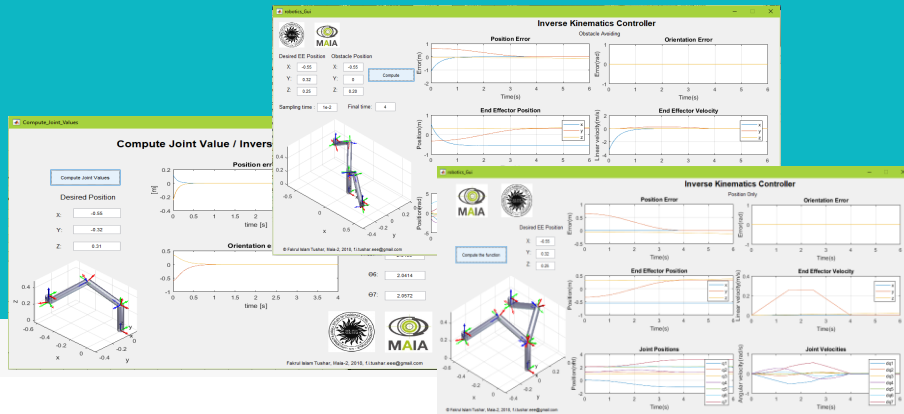




Project: Introduction To Robotics

PROFESSOR: GIANLUCA ANTONELLI



Fakrul Islam Tushar

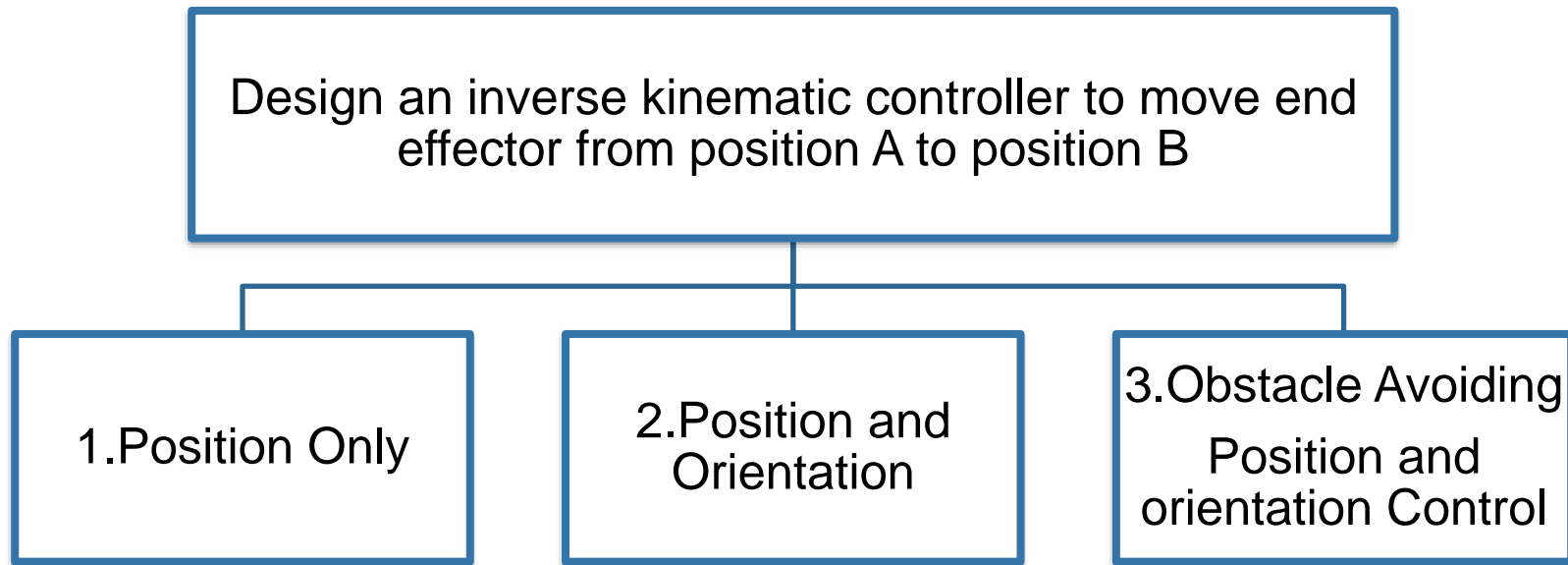
Medical Image Analysis and Applications (MAIA)
2nd Semester, University of Cassino.

Contents of The Presentation

- **Project Goal**
- **Kinematics**
- **DH Notations**
- **Jacobian**
- **Finding Initial Joint Value**
- **Inverse Kinematics Control Position only**
- **Inverse Kinematics Control Position and Orientation**
- **Inverse Kinematics Control Obstacle Avoiding**
- **Results**
- **Reference**

Project Goal

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Kinematics

Kinematic model given the relation between the **end-effector (EE) position and orientation** and special position of the joint links



Denavit-Hartenberg (DH) Notation

Set of conventions used to represent a robot.

