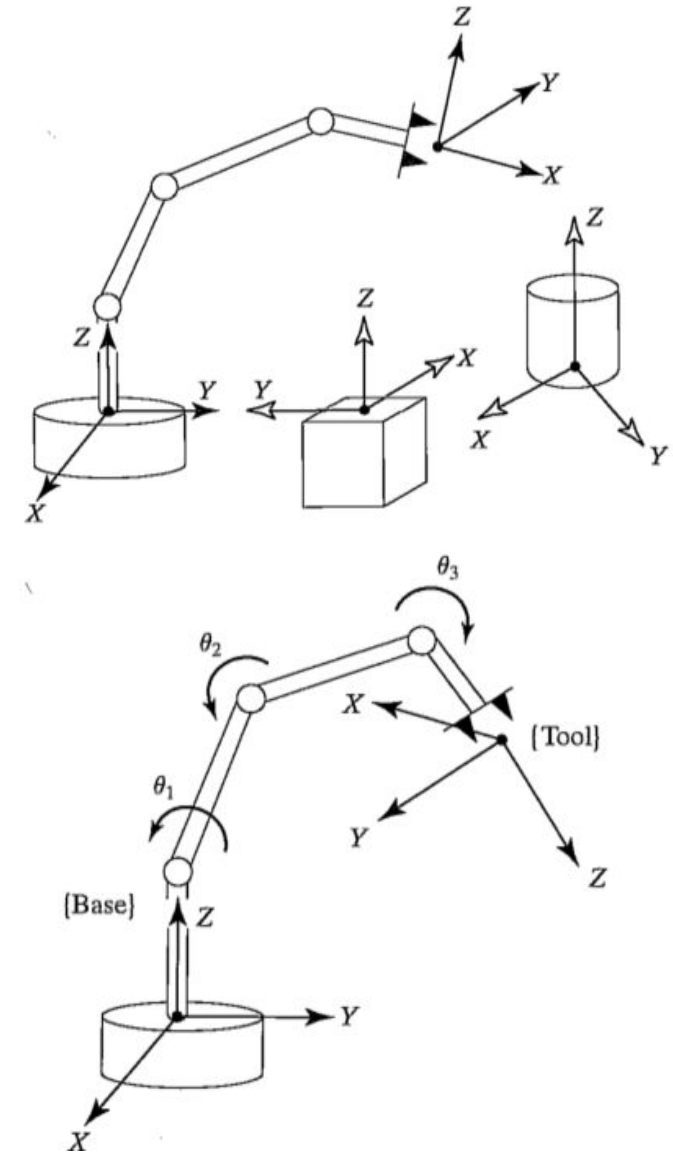


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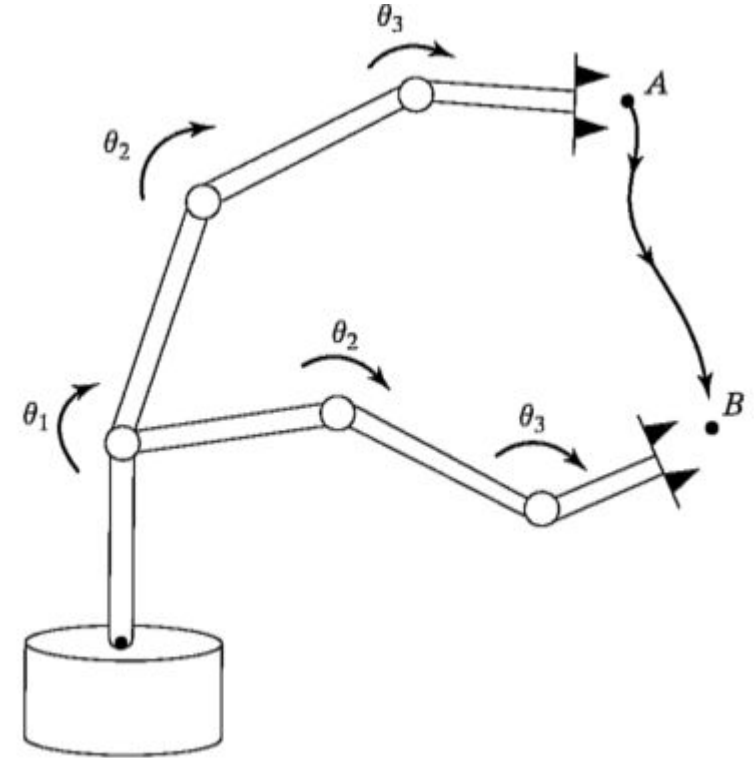
Recap : Robotic system

In order to describe the position and orientation of a body in space, we will always attach a coordinate system, or **frame**, rigidly to the object. We then proceed to describe the position and orientation of this frame with respect to some reference coordinate system. (See Fig. 1.5.)

Manipulators consist of nearly rigid **links**, which are connected by **joints** that allow relative motion of neighboring links. These joints are usually instrumented with position sensors, which allow the relative position of neighboring links to be measured. In the case of rotary or **revolute** joints, these displacements are called **joint angles**. Some manipulators contain sliding (or **prismatic**) joints, in which the relative displacement between links is a translation, sometimes called the **joint offset**.



