Robotic system development

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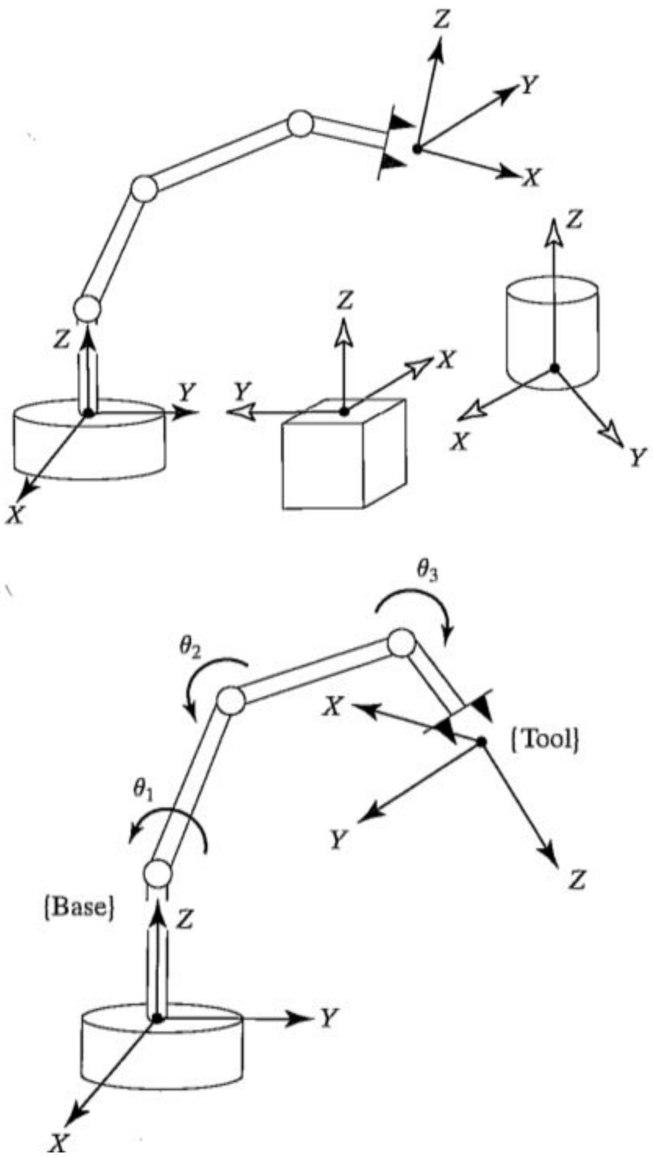
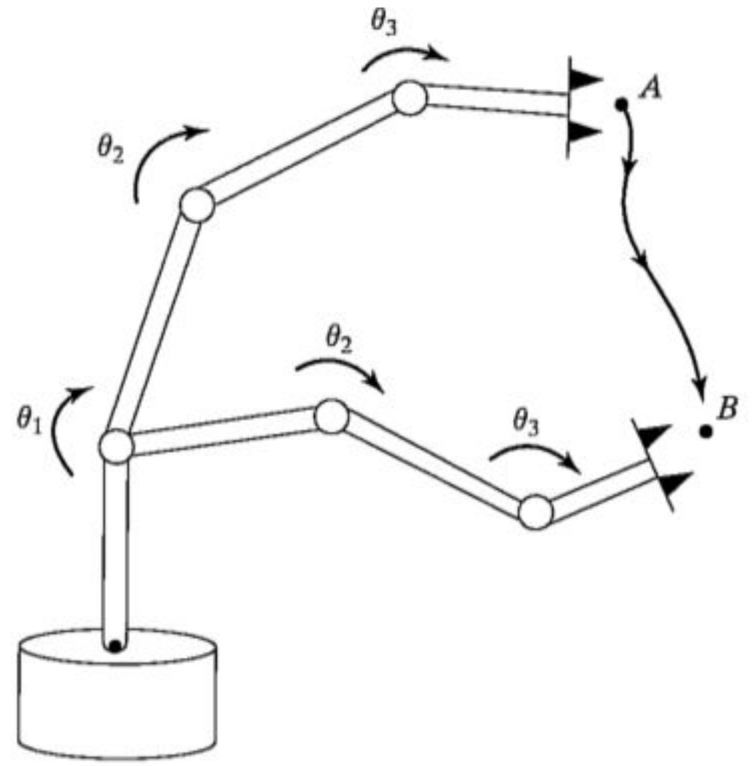
Recap : Robotic system

