EC6090 – ROBPTICS AND AUTOMATION

MINI PROJECT

TASK 01:

ROBOTIC ARM / MANIPULATOR ASSIGNED TO DO PICK & PLACE TASK

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AIM:

- Automate the pick and place process of a disk in a manufacturing line using a robotic arm, ensuring efficiency and accuracy.

OBJECTIVES:

- Selecting the Robotic arm based on the criteria
- Simulate using RoboDK
- Trajectory planning with MATLAB
- Forward and Inverse kinematics verification
- Validate the entire process through simulation

TASK DESCRIPTION:

Automate the pick and place operation of a disk in a manufacturing process line using a robotic arm. Select a suitable manipulator based on DOF, reach, and payload. Simulate the process using RoboDK and verify trajectory planning with MATLAB Robotics toolbox. The disk (2 cm width, 0.5 kg weight) will be moved between three stations:

Station 1 – Pick

Station 2 – Labeling

Station 3 – Transfer

Use two waypoints for trajectory planning and perform forward and inverse kinematics analysis to ensure accuracy and efficiency.

STRATEGIC PLAN:

For this task, ABB IRB 1100-4/0.58 robotic arm with 5 degrees of freedom (DOF) is selected. The arm's specifications meet the requirements for handling the disk (2 cm width, 0.5 kg weight) within the given workspace.

11 strategic targets are chosen to guide the robotic arm's movement between the pick and place operations for smoothness operation.

RoboDK DESIGN:

Robot Arm : ABB IRB 1100-4/0.58

Grip : RobotiQ Epick Vacuum Gripper (1 cup)