Recap : Direct and inverse kinematics



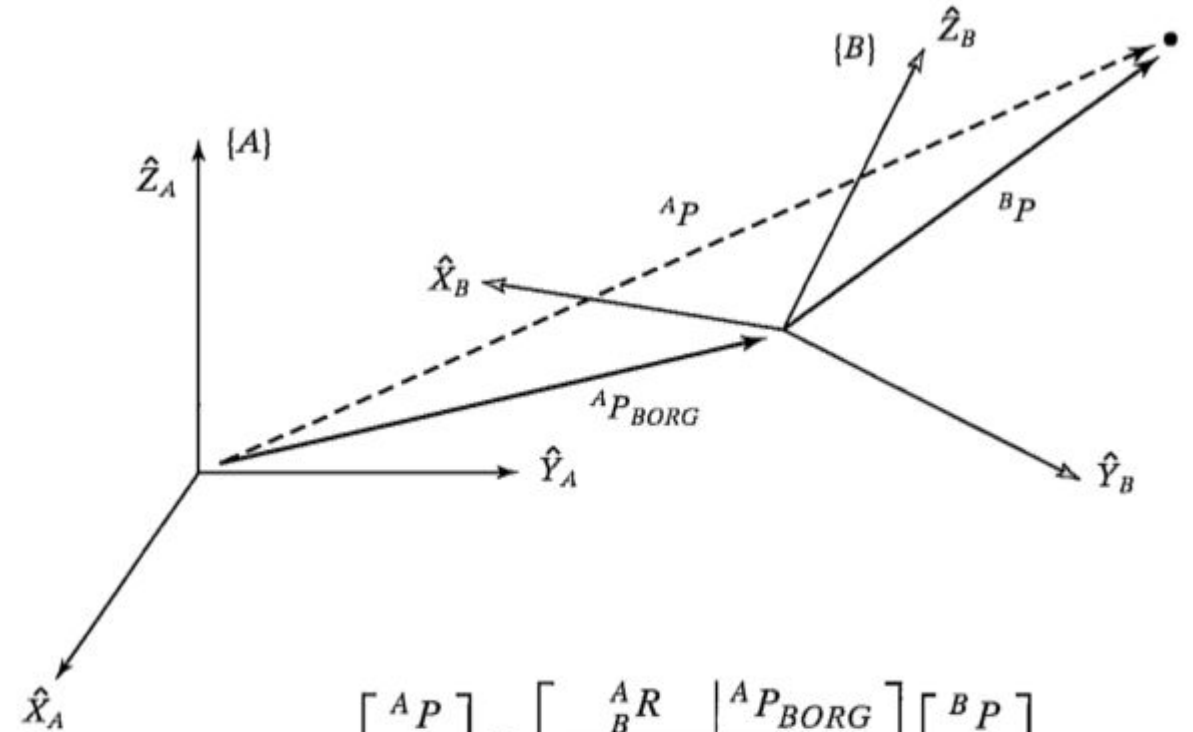
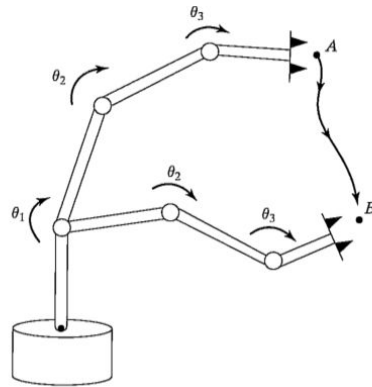
Recap : Direct and inverse kinematics

$$R_x = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos \theta & \sin \theta & 0 \\ 0 & -\sin \theta & \cos \theta & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$R_y = \begin{pmatrix} \cos \theta & 0 & -\sin \theta & 0 \\ 0 & 1 & 0 & 0 \\ \sin \theta & 0 & \cos \theta & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$R_z = \begin{pmatrix} \cos \theta & \sin \theta & 0 & 0 \\ -\sin \theta & \cos \theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$T = \begin{pmatrix} 1 & 0 & 0 & T_x \\ 0 & 1 & 0 & T_y \\ 0 & 0 & 1 & T_z \\ 0 & 0 & 0 & 1 \end{pmatrix}$$



$$\begin{bmatrix} {}^A P \\ 1 \end{bmatrix} = \left[\begin{array}{ccc|c} {}^A R_B & {}^A P_{BORG} \\ \hline 0 & 0 & 0 & 1 \end{array} \right] \begin{bmatrix} {}^B P \\ 1 \end{bmatrix}$$