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



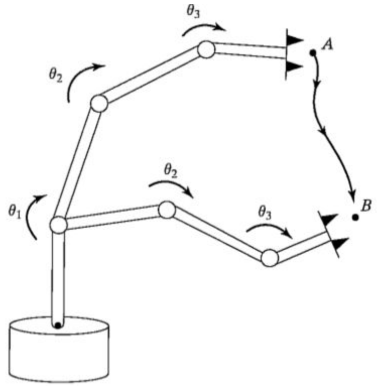
Recap : Direct and inverse kinematics

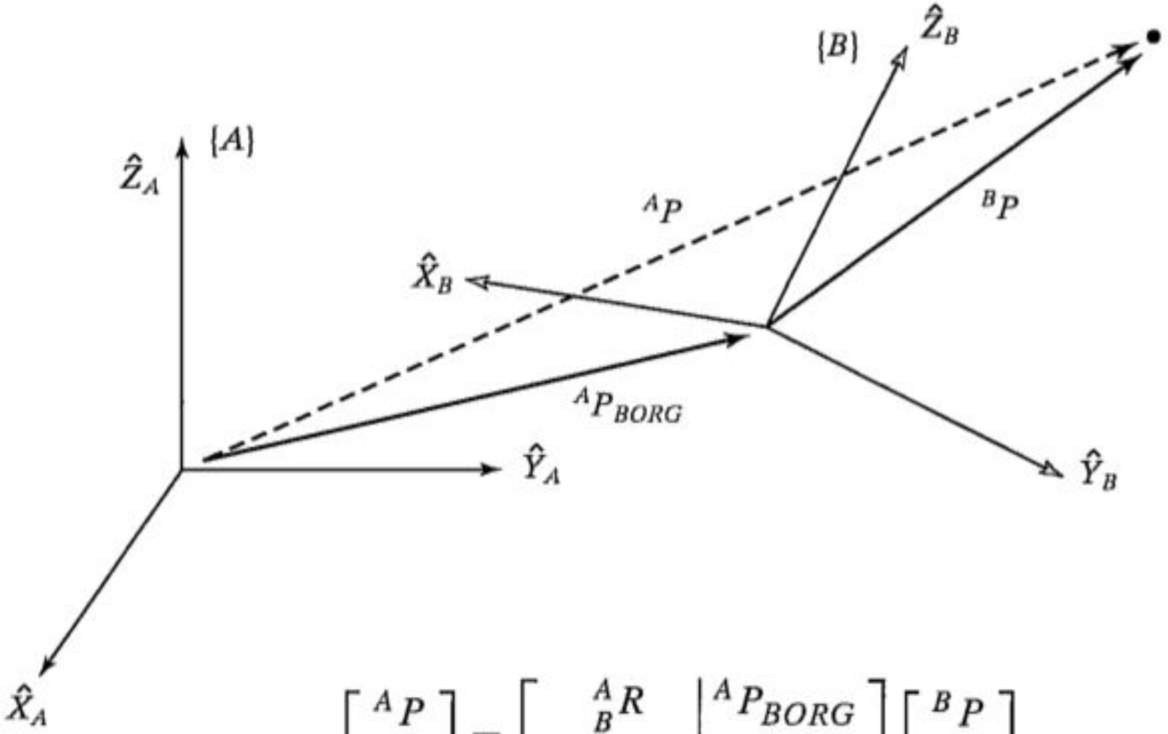
$$R_x = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta & \sin\theta & 0 \\ 0 & -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

