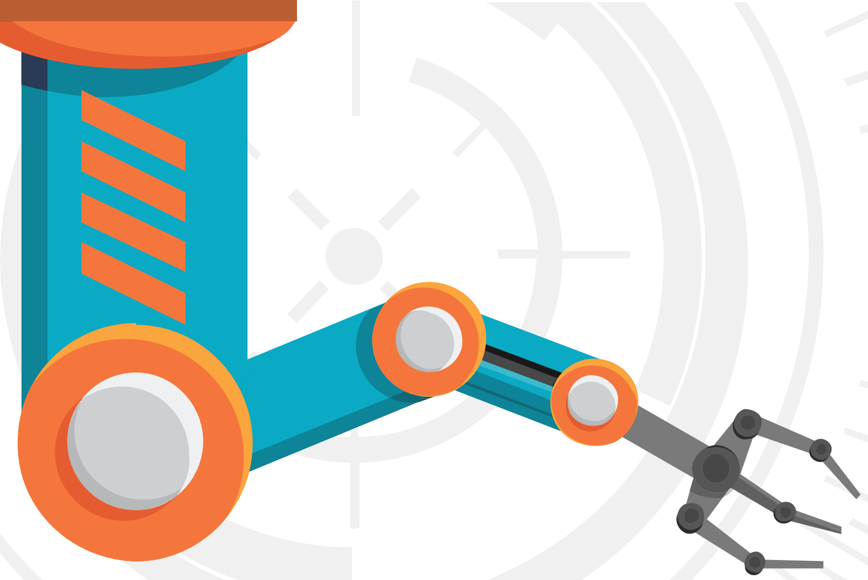
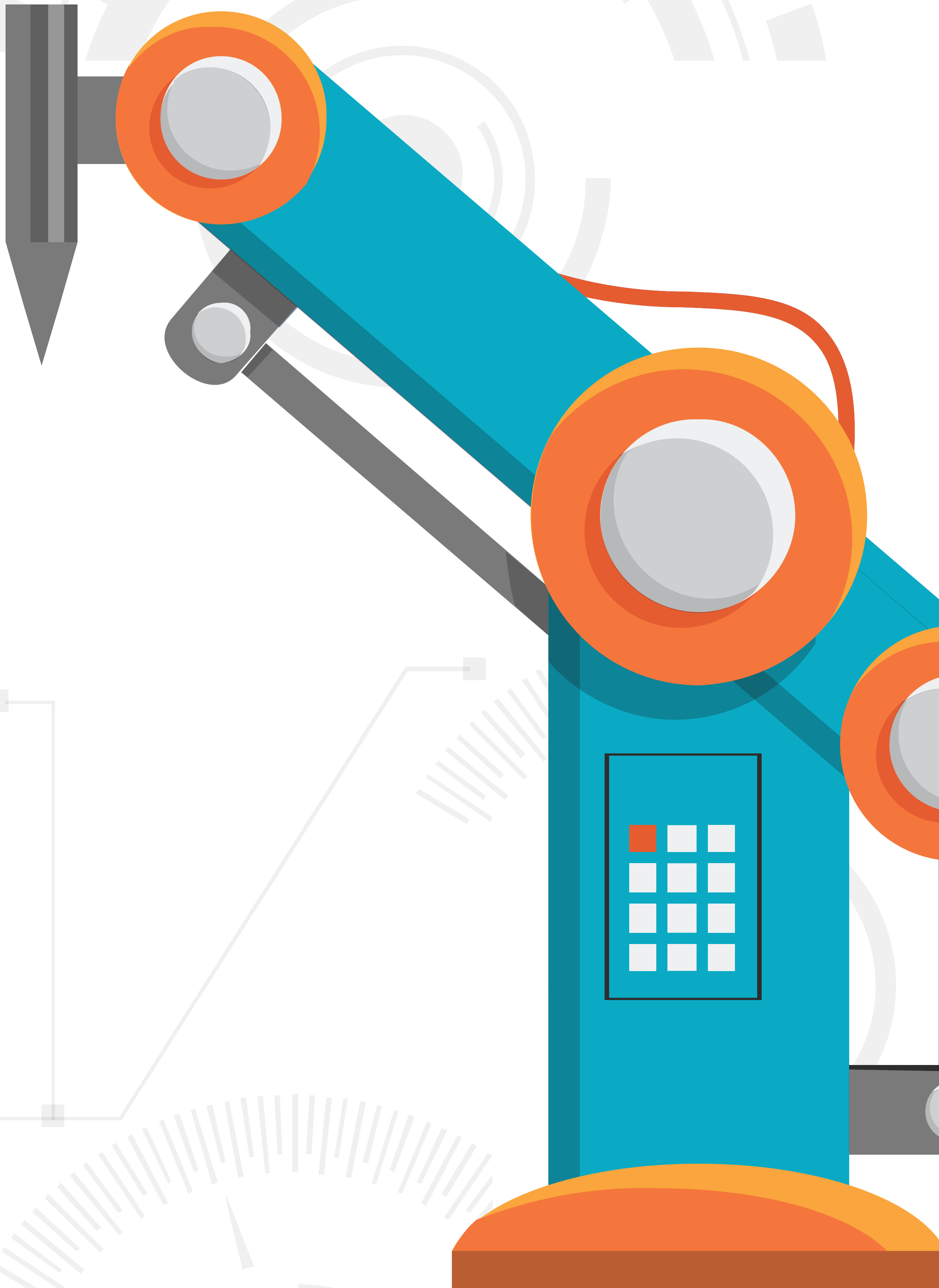
itc Institute Technical Council