Table size : 1400 x 800 x 800 mm

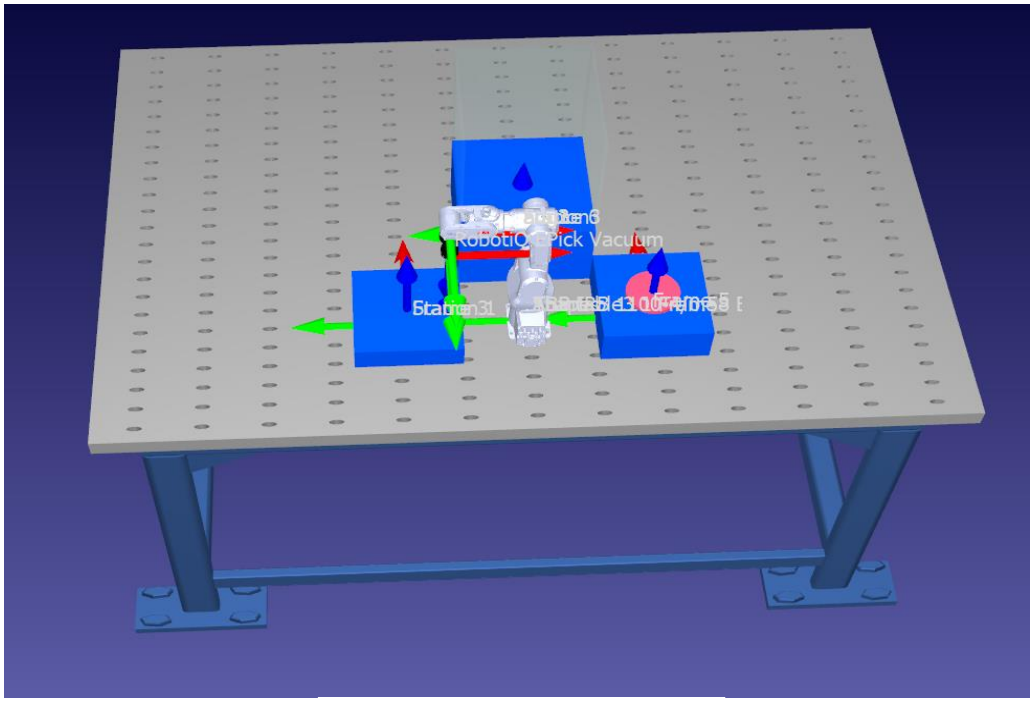

Figure 01: Design in RoboDK

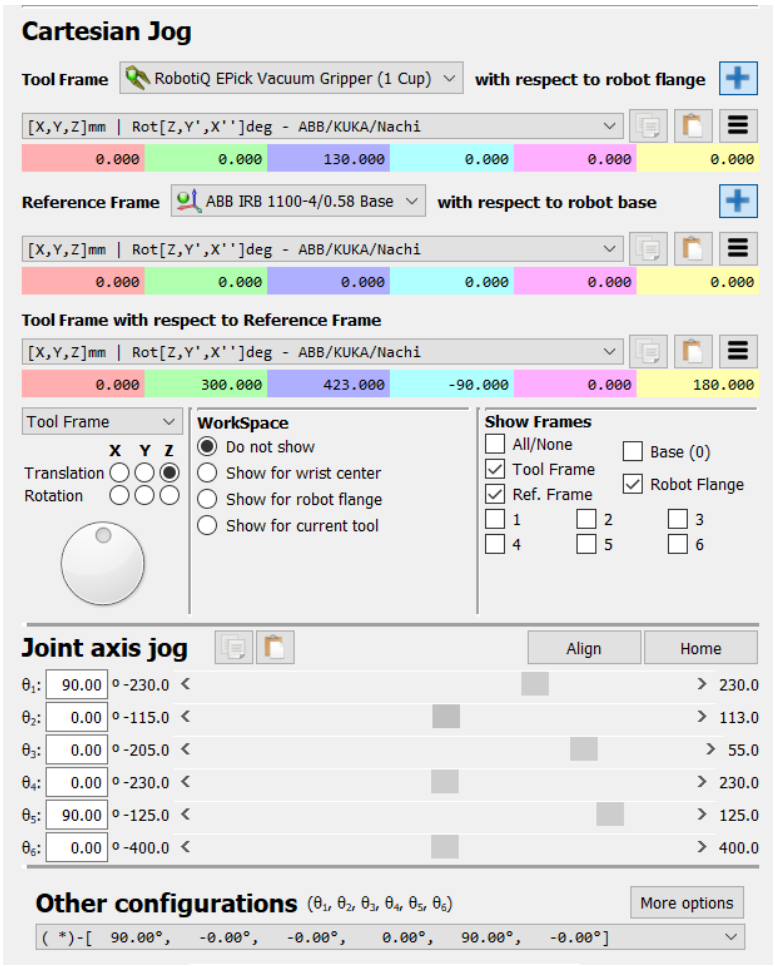

Figure 02: Joint parameters

RESULTS:

- Forward kinematics

```
Command Window
>> forward
End-Effector Position (x, y, z) for P1:
   -0.0000  370.0794  225.3802

End-Effector Position (x, y, z) for ATTACH1:
   -0.0000  363.2364   72.9688

End-Effector Position (x, y, z) for BACK:
    0.0000  368.9013  674.4329

End-Effector Position (x, y, z) for POSITION2:
  368.9040    0.0000  674.4312

End-Effector Position (x, y, z) for P2:
  374.4765    0.0000  340.5720

End-Effector Position (x, y, z) for DETACH1:
  369.7891    0.0000  219.3252

End-Effector Position (x, y, z) for POSITION3:
    0.0000 -368.9040  674.4312

End-Effector Position (x, y, z) for P3:
    0.0000 -369.7891  219.3252

End-Effector Position (x, y, z) for DETACH2:
    0.0000 -364.5812  109.0340

fx >>
```