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

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

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





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

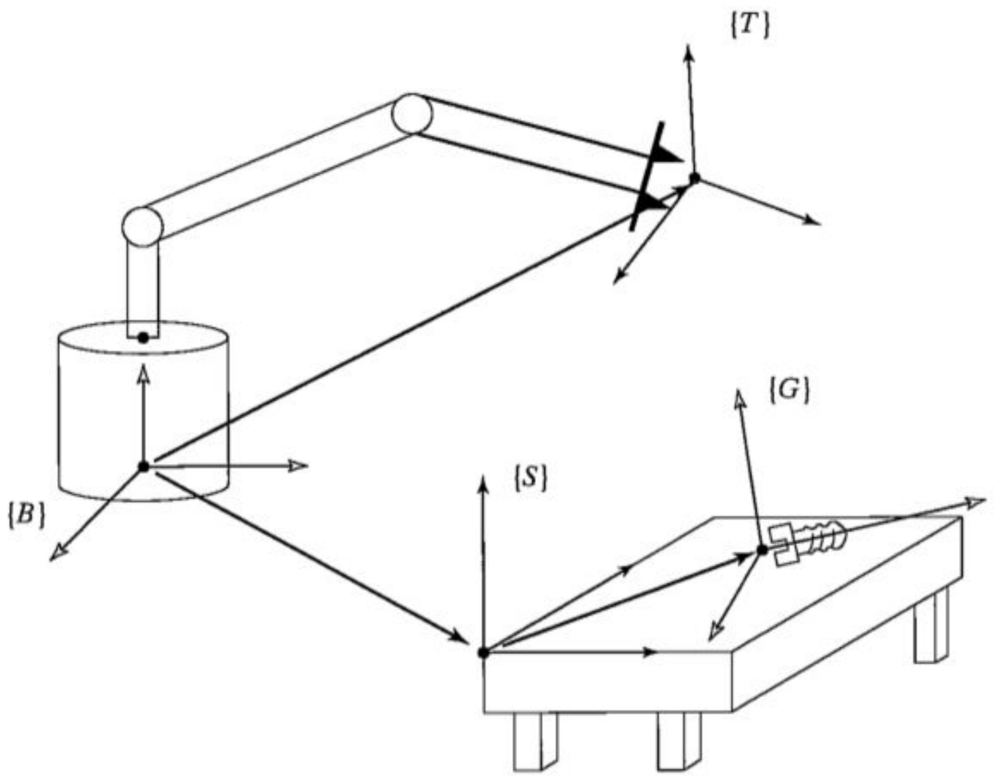
Recap : Direct and inverse kinematics

EXAMPLE 2.6

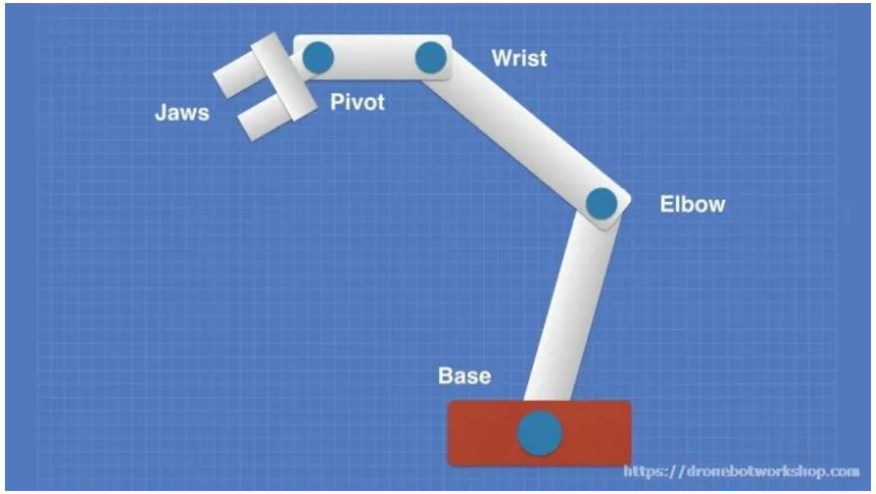
Assume that we know the transform ${}^{B}_{T}T$ in Fig. 2.16, which describes the frame at the manipulator's fingertips $\{T\}$ relative to the base of the manipulator, $\{B\}$, that we know where the tabletop is located in space relative to the manipulator's base (because we have a description of the 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, ${}^{T}_{G}T$.

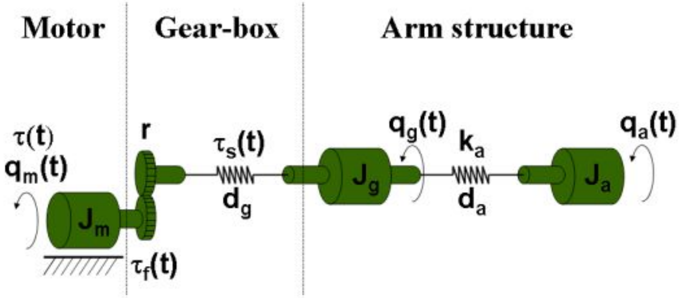
Guided by our notation (and, it is hoped, our understanding), we compute the bolt frame relative to the hand frame as

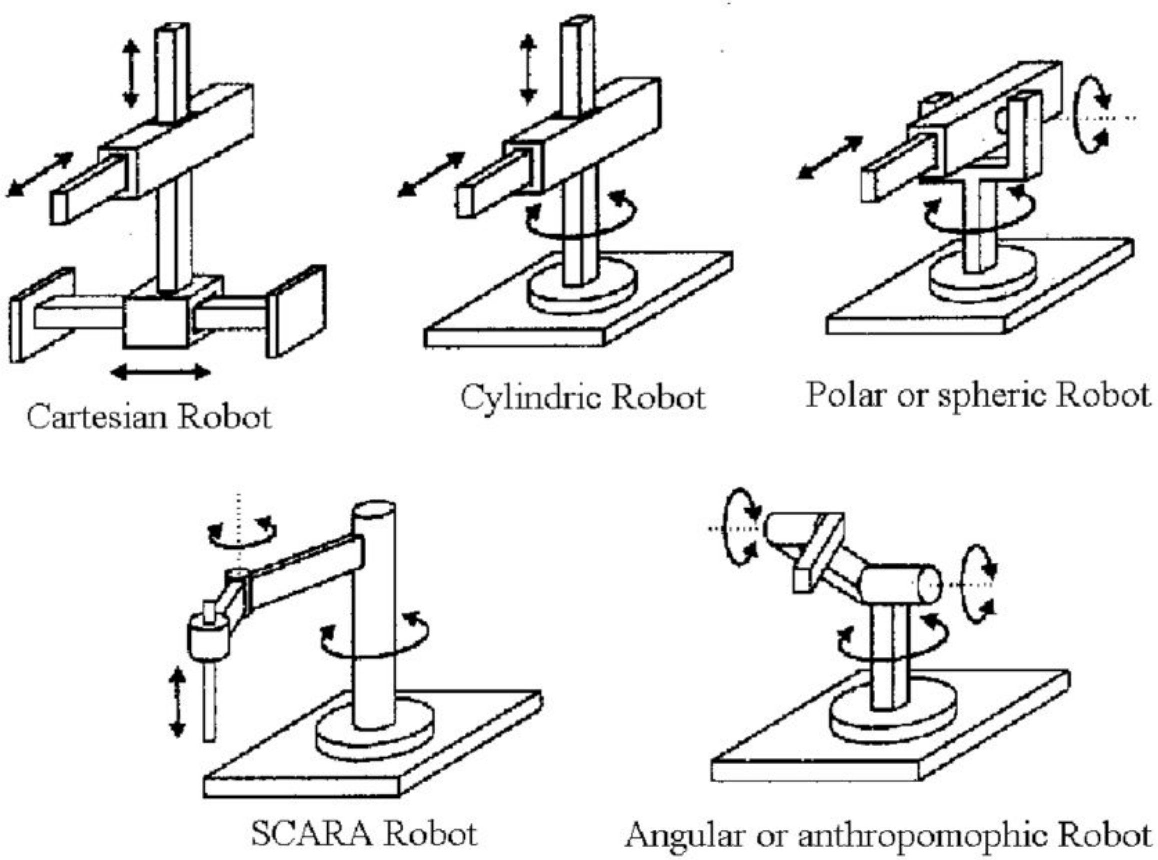
$$ {}^{T}_{G}T = {}^{B}_{T}T^{-1}\,{}^{B}_{S}T\,{}^{S}_{G}T. \tag{2.55}$$