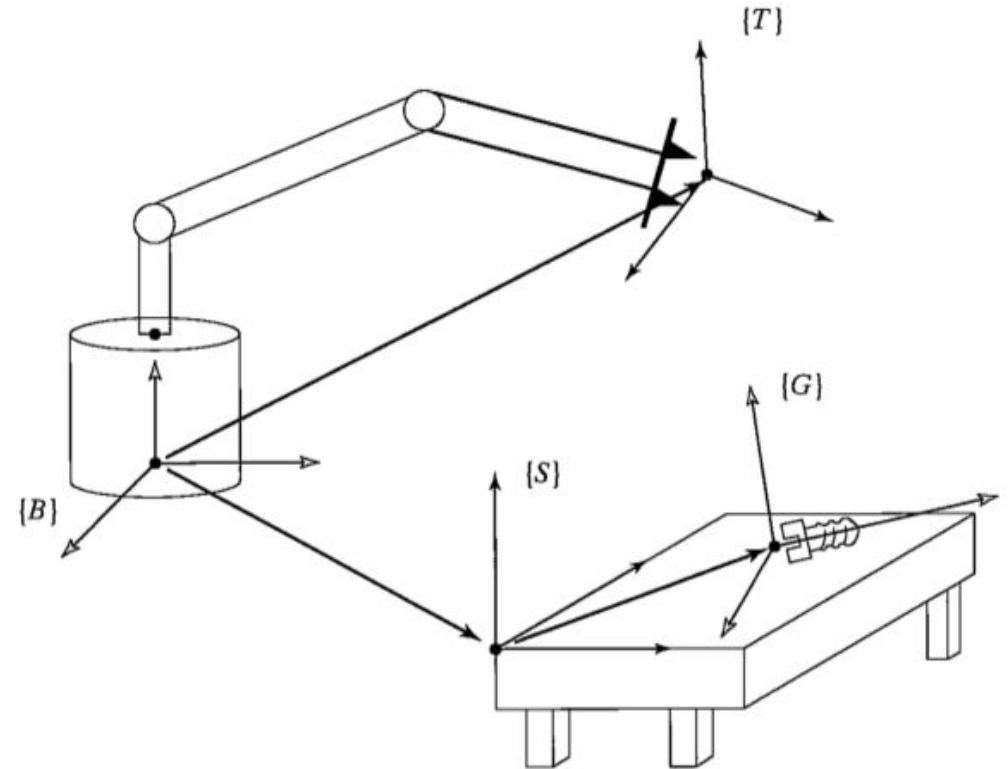
Recap : Direct and inverse kinematics

EXAMPLE 2.6

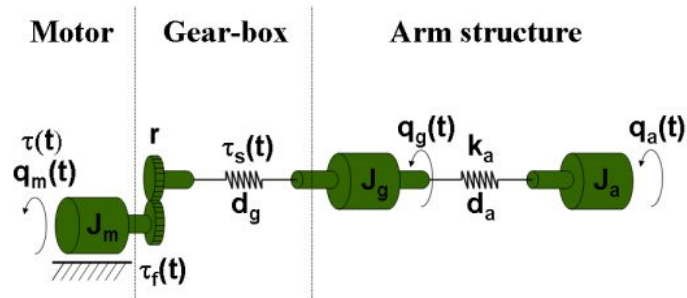
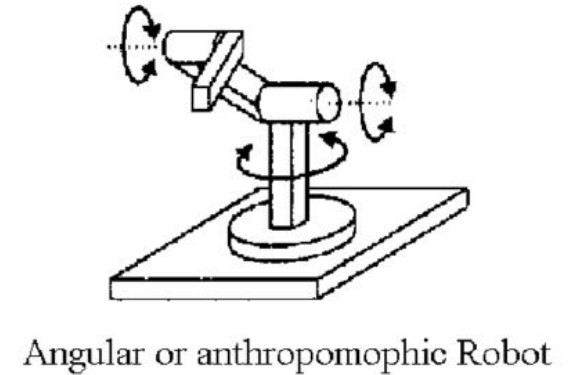
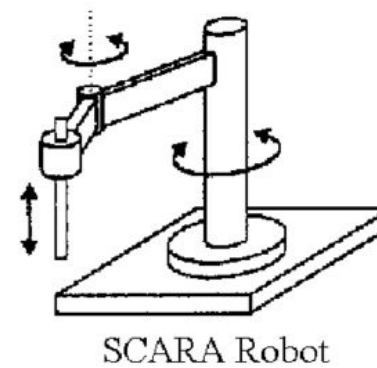
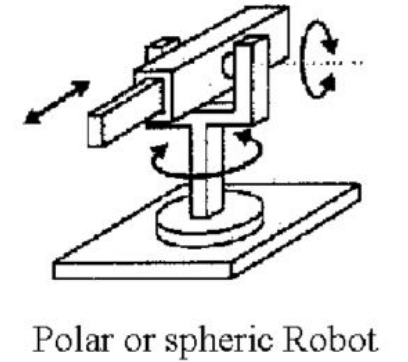
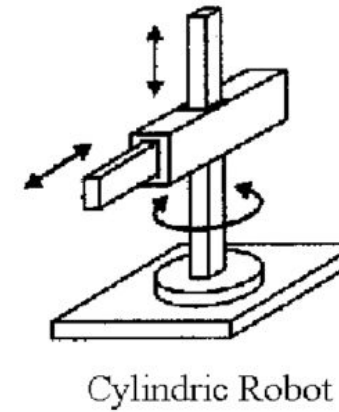
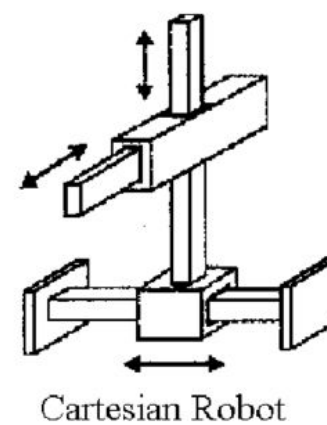
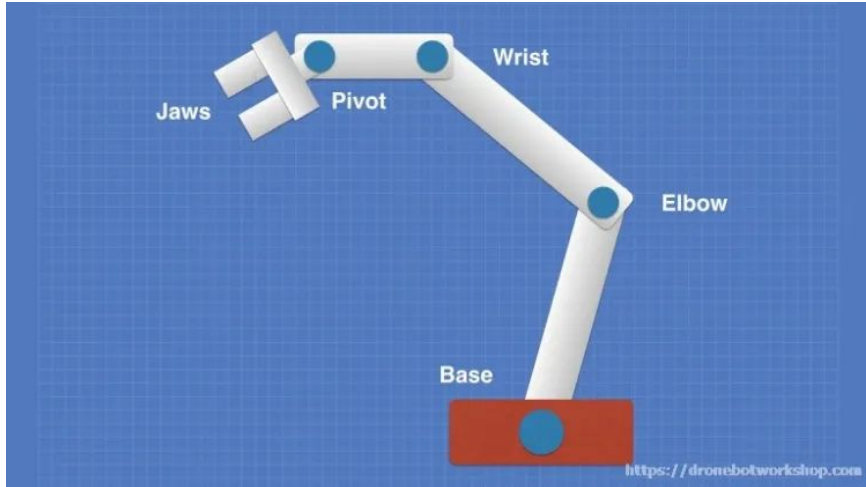
Assume that we know the transform ${}^B_T T$ in Fig. 2.16, which describes the frame at the manipulator's fingertips $\{T\}$ relative to the base of the manipulator, $\{B\}$, that we know where the tabletop is located in space relative to the manipulator's base (because we have a description of the frame $\{S\}$ that is attached to the table as shown, ${}^B_S T$), and that we know the location of the frame attached to the bolt lying on the table relative to the table frame—that is, ${}^S_G T$. Calculate the position and orientation of the bolt relative to the manipulator's hand, ${}^T_G T$.