- ✓ 4 values required to describe a combination of joints:
- ✓ Θ : Rotation along z axis
- ✓ d : Translation along z axis
- ✓ a : Translation along x axis
- ✓ α : Rotation along x axis

Link	a_i [m]	α_i [rad]	d_i [m]	θ_i [rad]
1	0	$\pi/2$	0.3105	θ_1
2	0	$-\pi/2$	0	θ_2
3	0	$\pi/2$	0.400	θ_3
4	0	$-\pi/2$	0	θ_4
5	0	$\pi/2$	0.4	θ_5
6	0	$-\pi/2$	0	θ_6
7	0	0	0.078	θ_7

Fig.1: DH table.

Jacobian

Jacobian is a function of joints values. $J = \frac{df}{dq}$

- ✓ let $X = \{x, y, z, rx, ry, rz\}$ represents the End Effector position and orientation, and q is the joint value
- ✓ $x = J * q$, **EE position.**
- ✓ $q = J^{-1} * x$, **joint value.**
- ✓ $\dot{x} = J * \dot{q}$, **EE velocity**
- ✓ $\dot{q} = J^{-1} * \dot{x}$, **EE velocity**

Finding The Initial Joint Value for Initial Position

Finding Initial Joint values

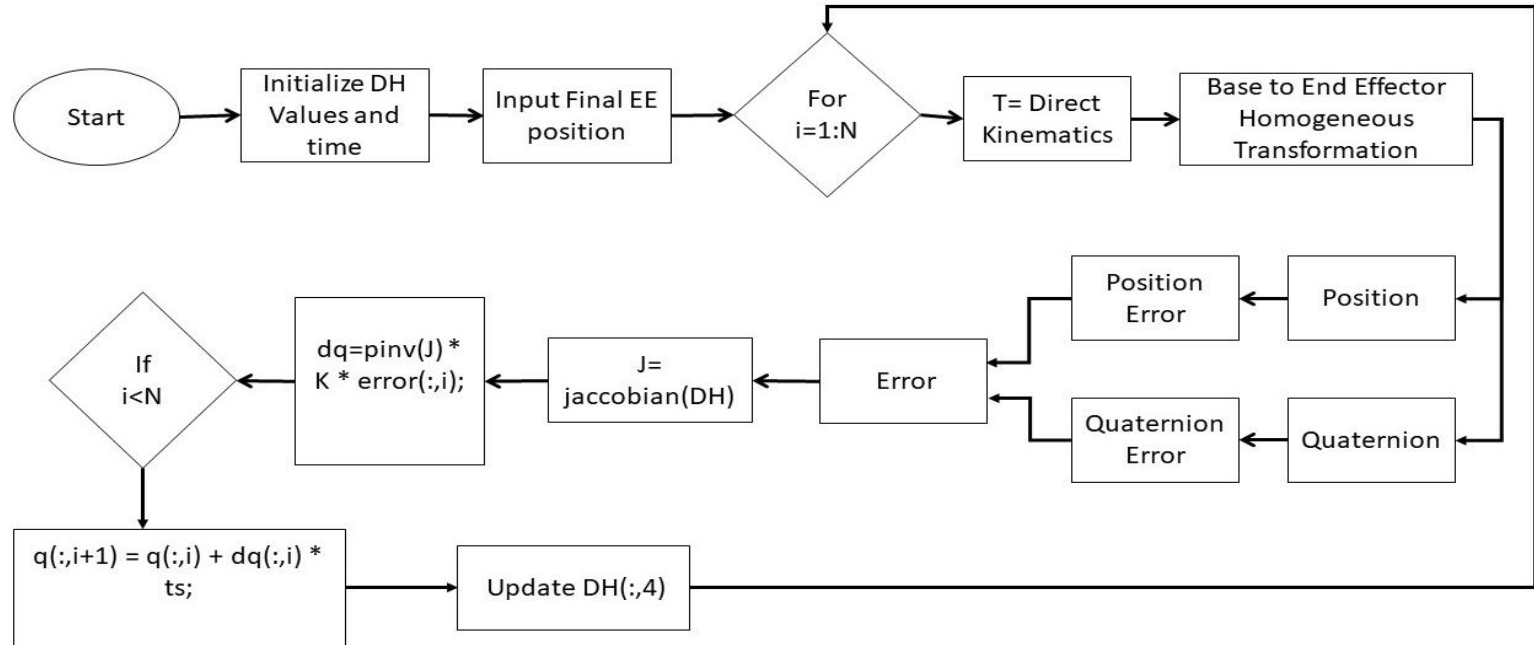


Fig.2: Block Diagram of finding joint values.