ELECTRONICS & ROBOTICS CLUB

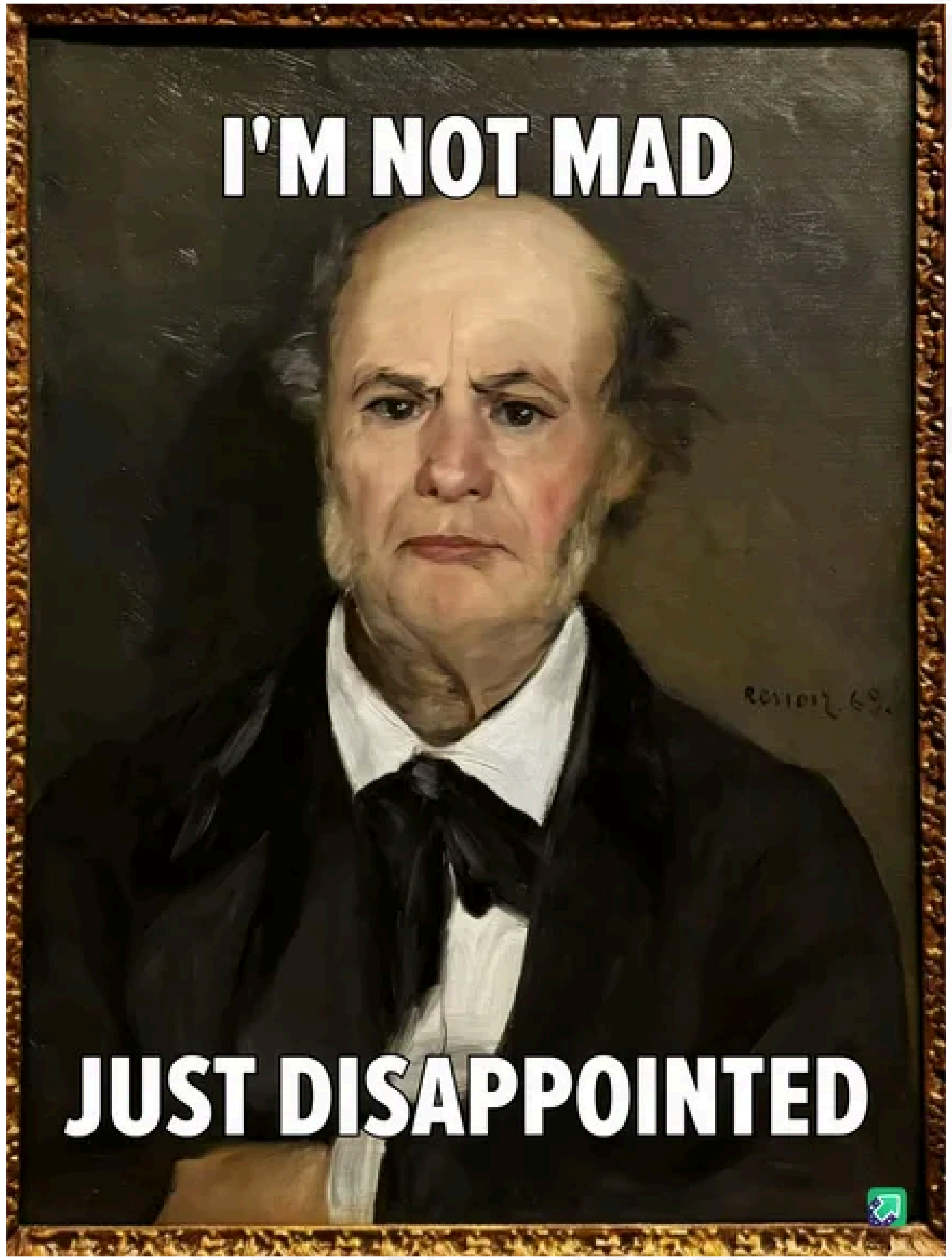
PRESENTS

HELLO ROBOT

Flow of the session

THEORY

SOME MORE THEORY


I'M NOT MAD
JUST DISAPPOINTED

Flow of the session

01 Kinematics

02 Controls

03 3-D modelling

04 Fun Activity

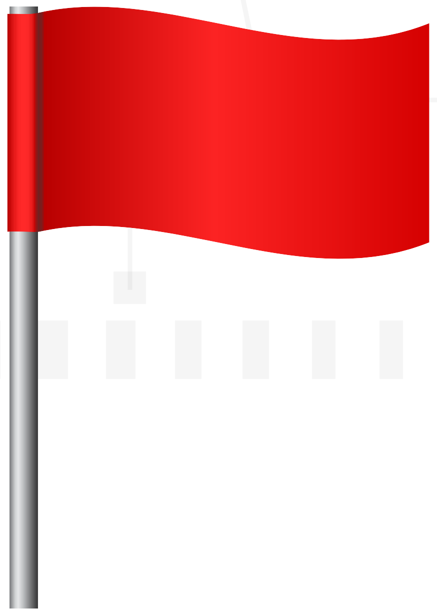
Kinematics

Kinematics, the abstruse subdivision of classical mechanics, intricately elucidates the temporal and spatial trajectories of discrete points, rigid bodies, or intricate systems, wholly disentangled from the dynamical forces instigating such motion. In the n-dimensional manifold, the topological configuration space of a rigid entity can be meticulously delineated by the convoluted superposition of translational and rotational degrees of freedom, typically expressed via the manifold's underlying algebraic structure — notably, a Lie group such as SE(n). In particular, SE(3), the special Euclidean group, encapsulates the permissible isometries of three-dimensional space. The instantaneous velocity vectors of said entities, residing within the tangent bundle of this manifold, are governed by differential geometric principles, while subjected to constraints—holonomic or non-holonomic—imposing strict limitations on the system's viable kinematic evolutions.

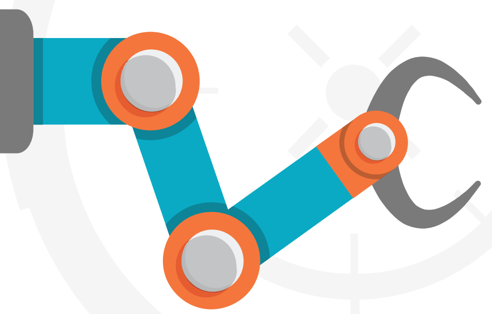
Kinematics

Kinematics refers to the study of the motion of points, objects, and group of objects

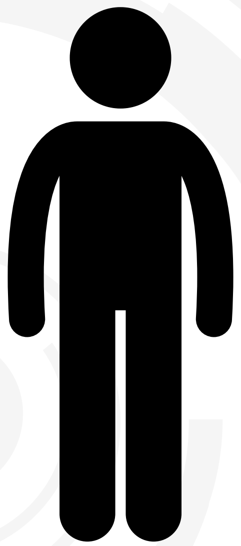
Chatur



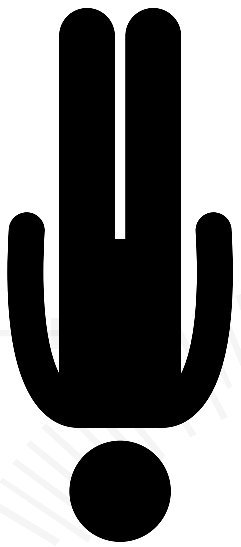
Rancho

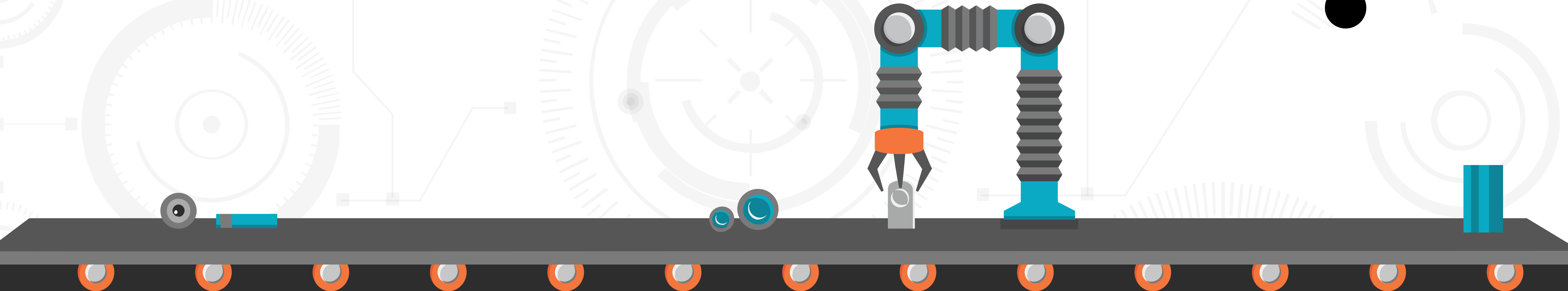


Forward Kinematics



Inverse Kinematics



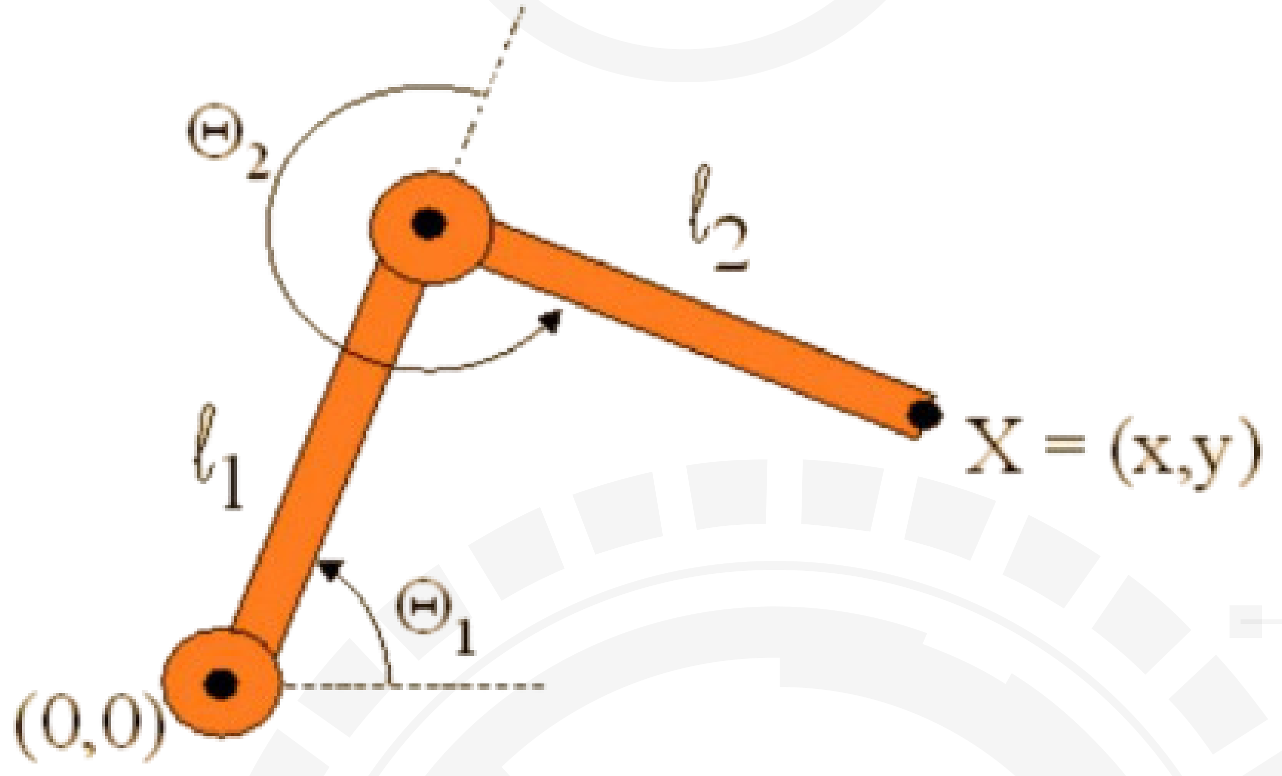


Forward Kinematics

- We use known joint variables (i.e. servo motor angles, displacement of a linear actuator, etc.)

- Calculate the position and orientation of the end effector of a robotic arm in 3D space

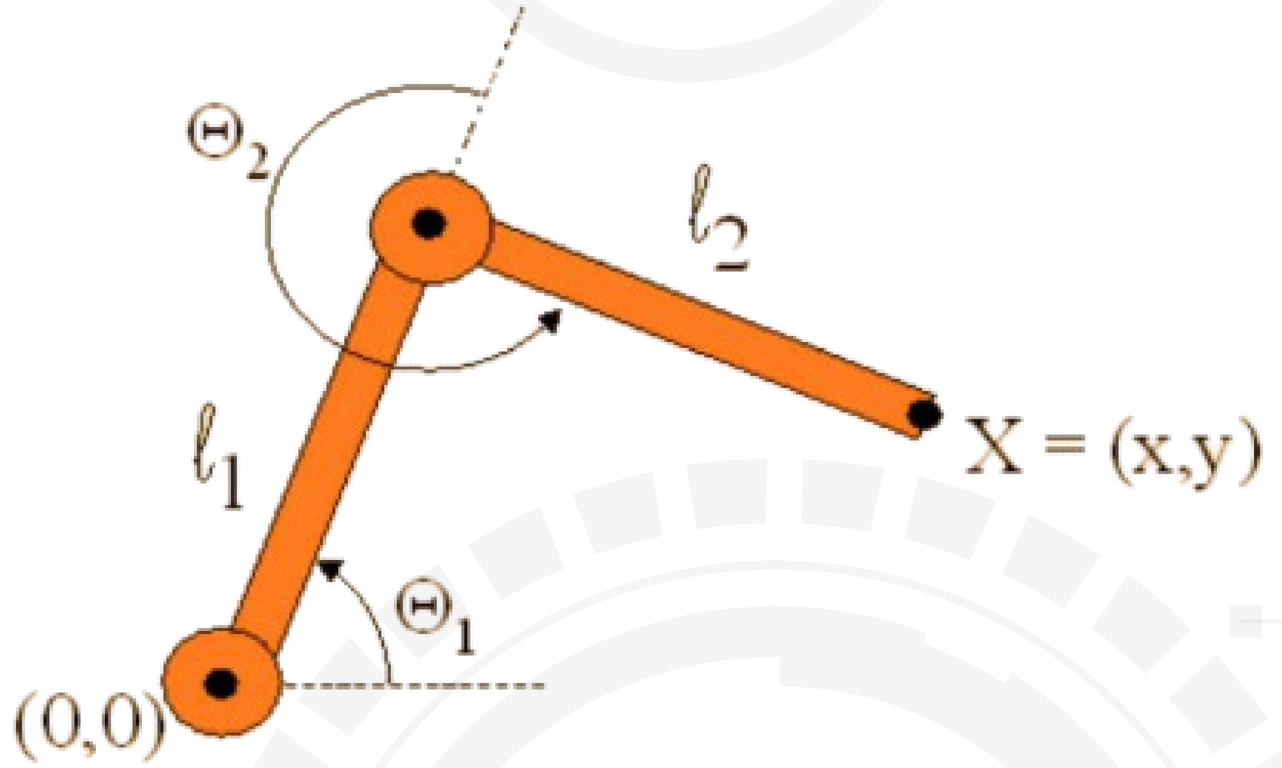
- This is called forward kinematics.