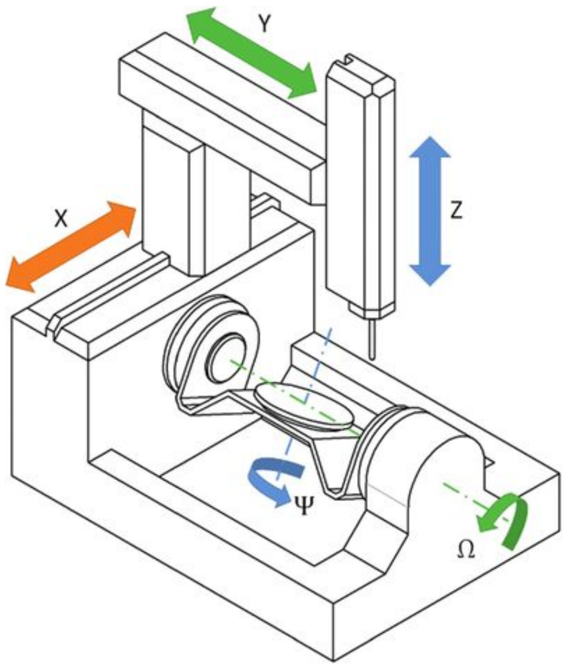
Common kinematics structures of robots

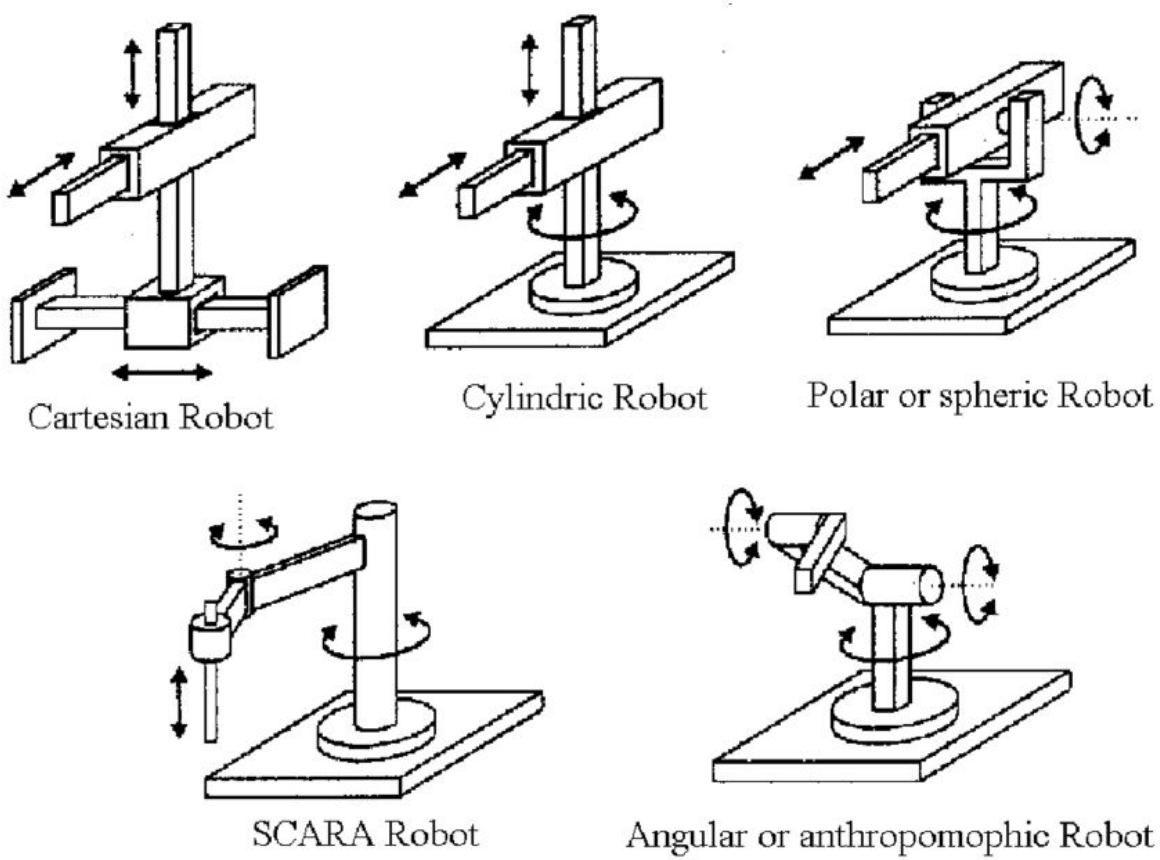




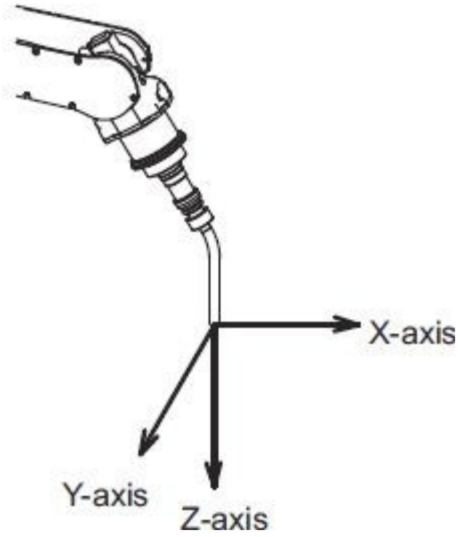


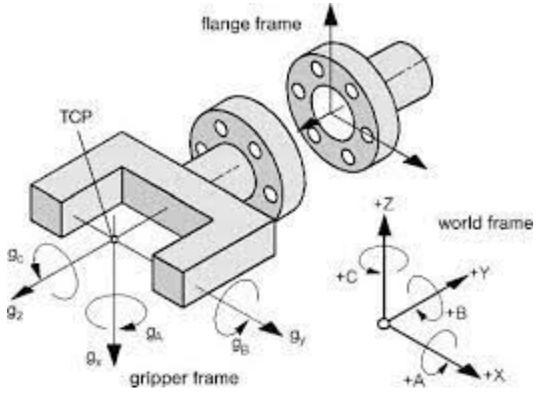
Common kinematics structures of robots

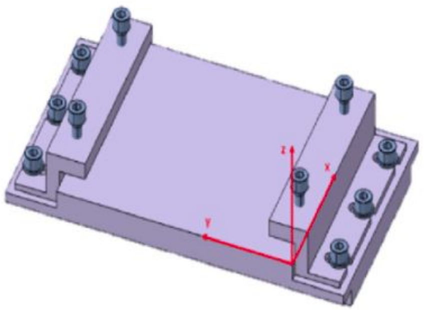




Tool Center Point (TCP)



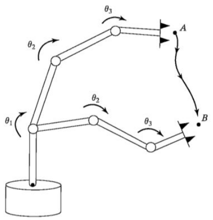