Finding Initial Joint values

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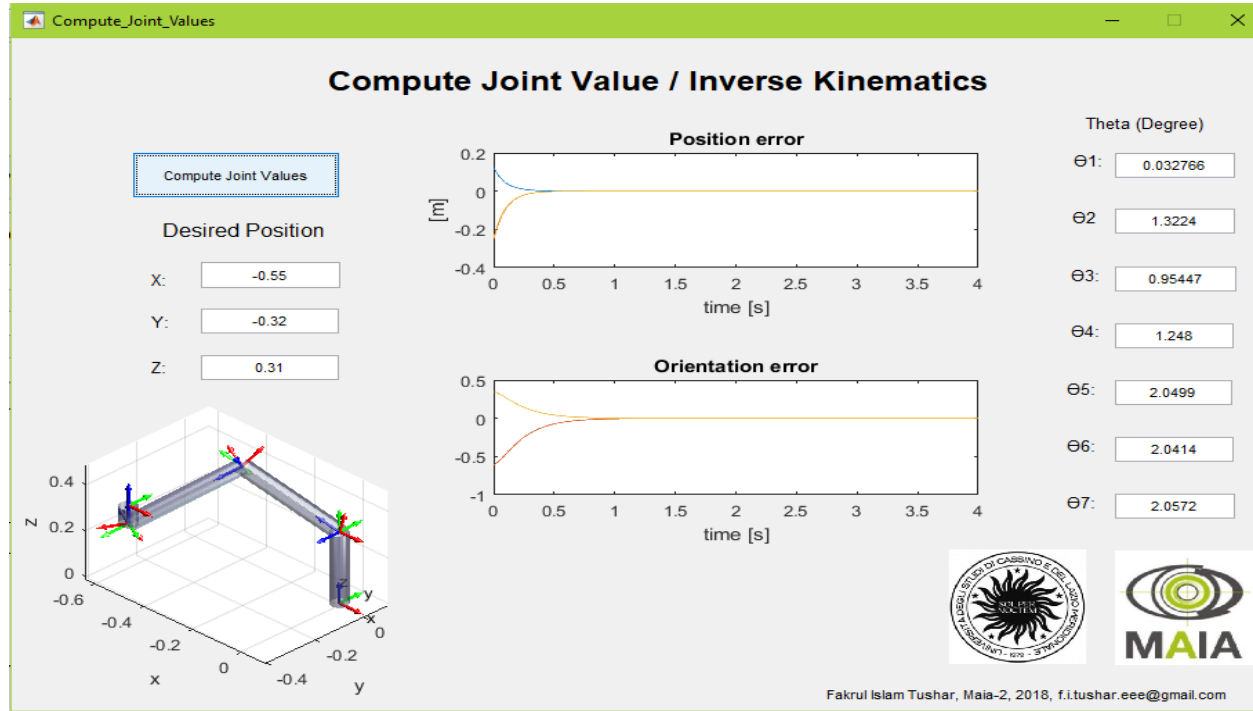


Fig.3: GUI for computing joint values.

Inverse Kinematics Controller Position Only

Position Control

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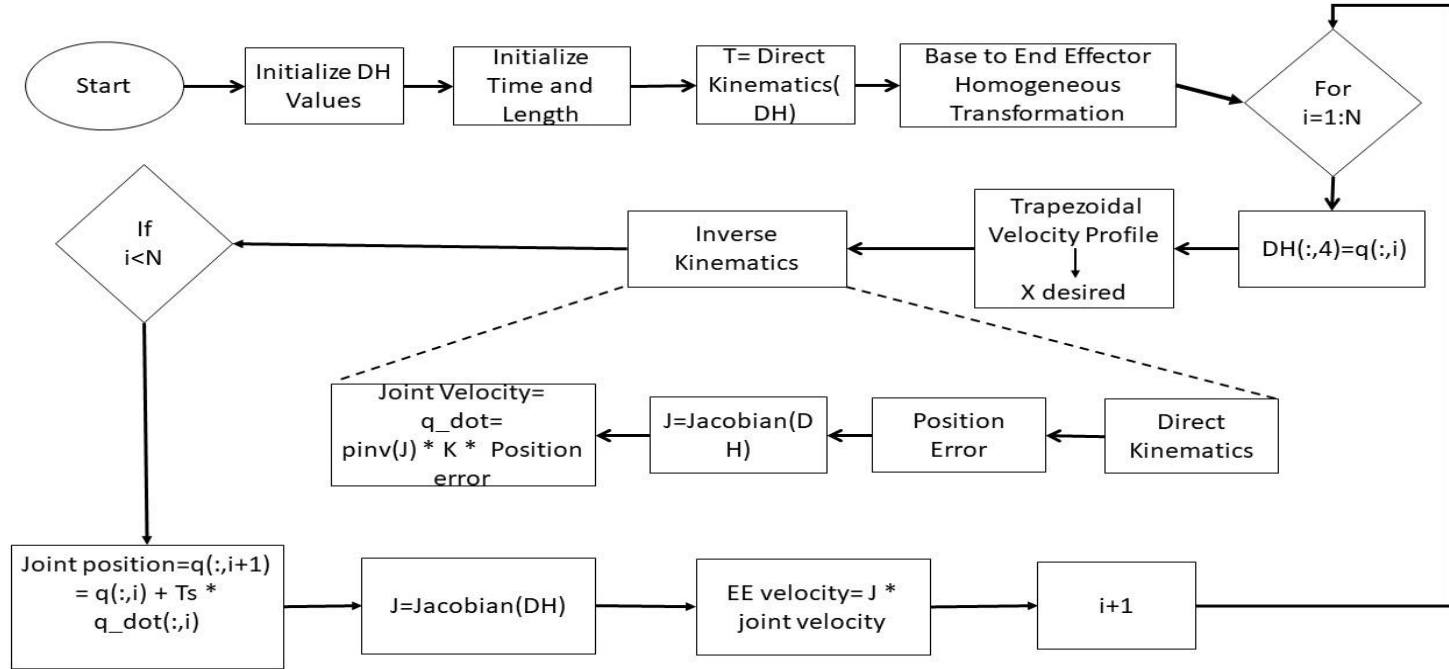


Fig.4: Inverse Kinematics Controller (Position only).