Guided by our notation (and, it is hoped, our understanding), we compute the bolt frame relative to the hand frame as

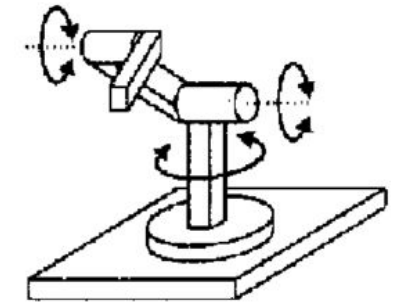
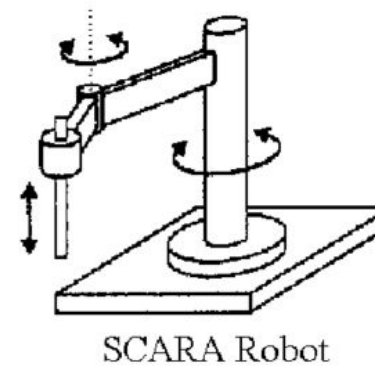
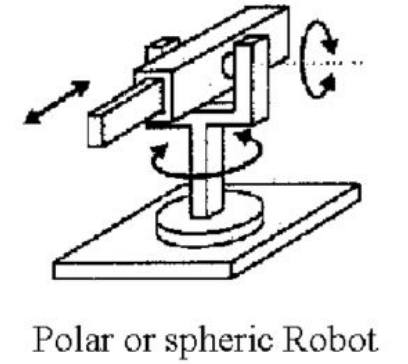
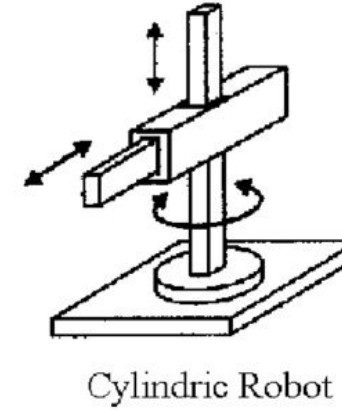
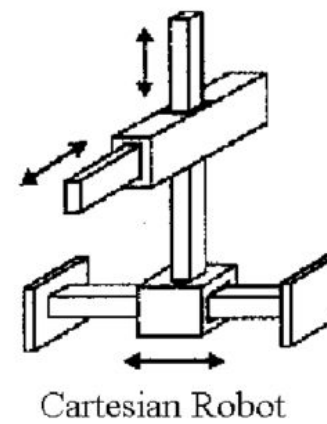
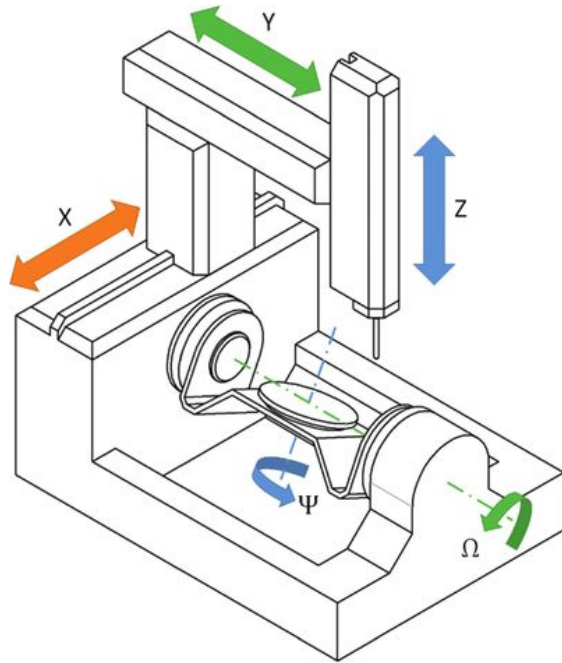
$${}^T_G T = {}^B_T T^{-1} {}^B_S T {}^S_G T. \quad (2.55)$$