Figure 03: Forward kinematics output from command window

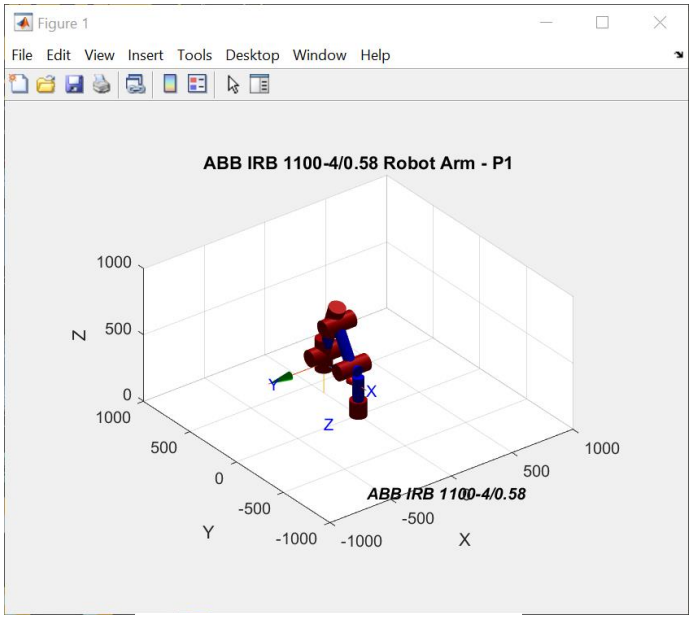

Figure 04: Arm position P1

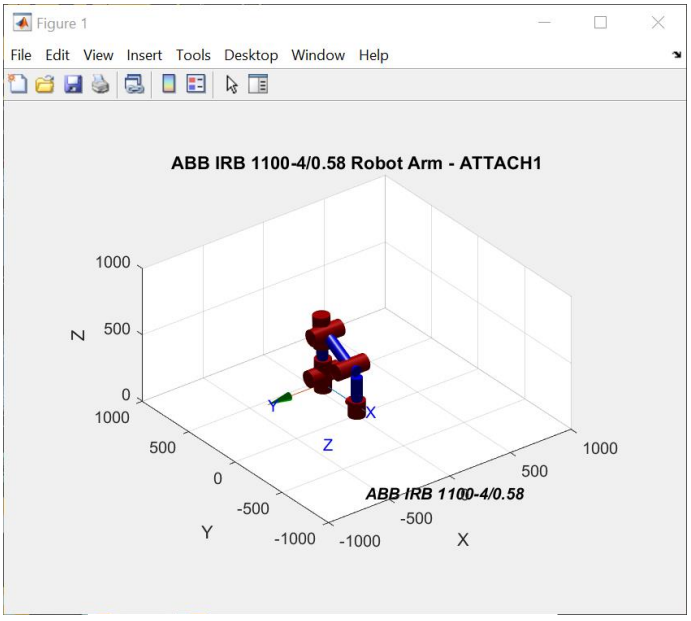

Figure 05: Arm position ATTACH 1

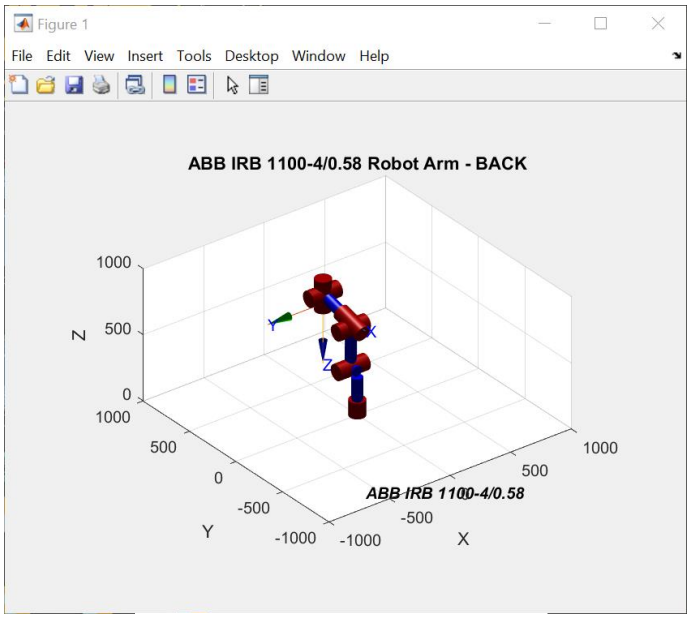

Figure 06: Arm position BACK

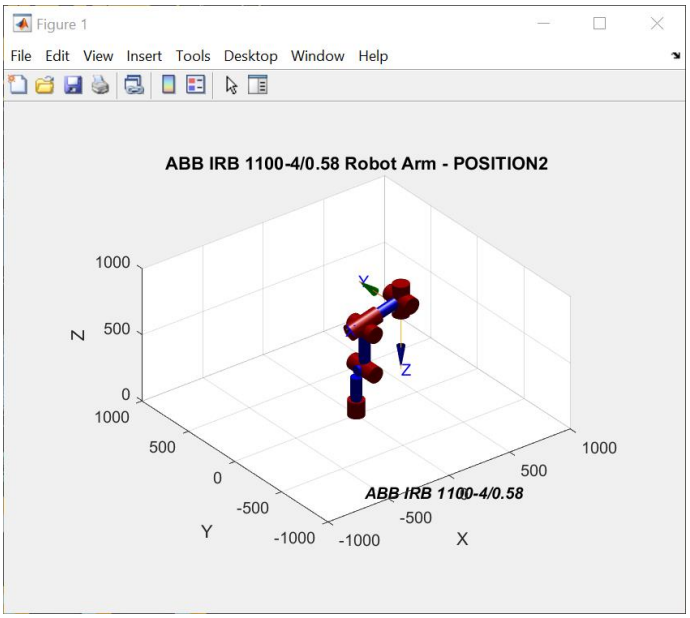

Figure 07: Arm position POSITION 2

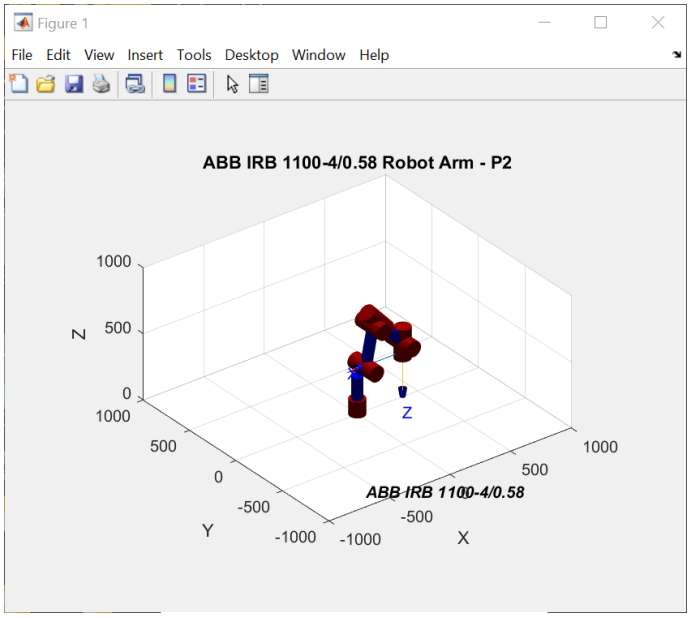

Figure 08: Arm position P2

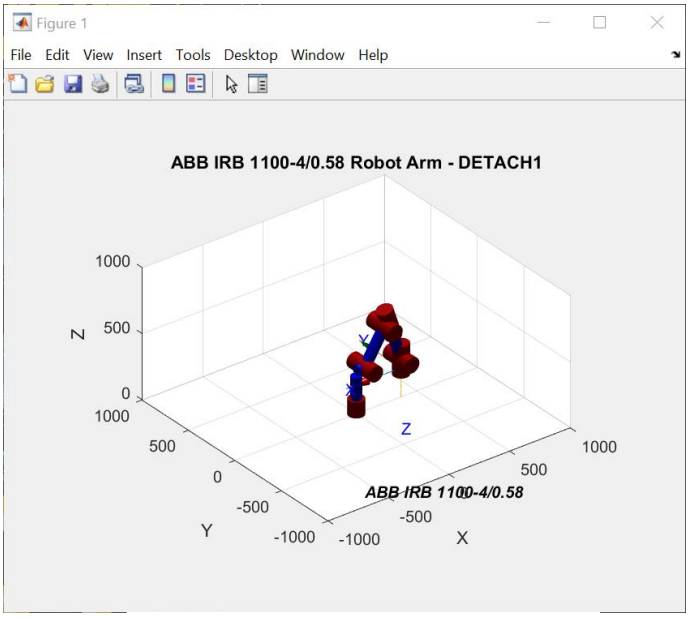

Figure 09: Arm position DETACH 1