Position Control

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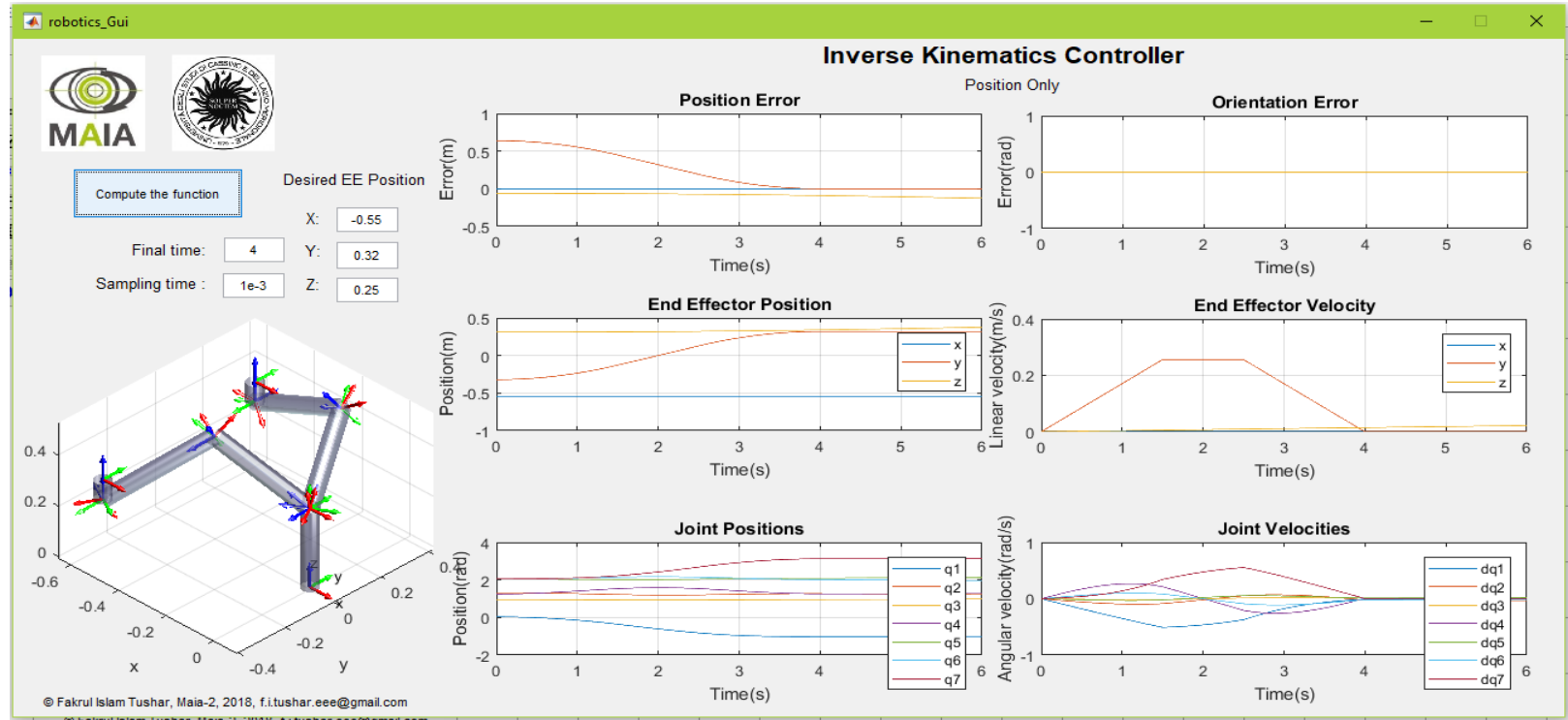


Fig.5: Inverse Kinematics Controller (Position only).