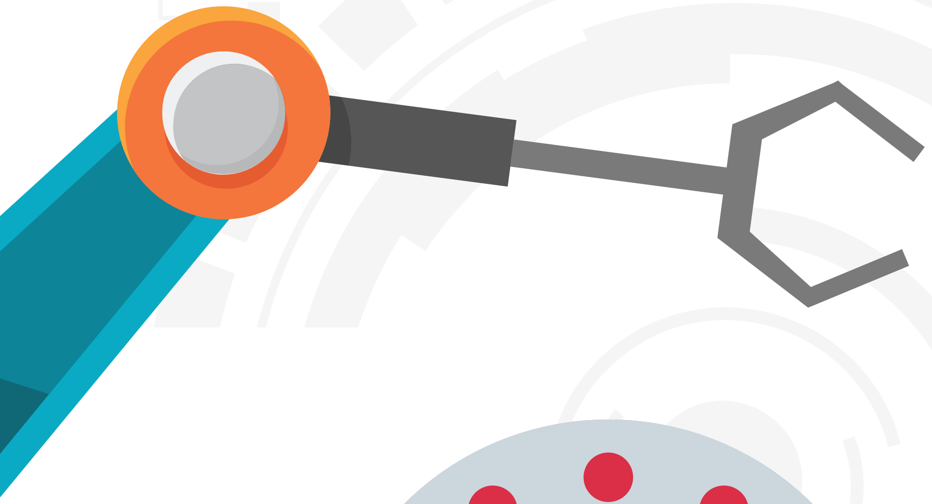


$$X = (l_1 \cos\Theta_1 + l_2 \cos(\Theta_1 + \Theta_2), l_1 \sin\Theta_1 + l_2 \sin(\Theta_1 + \Theta_2))$$

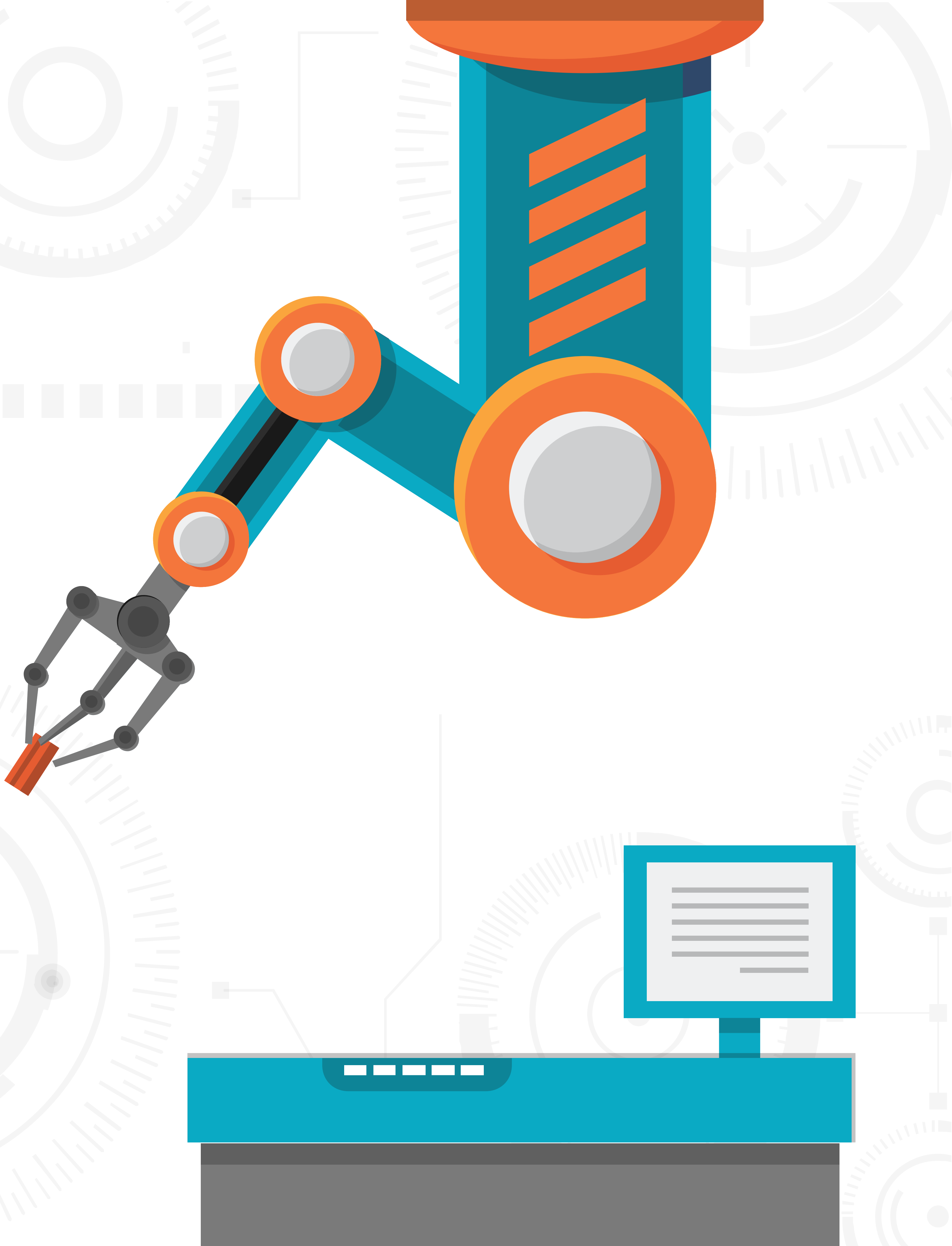
Inverse Kinematics

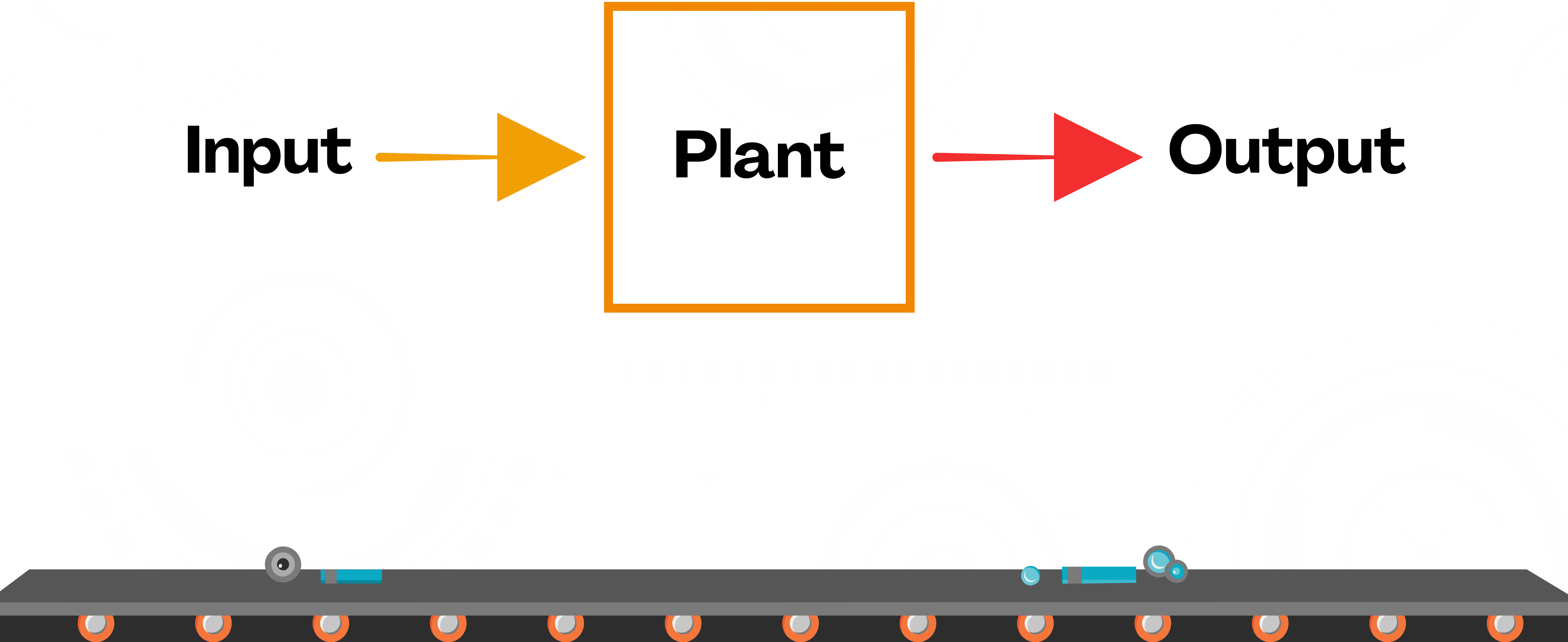
- We know the position and orientation of end effector.
- We want to find the values of the joint variables that generate that desired position and orientation of the end effector.
- Use case - We find what should be the angles of the servo motors need to be given to reach our desired position and orientation of the end effector of a robotic arm .