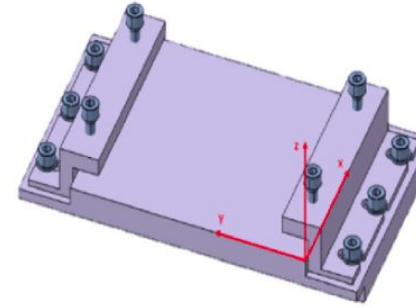
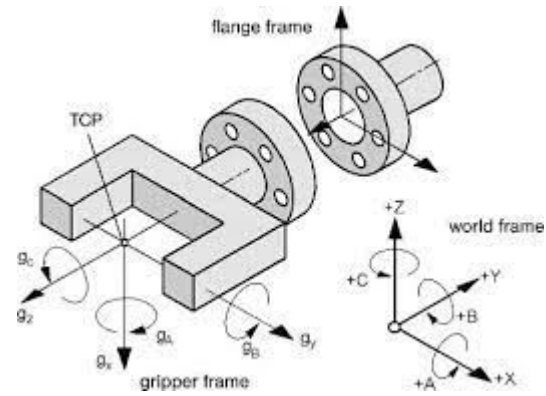
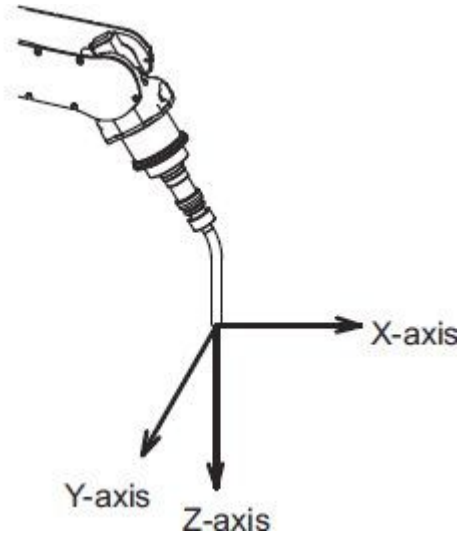
Common kinematics structures of robots



Common kinematics structures of robots



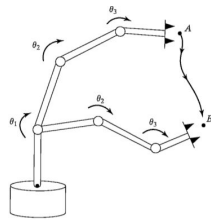
Tool Center Point (TCP)



How robot works

Torque to apply for each joint's motor to reach desired trajectory (joints angles computed by inverse kinematics algorithm by controller)

InvKine comput.

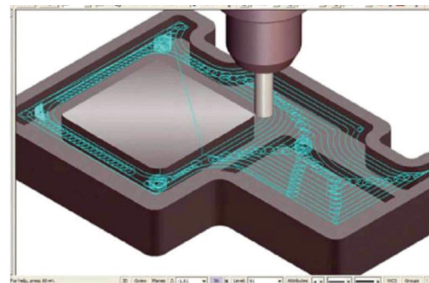


Control action

Joints states

Other info (camera, sensors...)