Inverse Kinematics Controller

Position and Orientation

Position and Orientation Control

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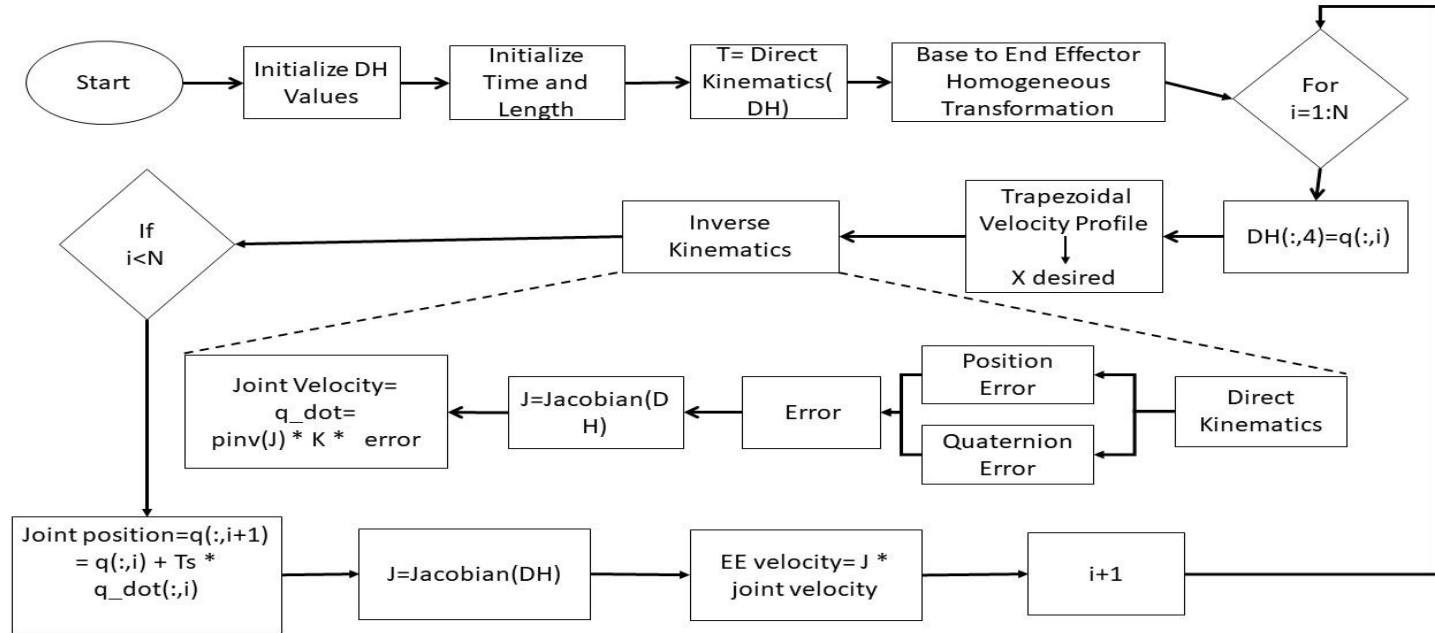


Fig.6: Inverse Kinematics Controller (Position and Orientation).

Position and Orientation Control

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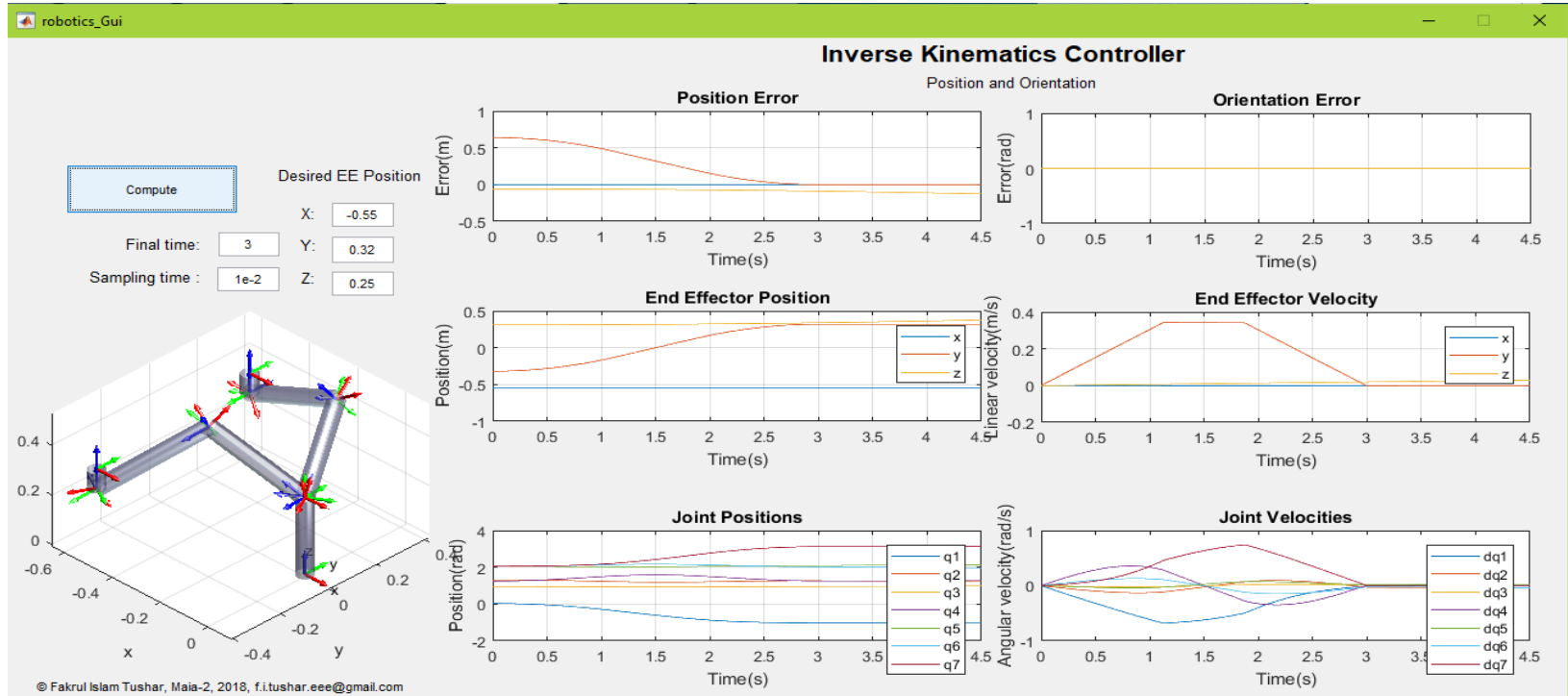