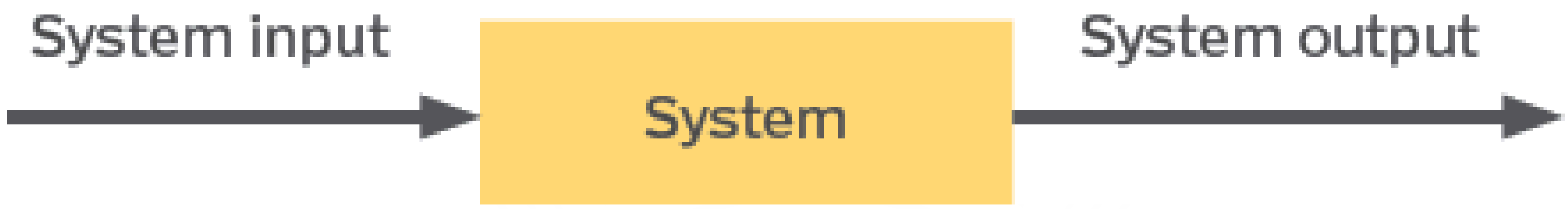


Control Da’ Systumm

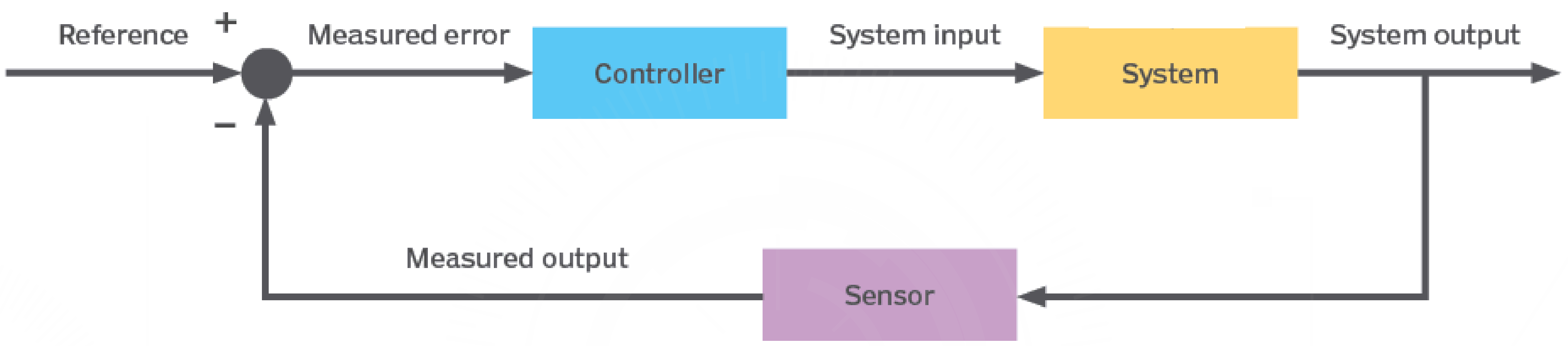


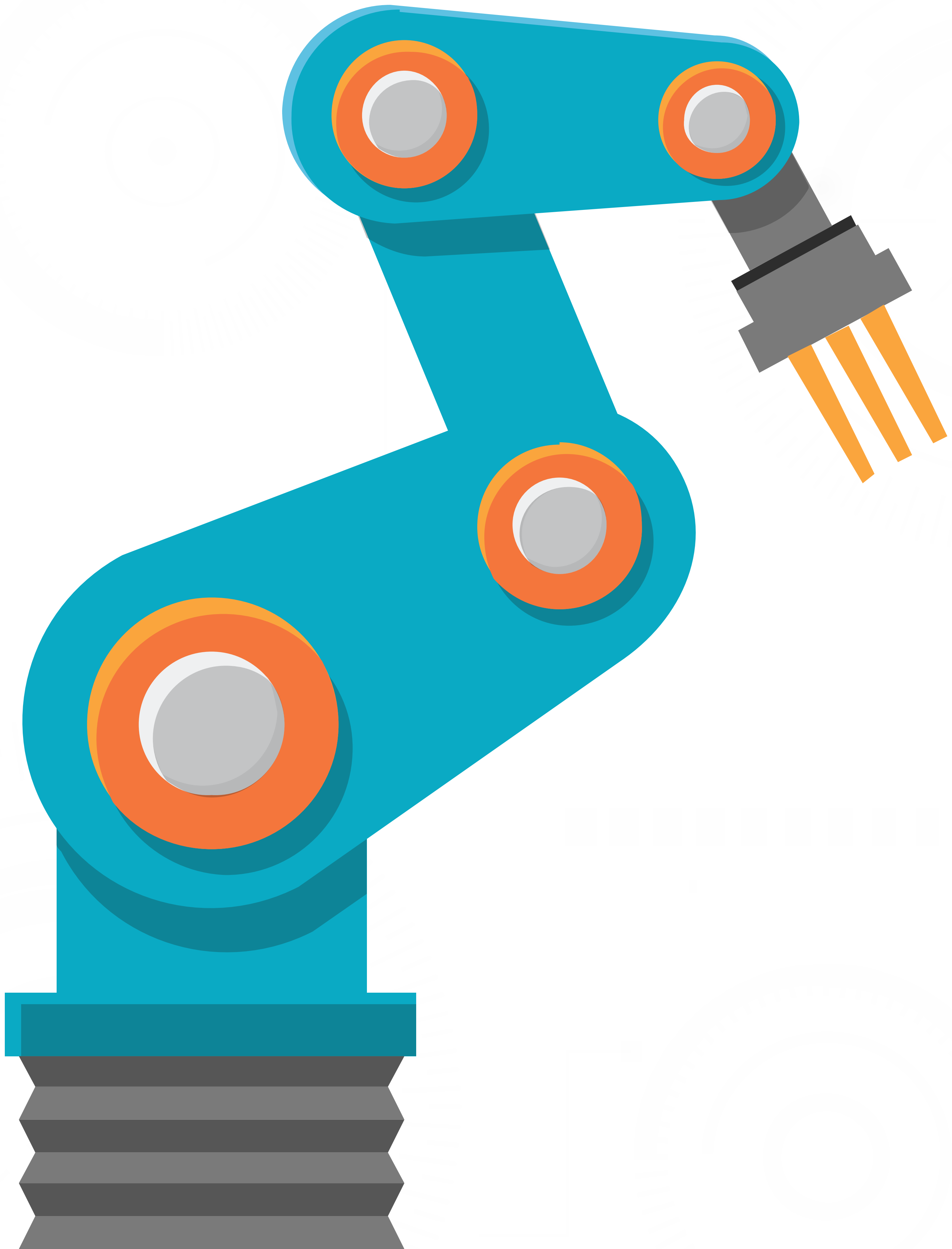

Input
Plant
Output

Open Loop

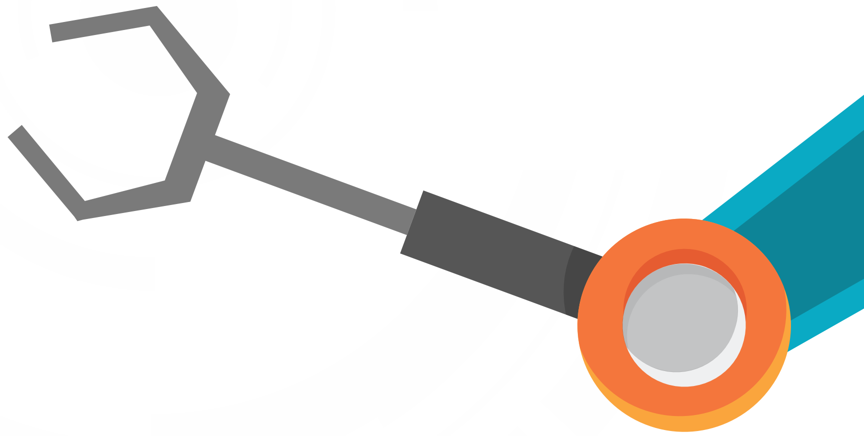


Closed Loop


Reference
+
−
Measured error
Controller
System input
System
System output
Measured output
Sensor



Let’s Begin with some SIMULATION!