How robot works

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

InvKine comput.

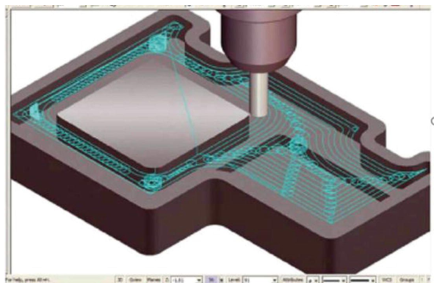


Control action

Joints states

Other info (camera, sensors…)

Trajectory



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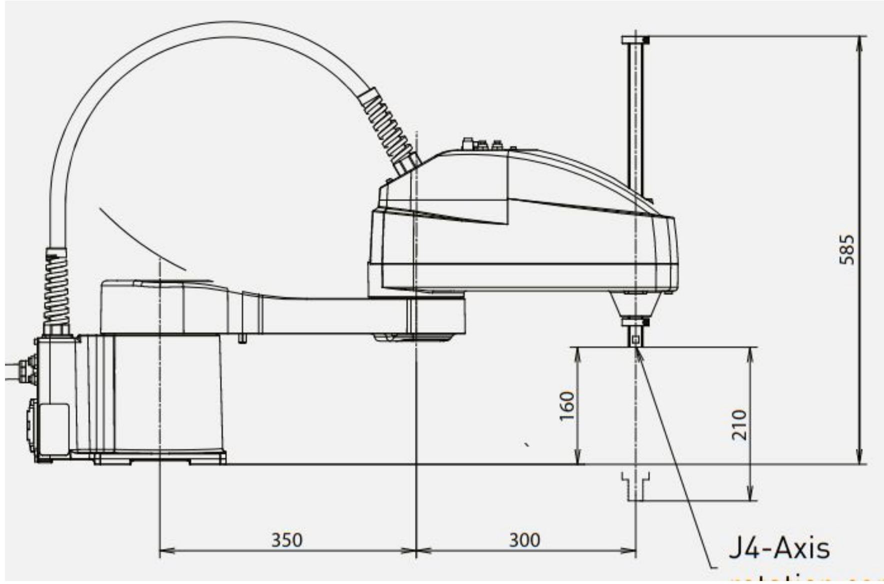
Modelling of SCARA robot in simulink