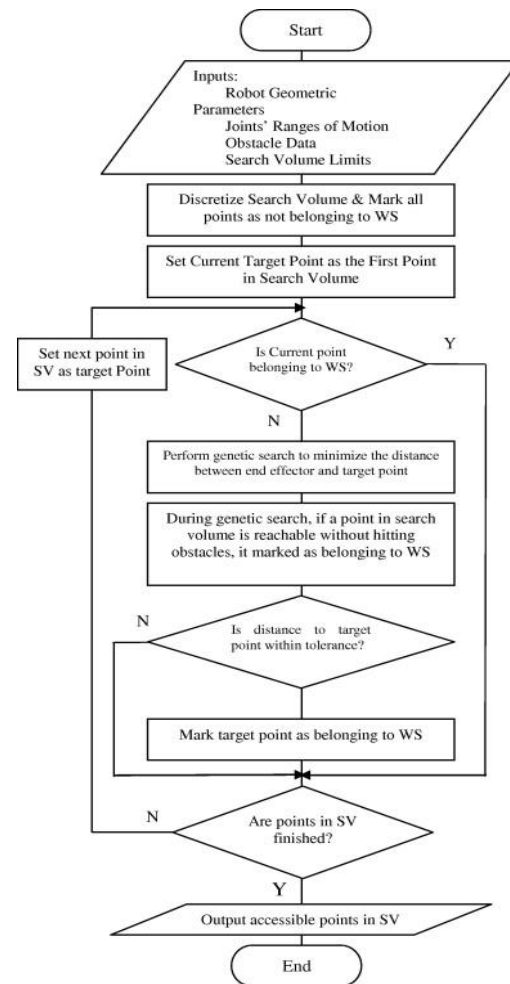
Fig.7: Inverse Kinematics Controller (Position and Orientation).

Inverse Kinematics Controller Obstacle Avoiding

Obstacle Avoiding Control

the obstacle avoiding motion

$$\dot{\mathbf{q}} = \mathbf{J}_{\mathbf{d}_0}^+ \mathbf{v}_0 + (\mathbf{I} - \mathbf{J}_{\mathbf{d}_0}^+ \mathbf{J}_{\mathbf{d}_0}) \mathbf{J}^+ \dot{\mathbf{x}}.$$