Trajectory

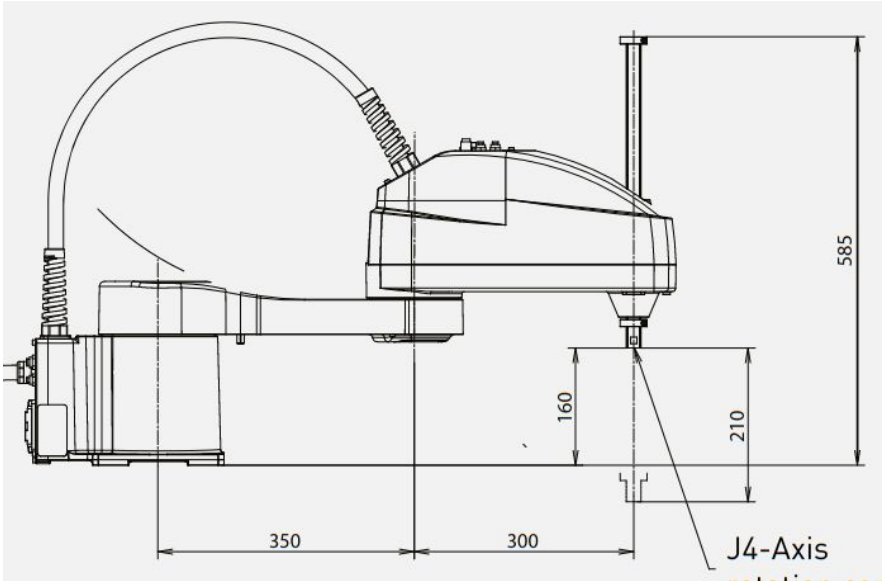


Modelling of SCARA robot in simulink

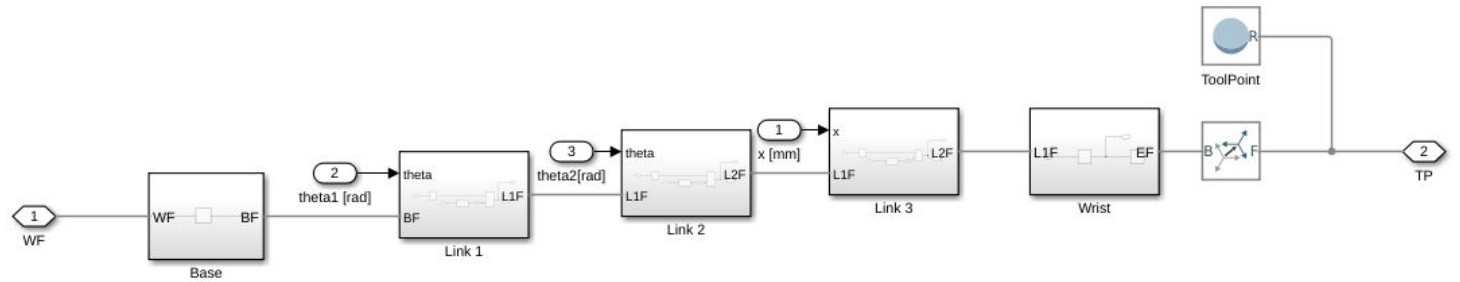
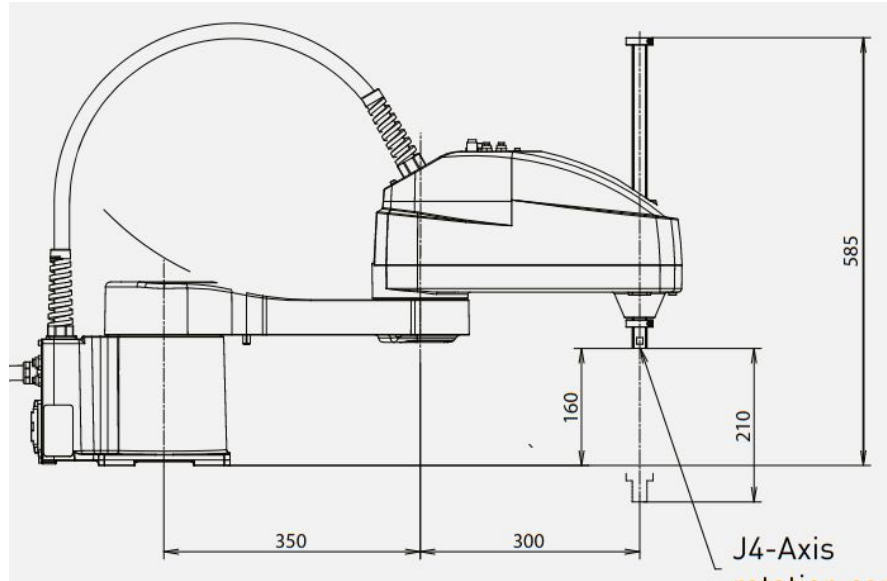


Controlled axes	Repeatability (mm)	Mechanical weight (kg)	Motion range (°)						Maximum speed (°/s)					
			J1	J2	J3	J4	J5	J6	J1	J2	J3	J4	J5	J6
4	± 0.01 (J1,J2, J3) ± 0.004 (J4)	30	296	300	210mm	720	-	-	440	700	2000 mm/sec	2500	-	-