MATLAB INSTALLATION

Use the link present in the github repo or type: https://in.mathworks.com/downloads/

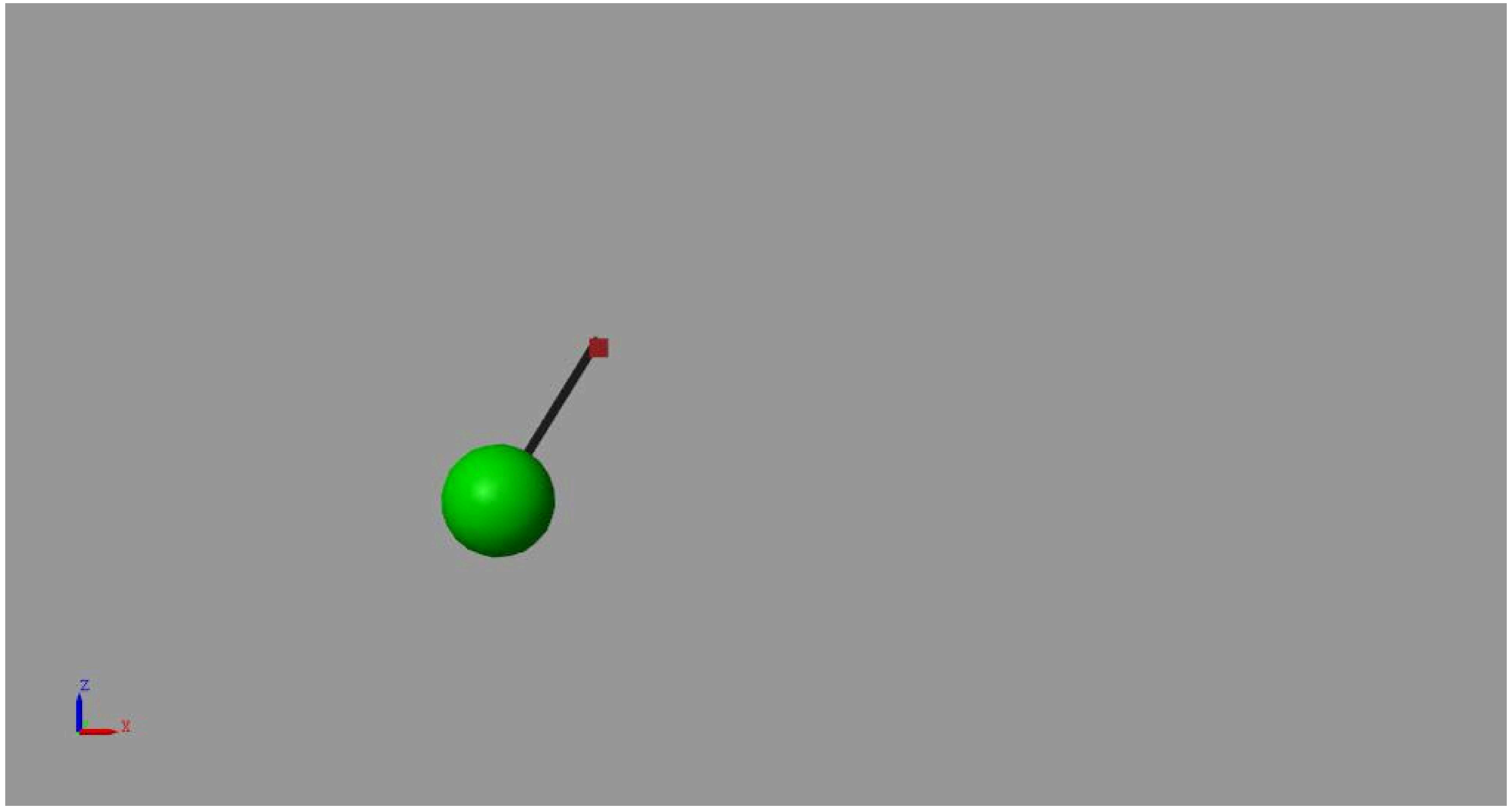
- Go to MathWorks Download Page.

Version: 2024b
Account: LDAP login

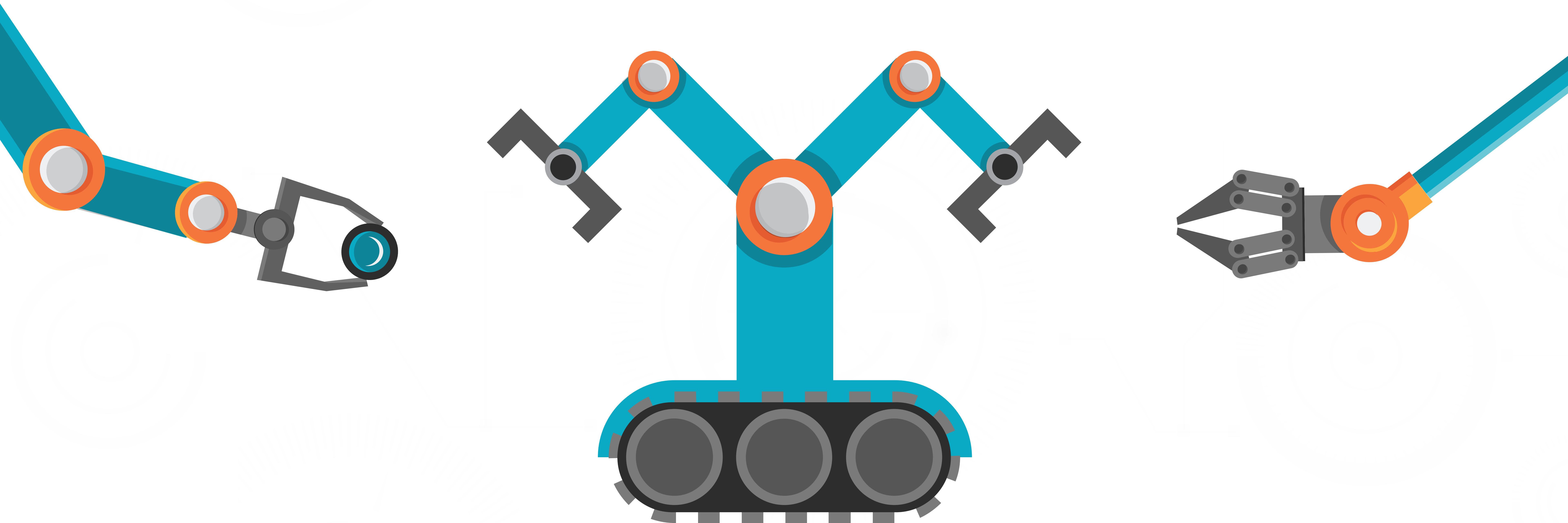
Add-on to be included while installing:

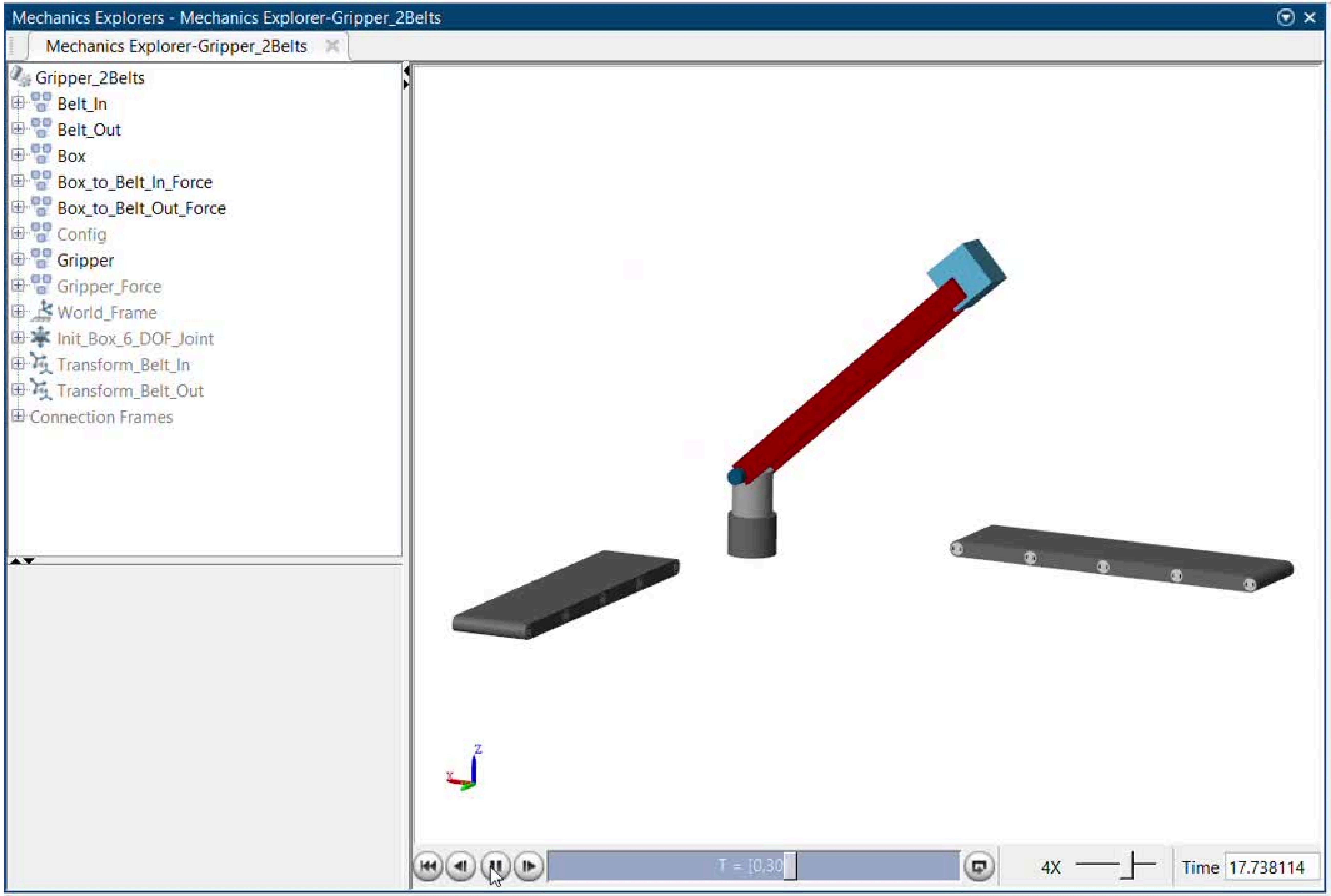
- Matlab
- Simulink
- Simscape
- Simscape Multibody
- Simulink 3D animation

Controlling A PENDULUM !!