Obstacle Avoiding Control

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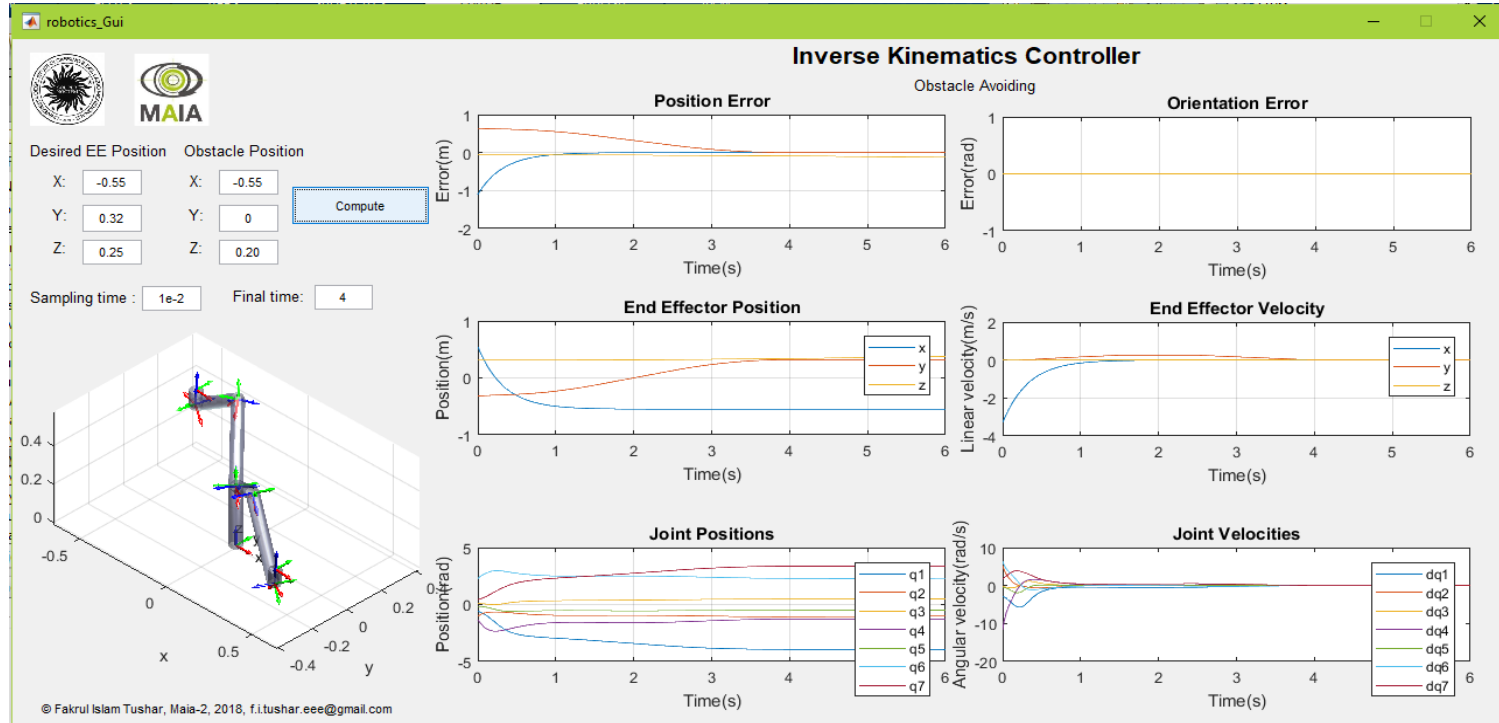
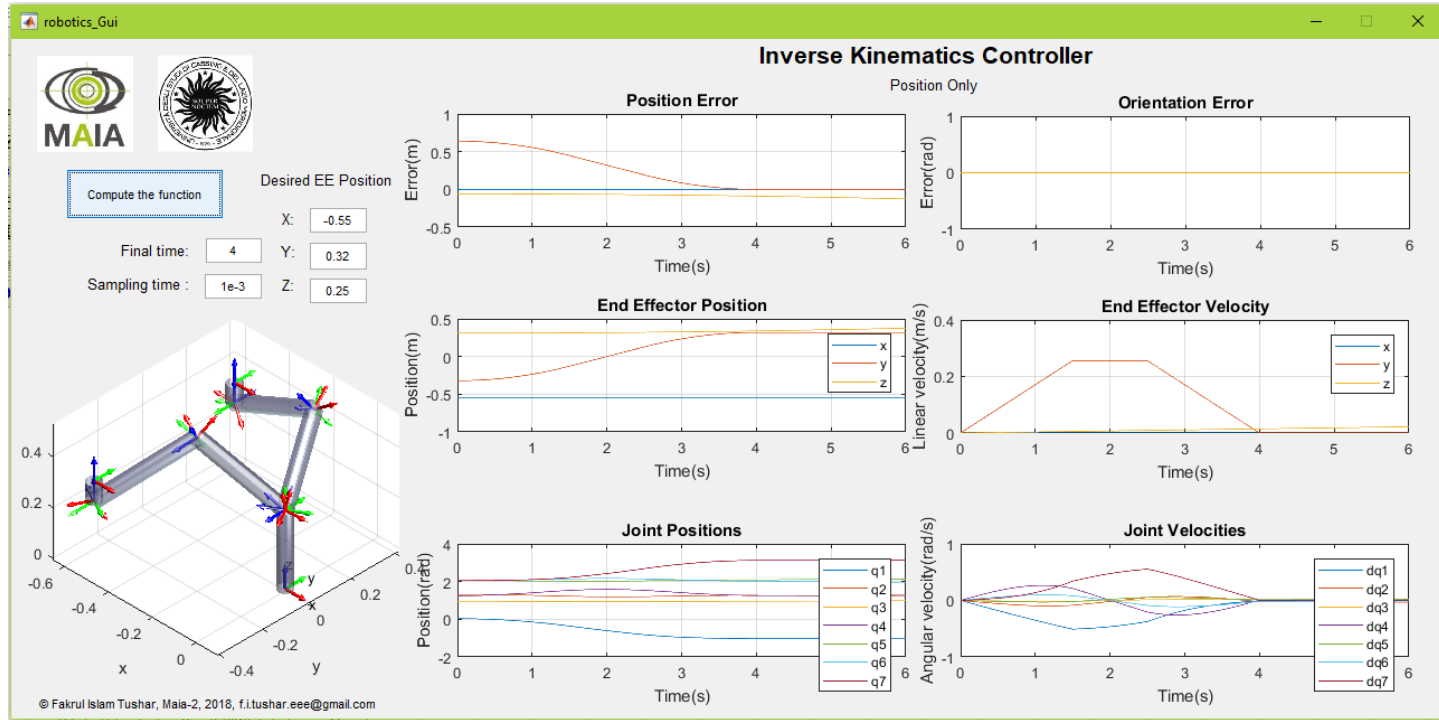


Fig.7: Inverse Kinematics Controller (Position and Orientation).