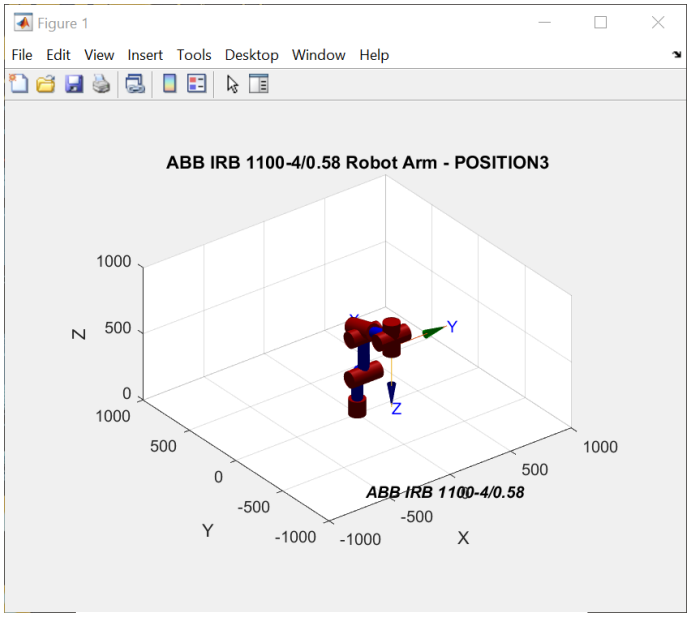

Figure 10: Arm position POSITION 3

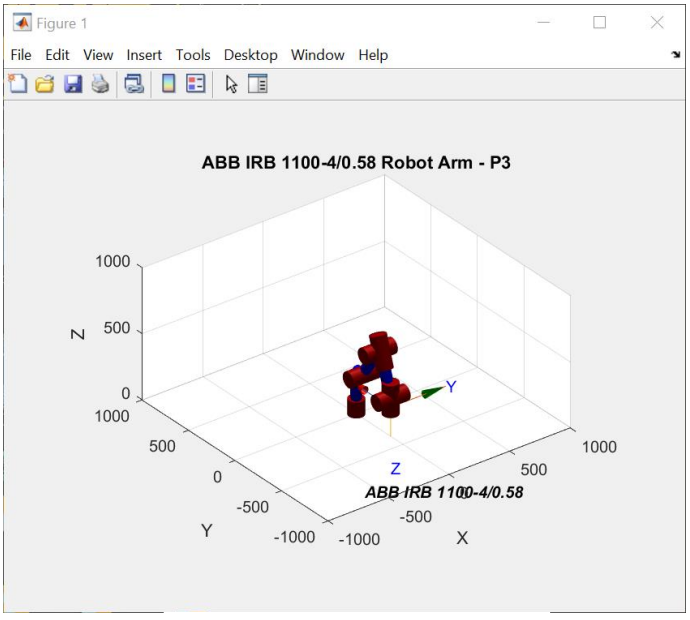

Figure 11: Arm position P3

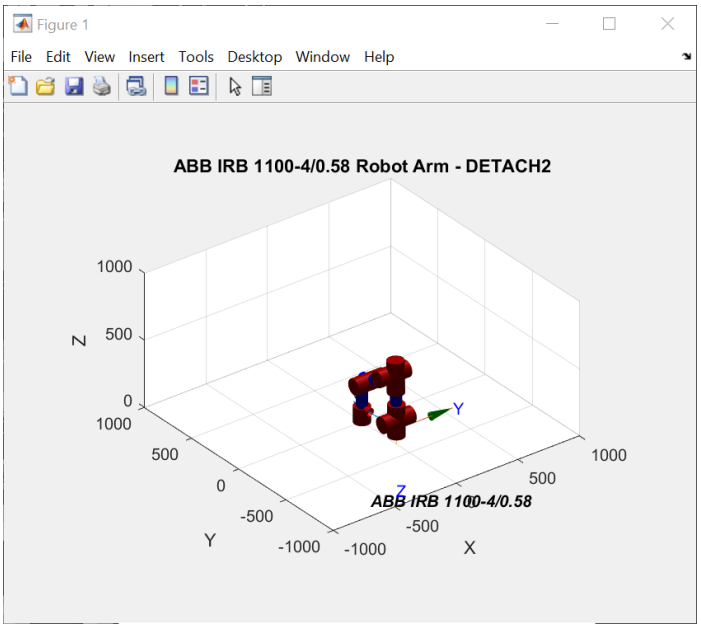

Figure 12: Arm position DETACH 2

- Inverse kinematics

```
Command Window
>> inverse
Joint Angles (degrees) for P1:
  -89.9277  128.8268    2.5129  178.3899   16.3046         0

Computed End-Effector Position (x, y, z) for P1:
    0.0000  450.0000  308.0960

Joint Angles (degrees) for ATTACH1:
  -82.2891  131.9970  -43.0846   57.1819   93.7583         0

Computed End-Effector Position (x, y, z) for ATTACH1:
   -0.0000  450.0000  100.0000

Joint Angles (degrees) for P2:
   -0.0000  -81.2670   16.4852    0.0000   41.9734         0

Computed End-Effector Position (x, y, z) for P2:
  450.0040   -0.0000  459.9980

Joint Angles (degrees) for DETACH1:
   -0.0000  -64.6763   29.2027    0.0000    7.8315         0

Computed End-Effector Position (x, y, z) for DETACH1:
  450.0040   -0.0000  300.0000

fx >>
```