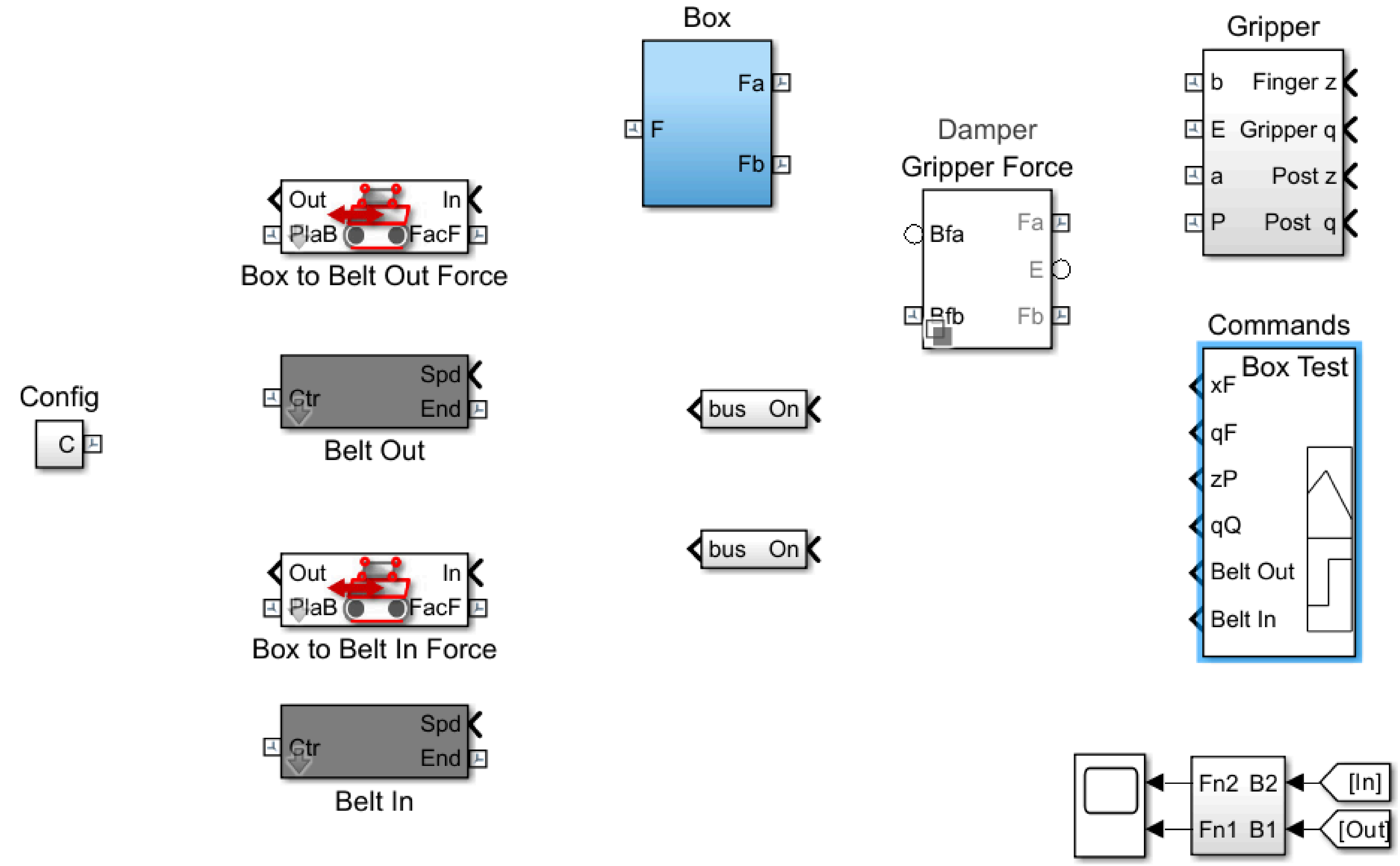


Pick and Place Robotic Arm

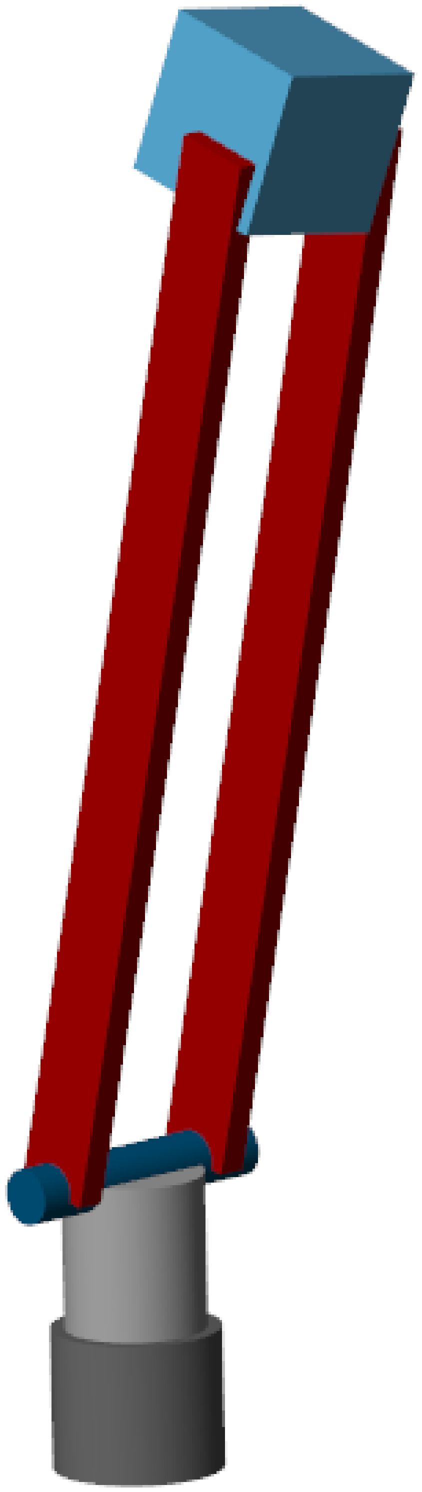


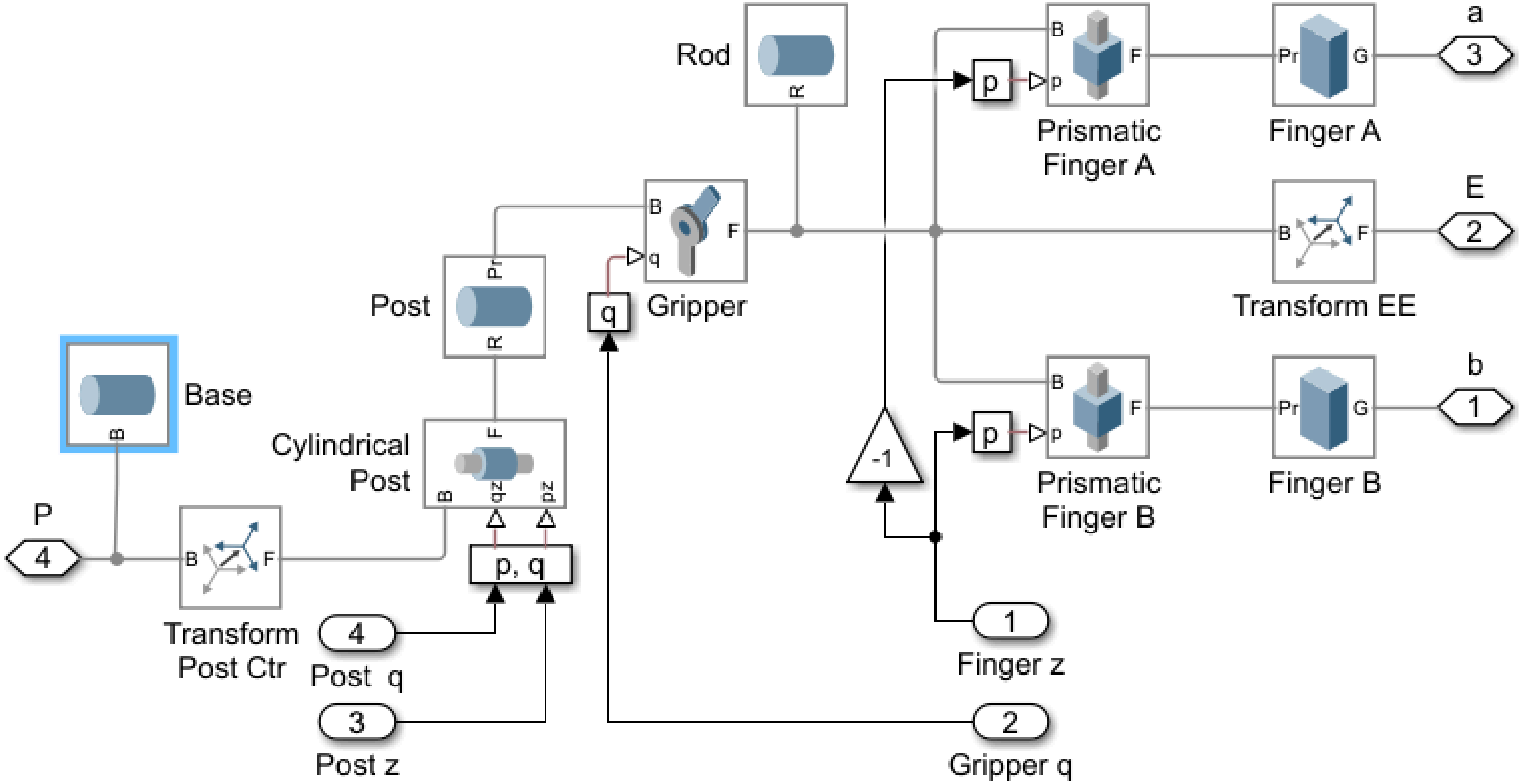

Mechanics Explorers - Mechanics Explorer-Gripper_2Belts
Mechanics Explorer-Gripper_2Belts
Gripper_2Belts
Belt_In
Belt_Out
Box
Box_to_Belt_In_Force
Box_to_Belt_Out_Force
Config
Gripper
Gripper_Force
World_Frame
Init_Box_6_DOF_Joint
Transform_Belt_In
Transform_Belt_Out
Connection Frames
4X
Time 17.738114

What all do you see in Gripper_2Belts.slx ?