AXIS ROBOT	REACH	LOAD CAPACITY
4	650 mm	6 kg

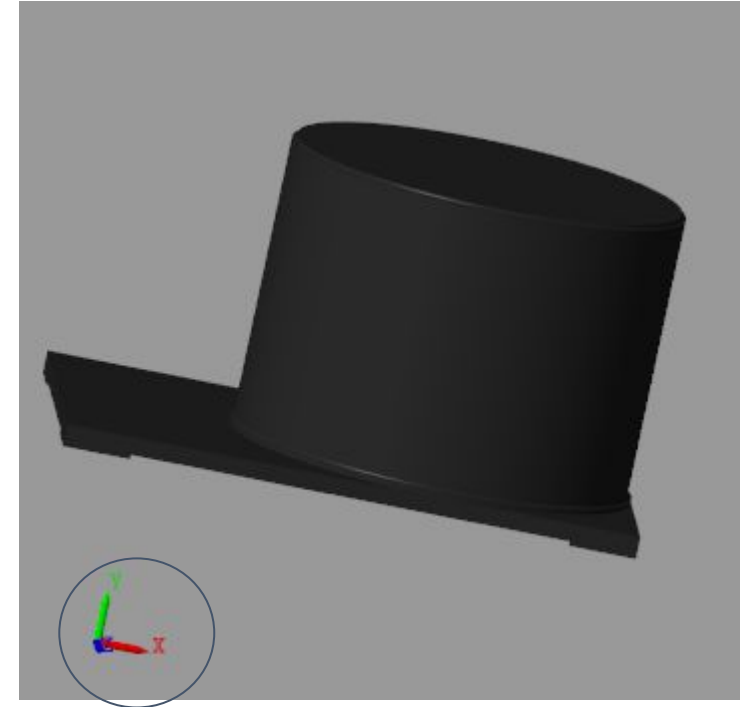


Modelling of SCARA robot in simulink

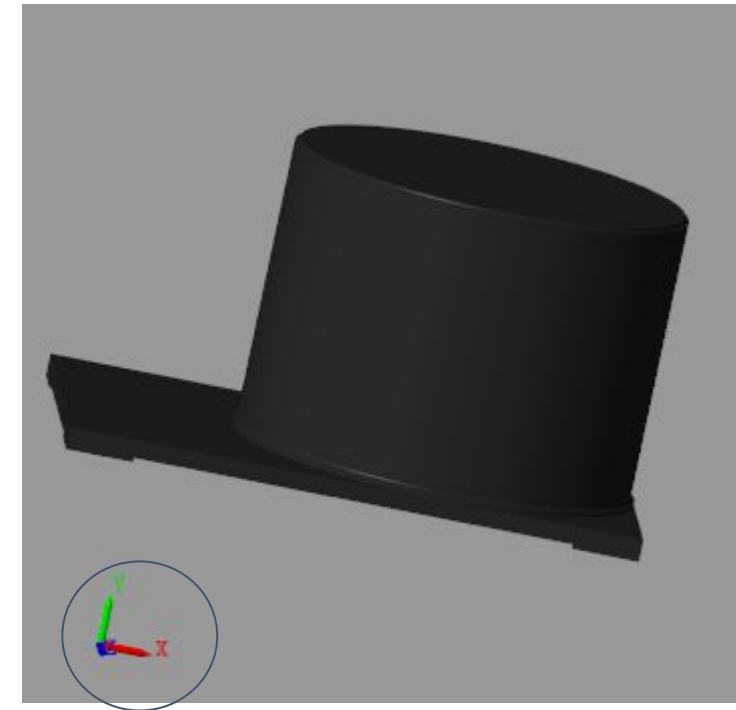
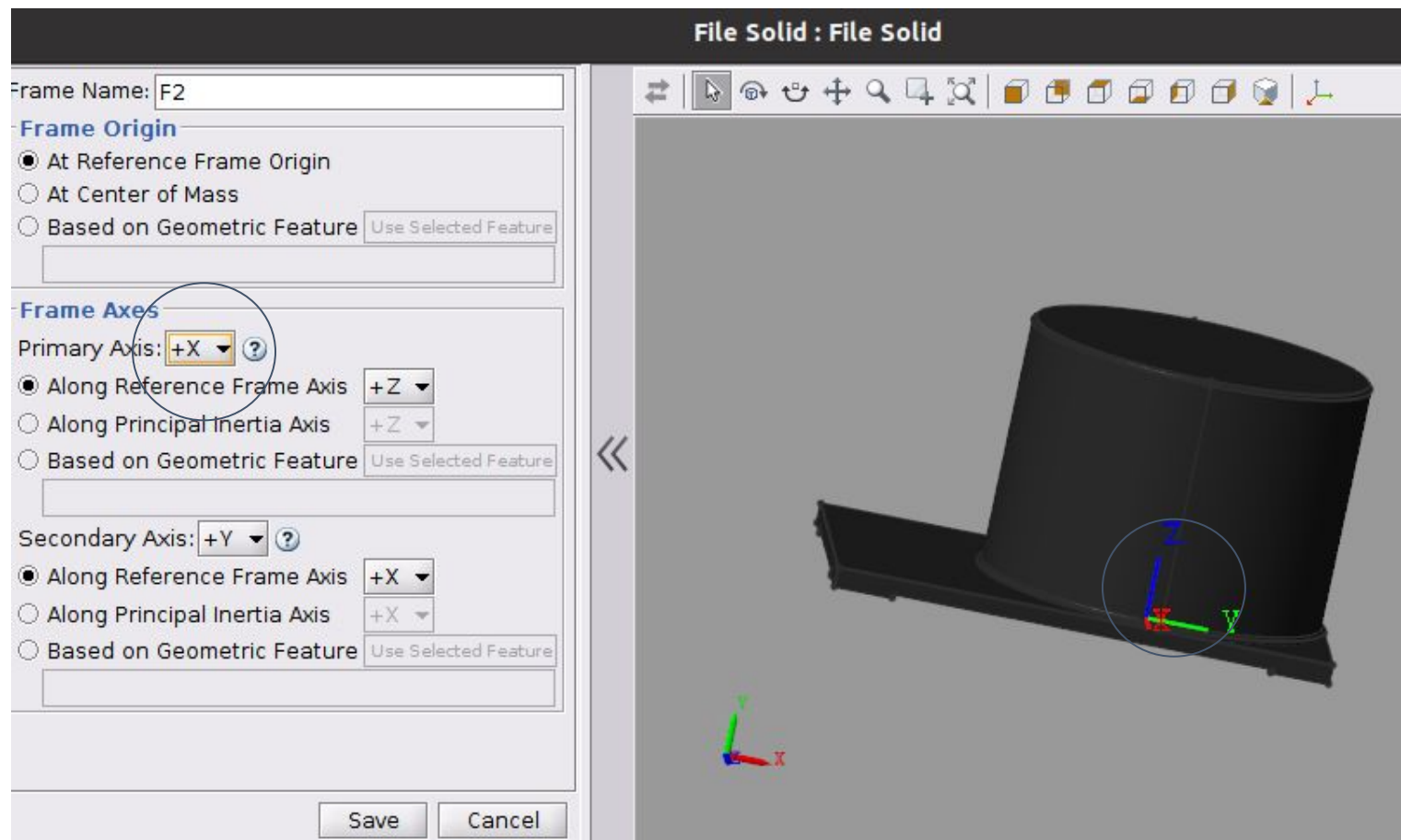


Modelling of SCARA robot in simulink

- Importing CAD file with file solid
- Check RS of component, we need a z axis in the direction of joint 1 motion!!
- Add a new frame
- Using this new frame to add a new link and put a joint between those