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



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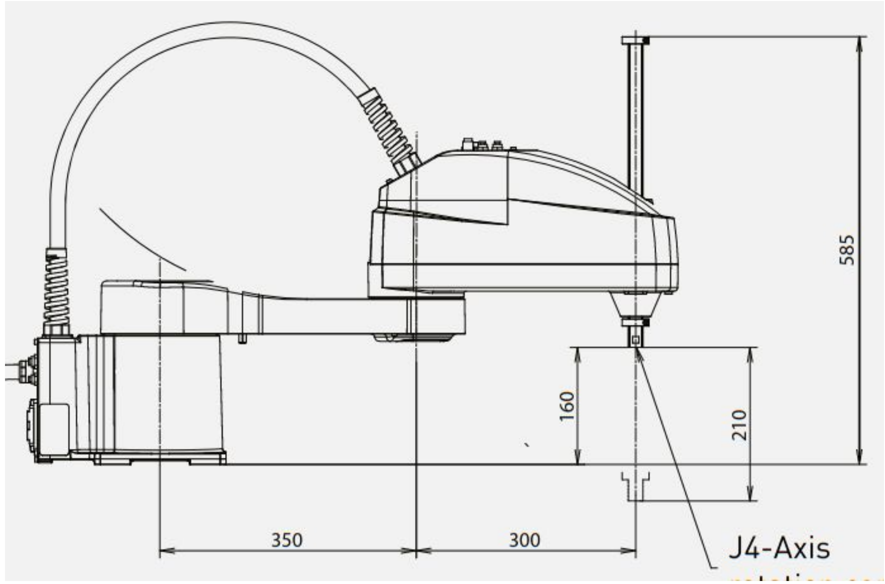
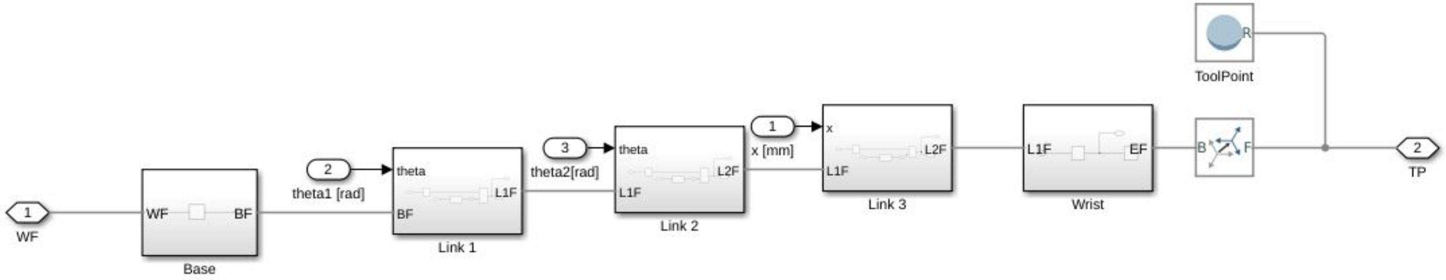
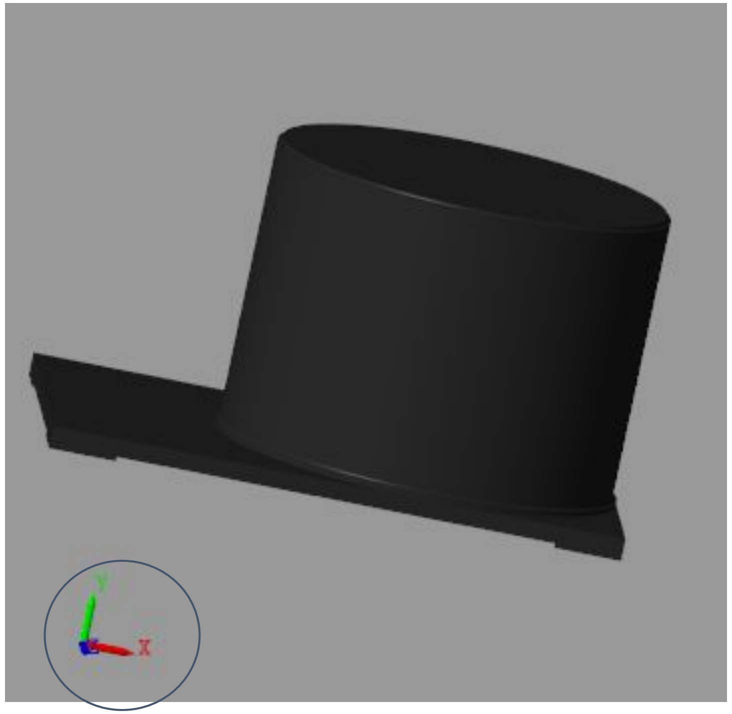




Modelling of SCARA robot in simulink

- 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



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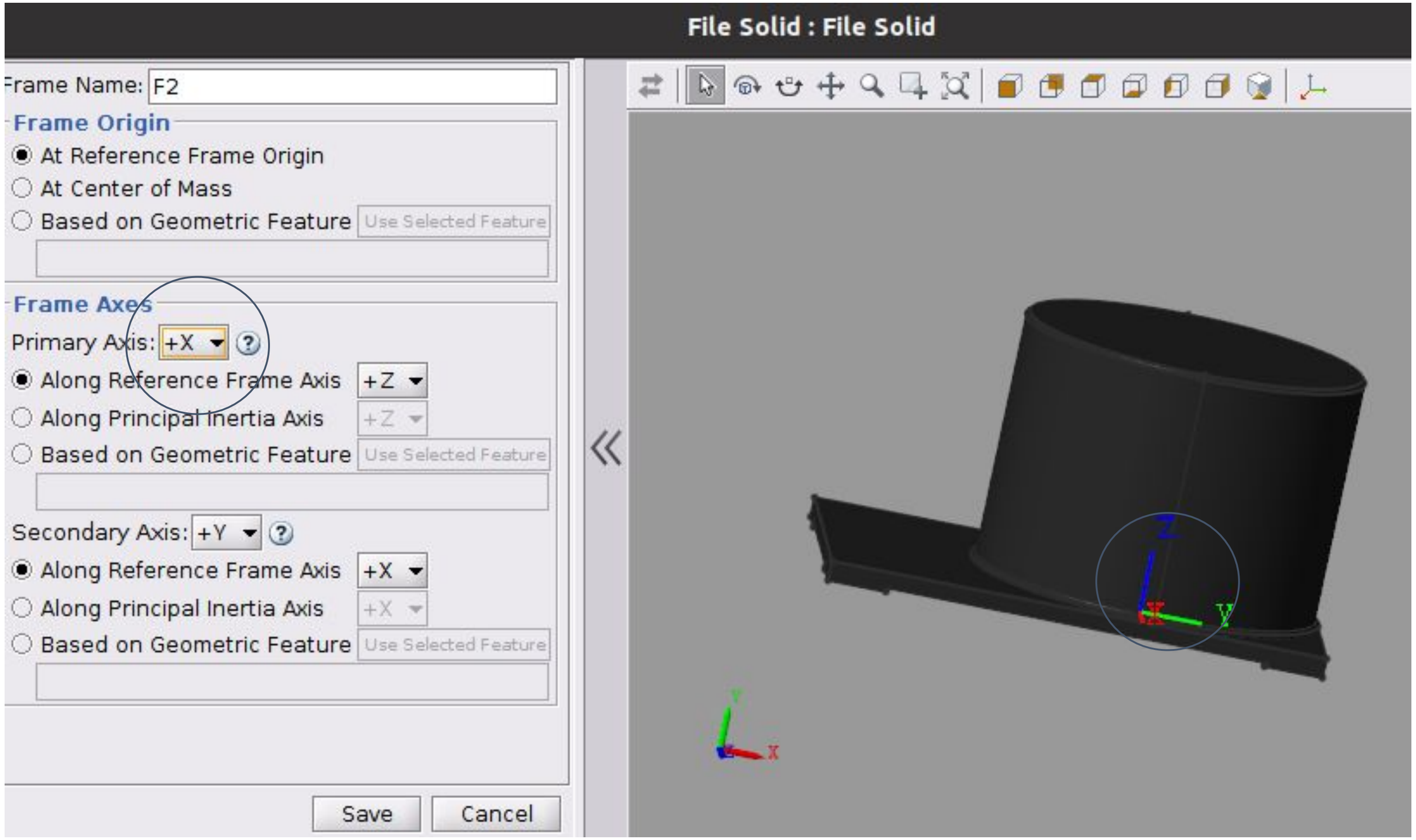