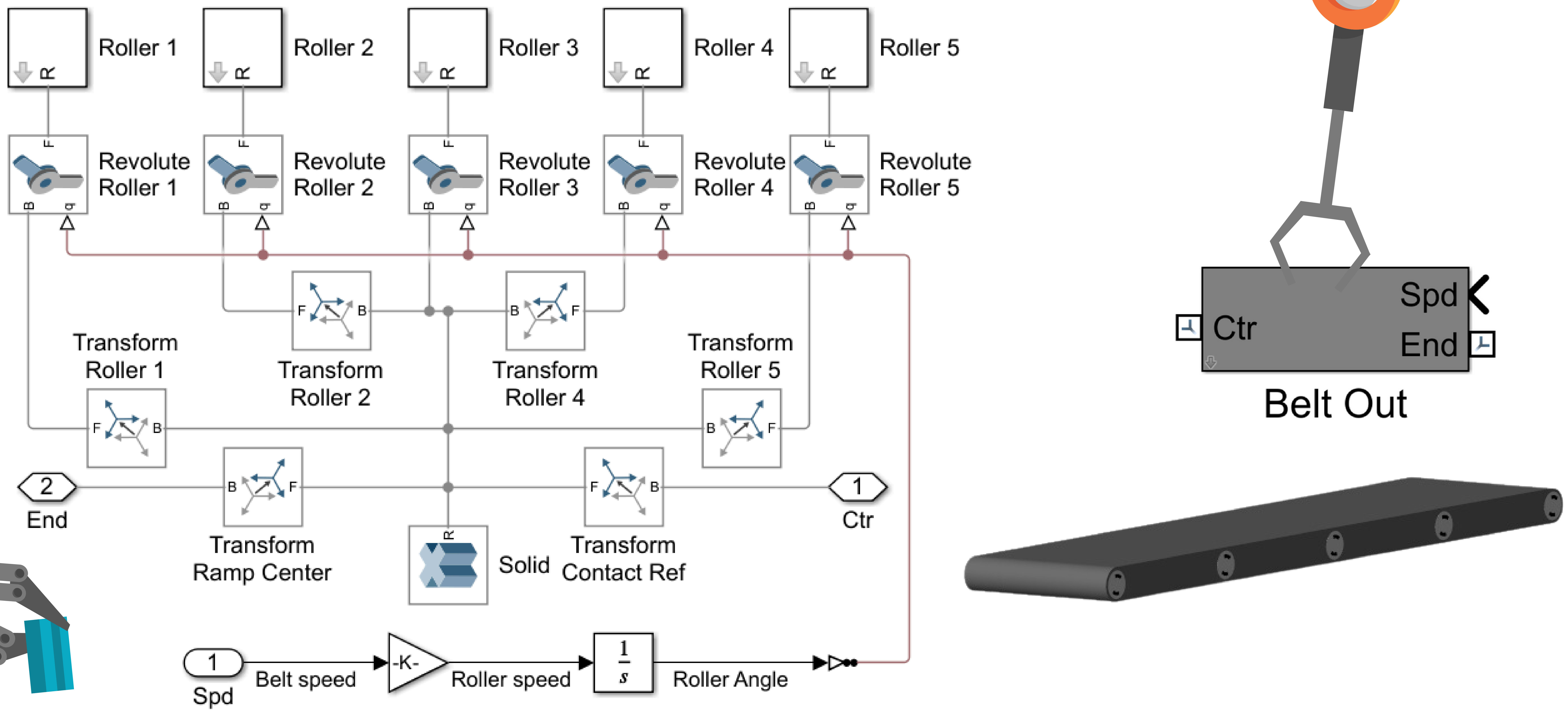
GRIPPER



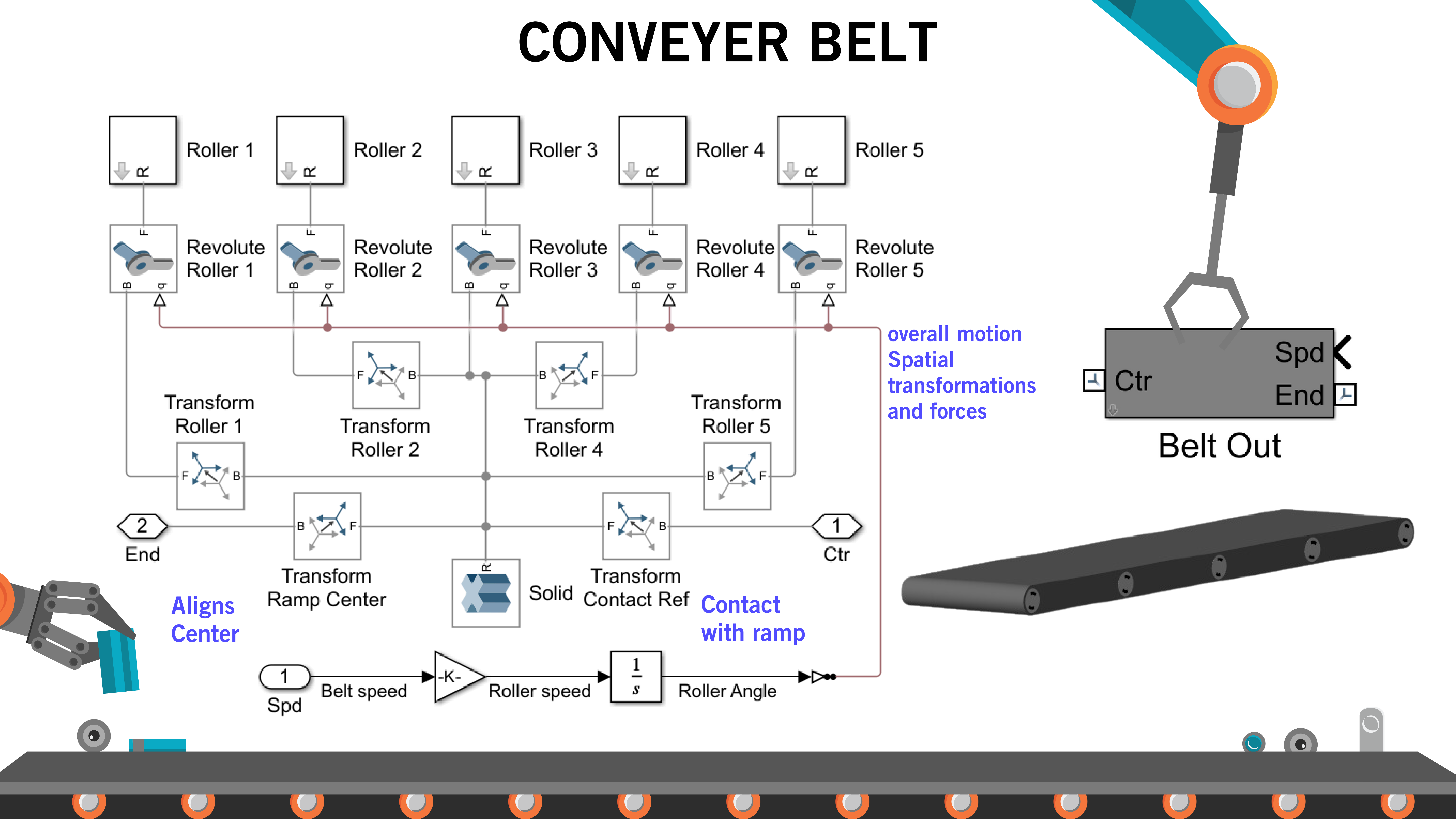


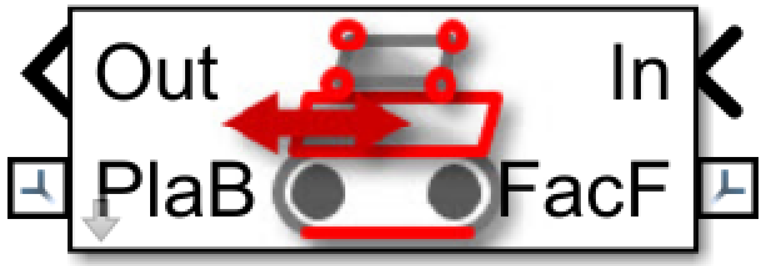
Rod
R
B
F
q
Gripper
q
Post
Pr
R
Base
B
Cylindrical
Post
F
B
qz
pz
p, q
P
4
B
F
Transform
Post Ctr
4
Post q
3
Post z
B
F
p
p
Prismatic
Finger A
Pr
G
Finger A
a
3
E
2
B
F
Transform EE
-1
B
F
p
p
Prismatic
Finger B
Pr
G
Finger B
b
1
1
Finger z
2
Gripper q