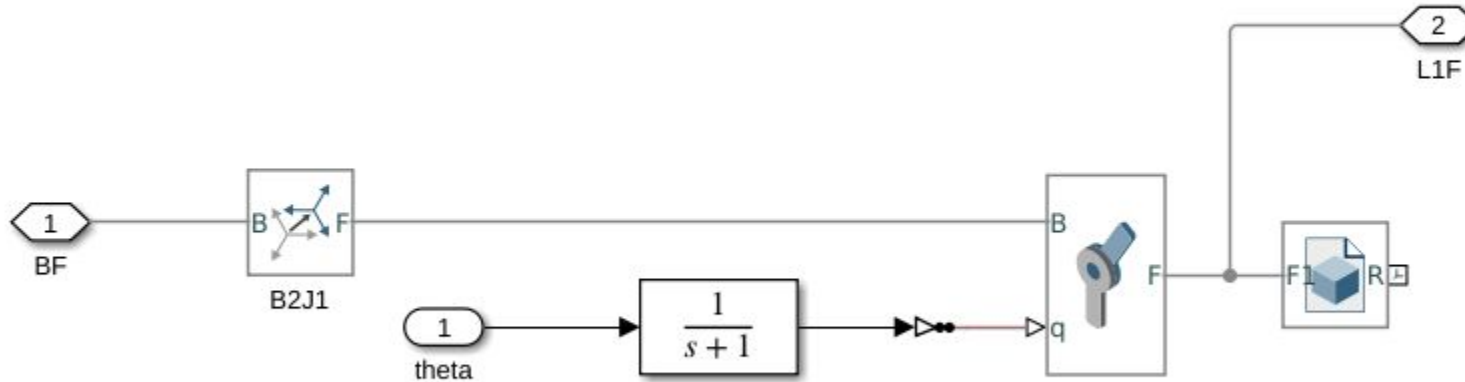


Modelling of SCARA robot in simulink



Frames	
Show Port R	<input checked="" type="checkbox"/>
Frame1	F1
New Frame	

Modelling of SCARA robot in simulink



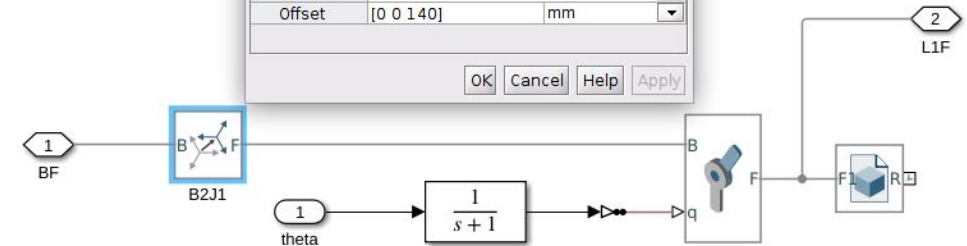
Properties

Z Revolute Primitive (Rz)		
State Targets		
Internal Mechanics		
Limits		
Specify Lower Limit	<input checked="" type="checkbox"/>	
Bound	-LJ1	deg
Spring Stiffness	1e4	N*m/deg
Damping Coefficient	10	N*m/(deg/s)
Transition Region Width	0.1	deg
Specify Upper Limit	<input checked="" type="checkbox"/>	
Bound	LJ1	deg
Spring Stiffness	1e4	N*m/deg
Damping Coefficient	10	N*m/(deg/s)
Transition Region Width	0.1	deg
Actuation		
Torque	Automatically Computed	
Motion	Provided by Input	
Sensing		
Mode Configuration		
Composite Force/Torque Sensing		

Ports B and F are frame ports that represent the base and follower frames, respectively. The transformation represents the follower frame origin and axis orientation in the base frame.

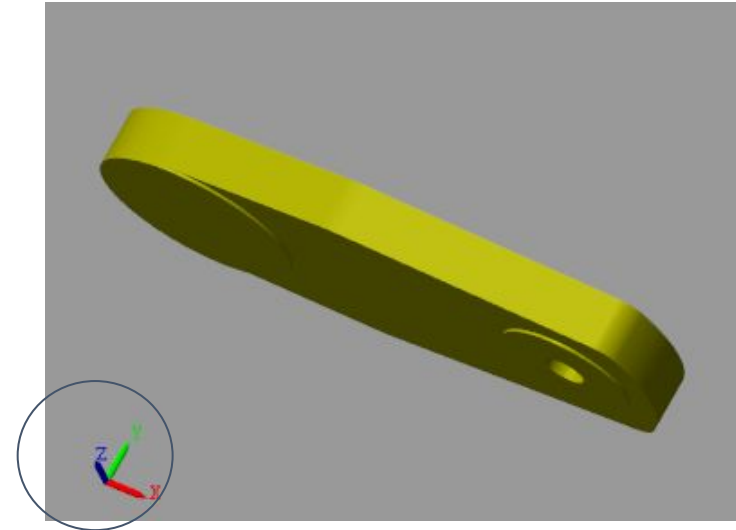
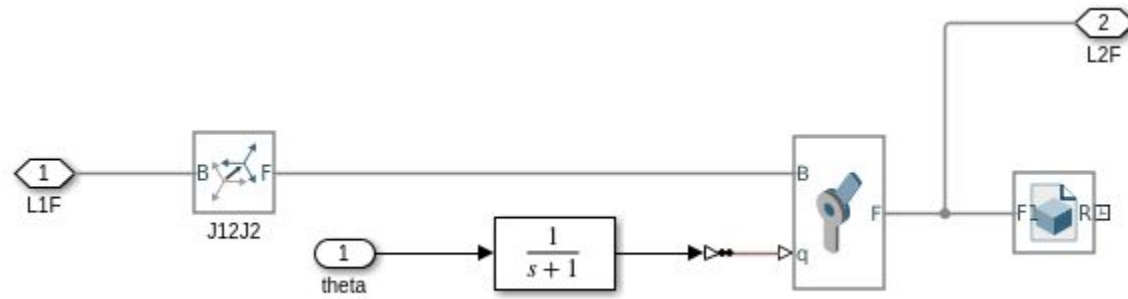
Properties

Rotation	
Method	None
Translation	
Method	Cartesian
Offset	[0 0 140] mm
OK Cancel Help Apply	



Modelling of SCARA robot in simulink

Properties		
Rotation		
Method	None	
Translation		
Method	Cartesian	
Offset	[0 350 40]	mm



Modelling of SCARA robot in simulink