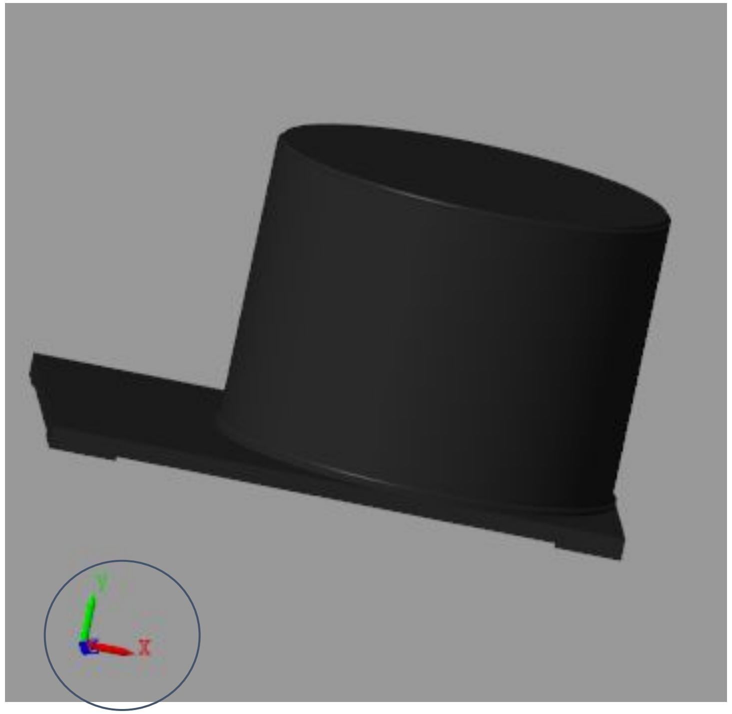

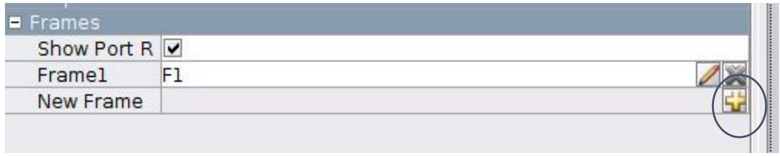

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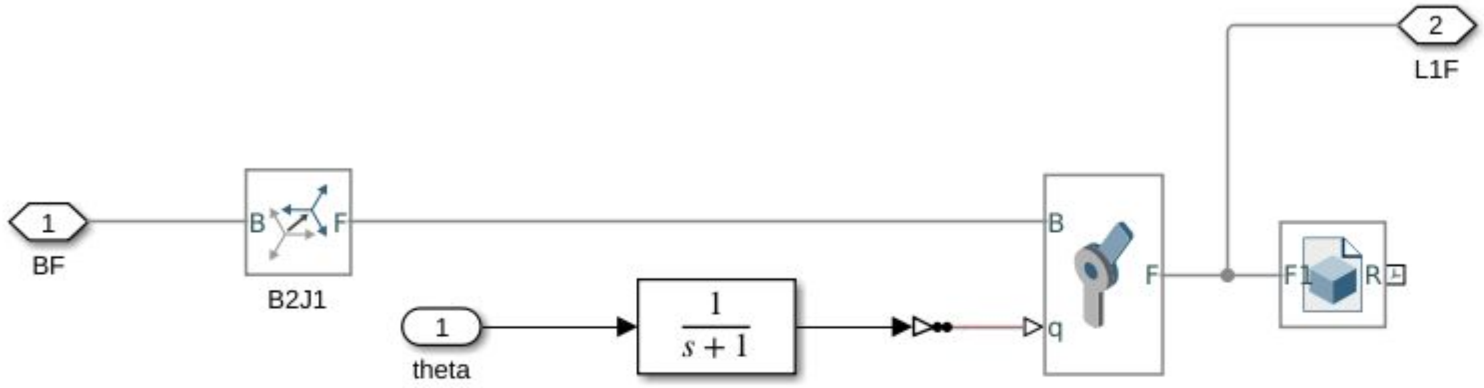