CONVEYER BELT



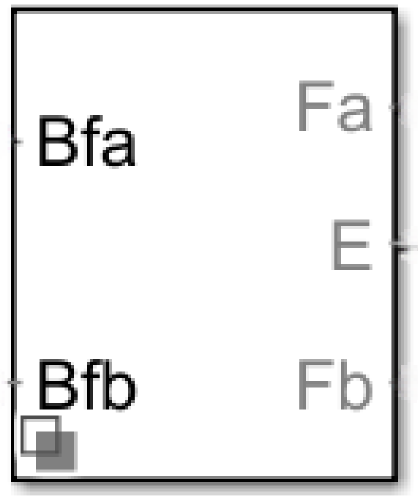
CONVEYER BELT





Box to Belt Out Force

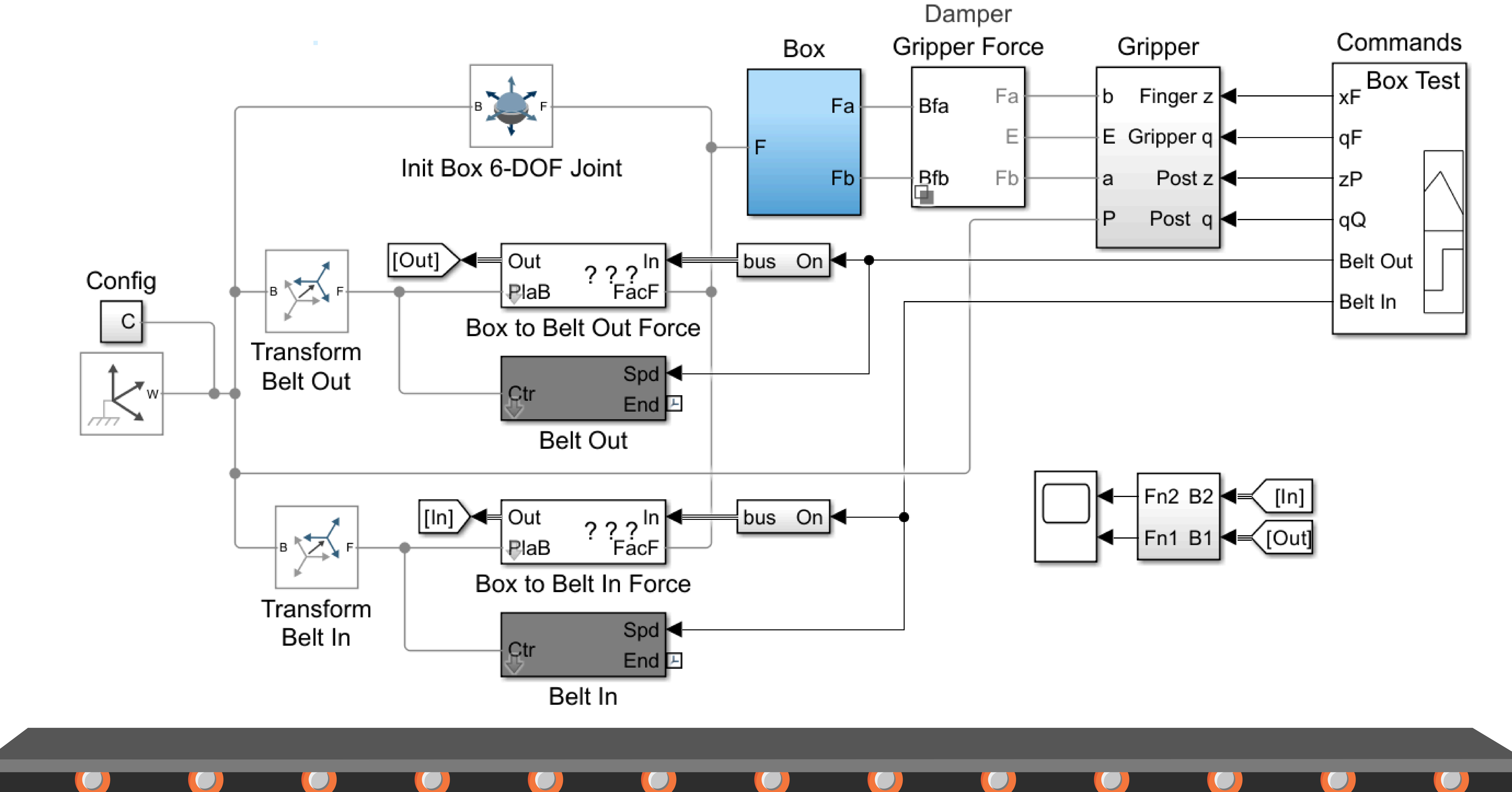
Damper
Gripper Force

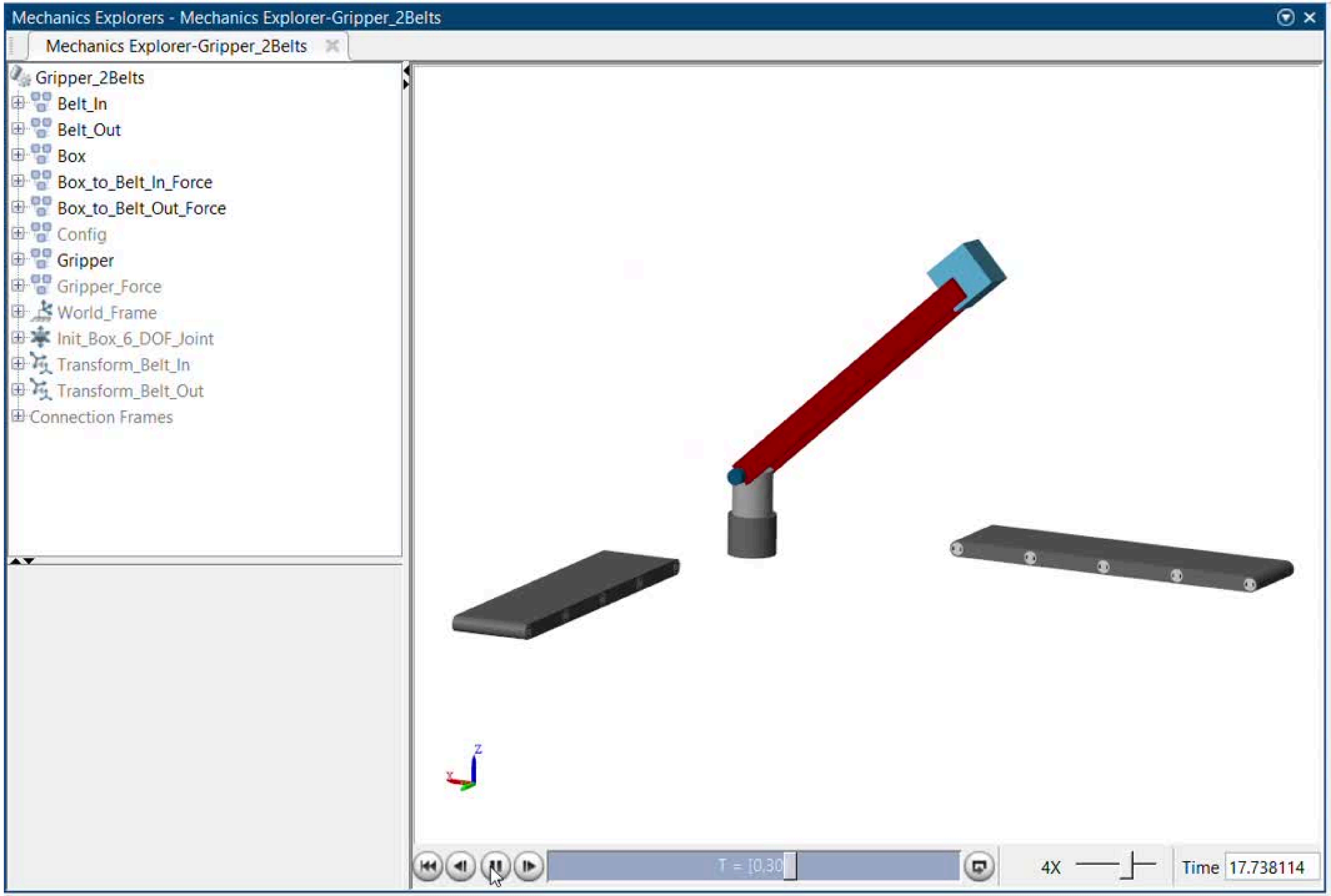


- **Forces - Box and Belt**
- **Plab Port**
- **FacF Port**
- **Out: Relative velocites, Contact Forces**
- **In: Speed**

Damper Gripper Force:

- **Controlled Damper Model (Activation)**
- **Stiff 6-DOF Damping Force**


Damper
Gripper Force
Box
Gripper
Commands
Box Test
Init Box 6-DOF Joint
Fa
F
Fb
Bfa
Bfb
E
b
Finger z
Gripper q
a
Post z
P
Post q
xF
qF
zP
qQ
Belt Out
Belt In
Config
C
[Out]
Out
PlaB
? ? ?
In
FacF
bus
On
Box to Belt Out Force
Transform
Belt Out
Spd
Ctr
End
Belt Out
[In]
Out
PlaB
? ? ?
In
FacF
bus
On
Box to Belt In Force
Transform
Belt In
Spd
Ctr
End
Belt In
Fn2
B2
Fn1
B1
[In]
[Out]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Mechanics Explorer-Gripper_2Belts
Gripper_2Belts
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Box
Box_to_Belt_In_Force
Box_to_Belt_Out_Force
Config
Gripper
Gripper_Force
World_Frame
Init_Box_6_DOF_Joint
Transform_Belt_In
Transform_Belt_Out
Connection Frames
4X
Time 17.738114

THANKS