Figure 13: Inverse kinematics output from command window

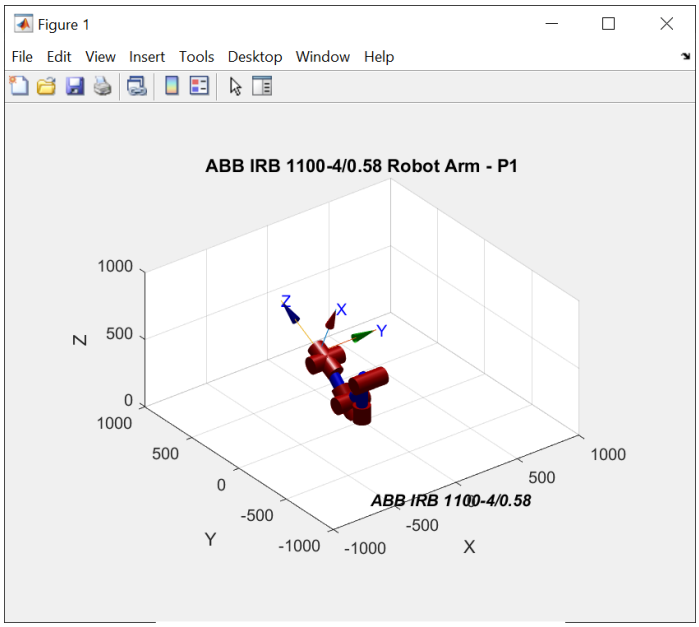

Figure 14: Target position P1

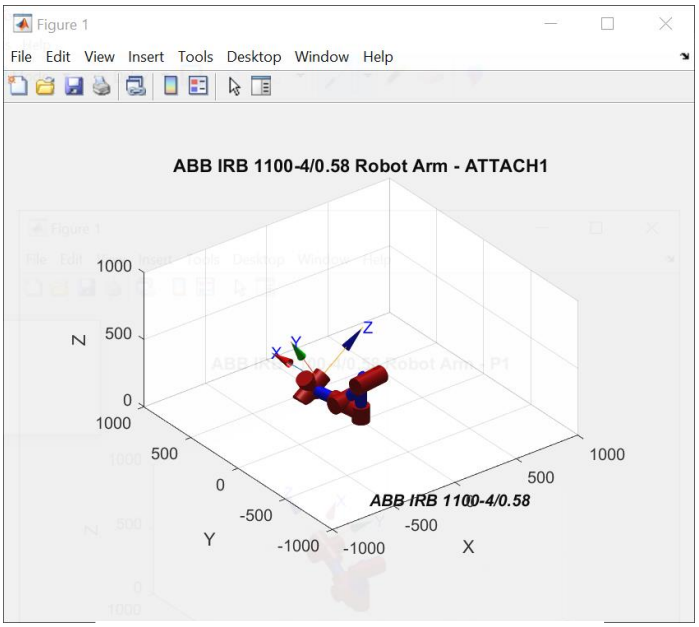

Figure 15: Target position ATTACH 1