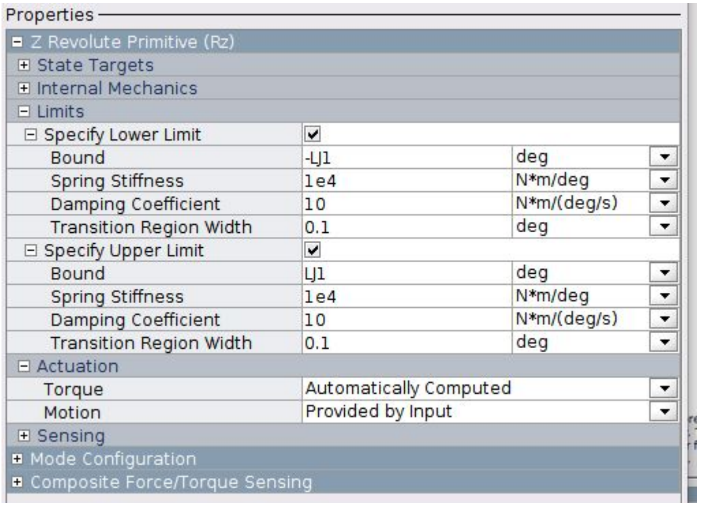

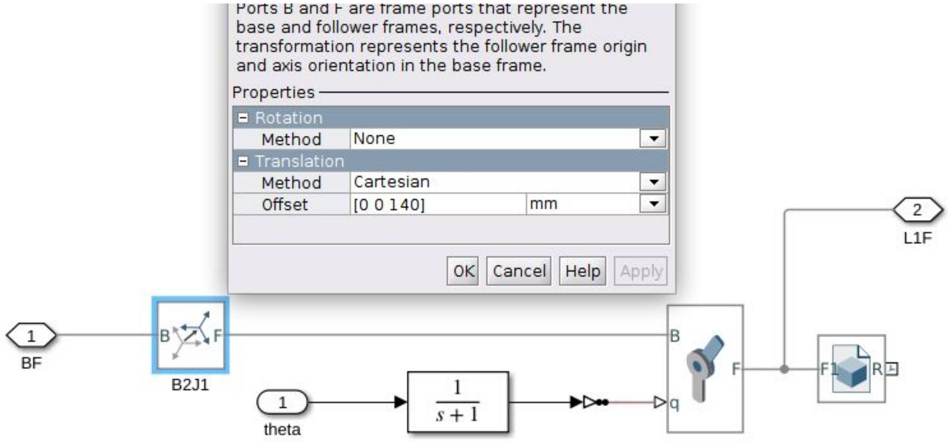

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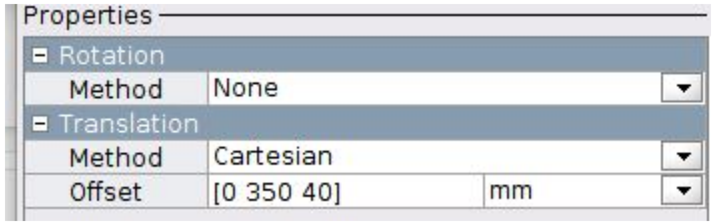

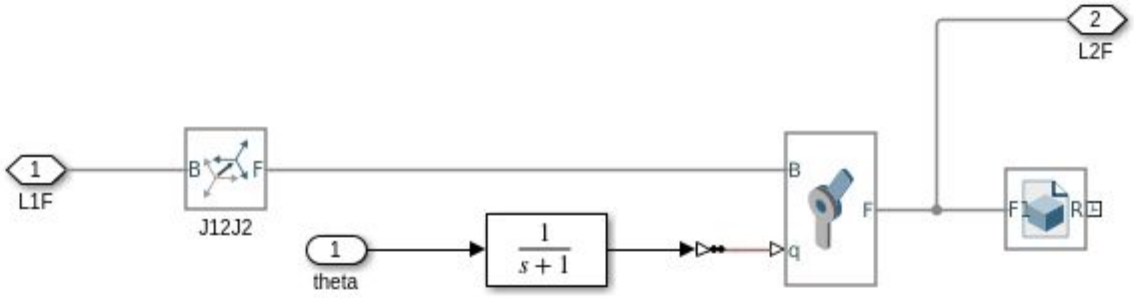

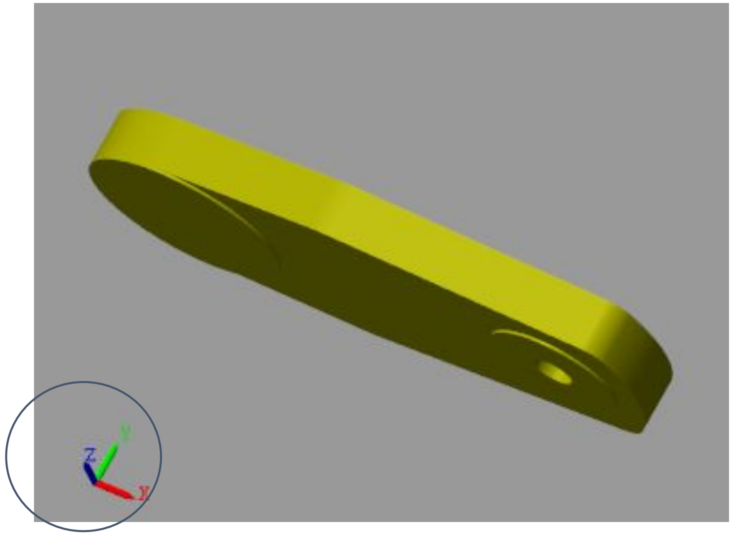

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