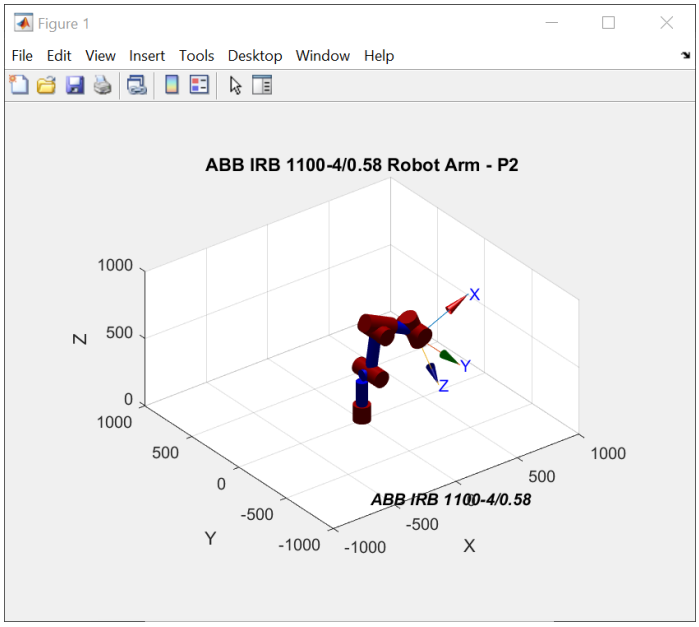

Figure 16: Target position P2

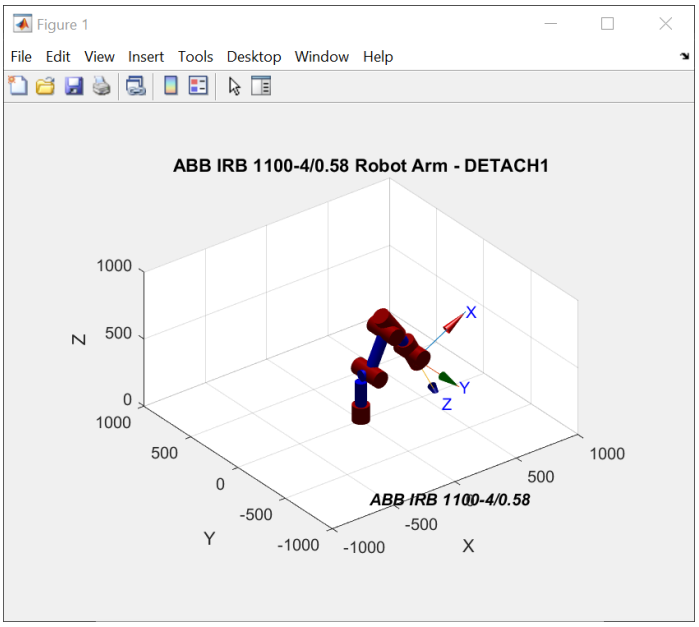

Figure 17: Target position DETACH 1

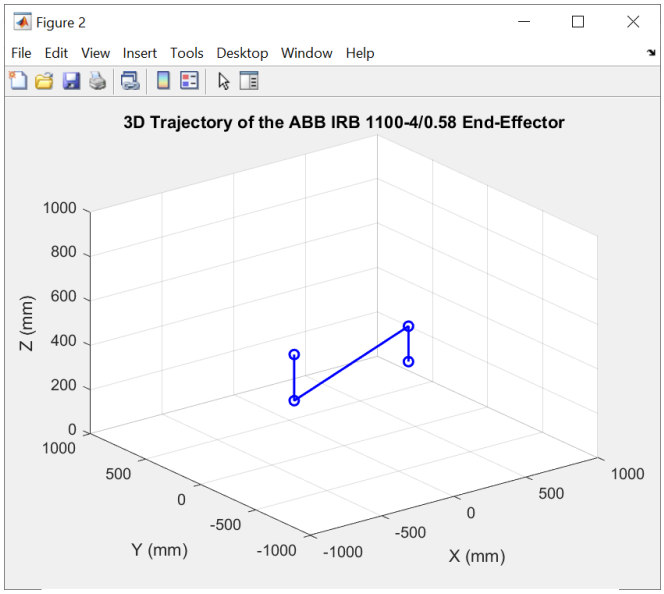

Figure 18: 3D Trajectory of the End effector