Results

Position only

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Position only

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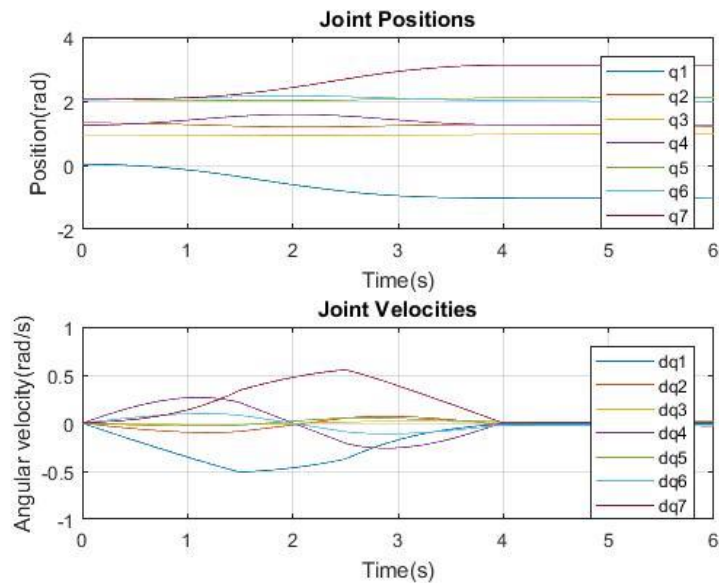
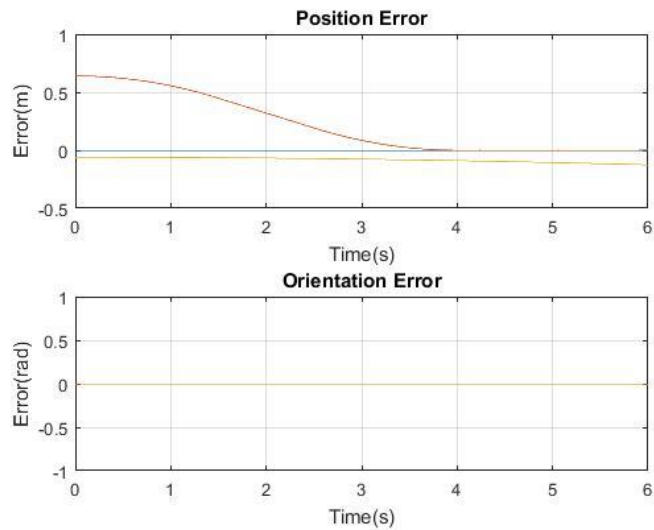


Fig.9: Block diagram for manual Segmentation.

Position only

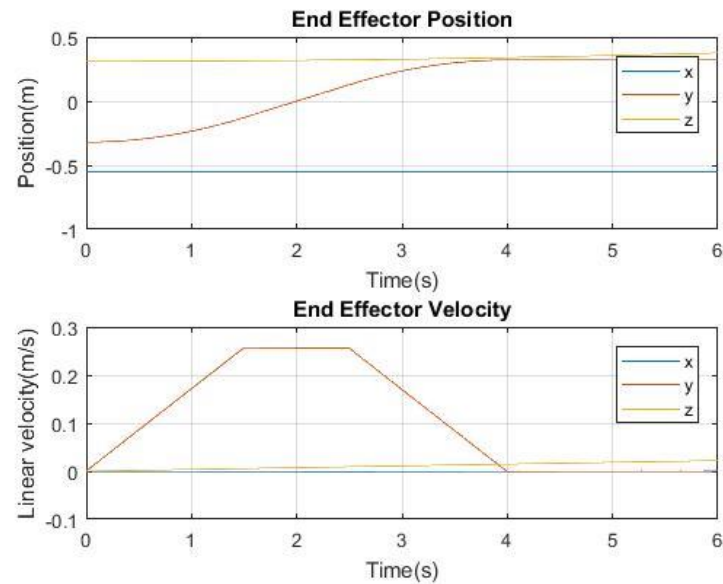
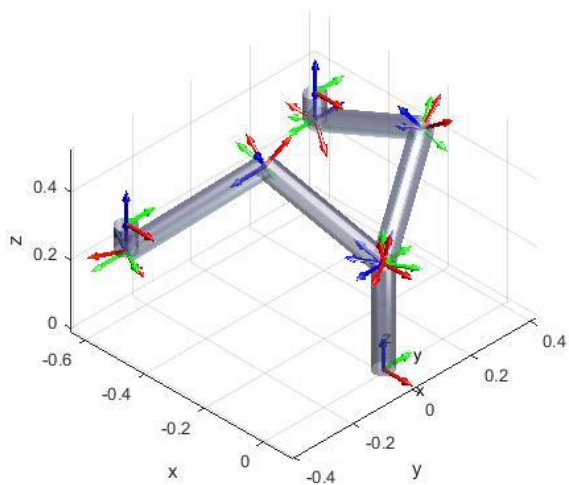
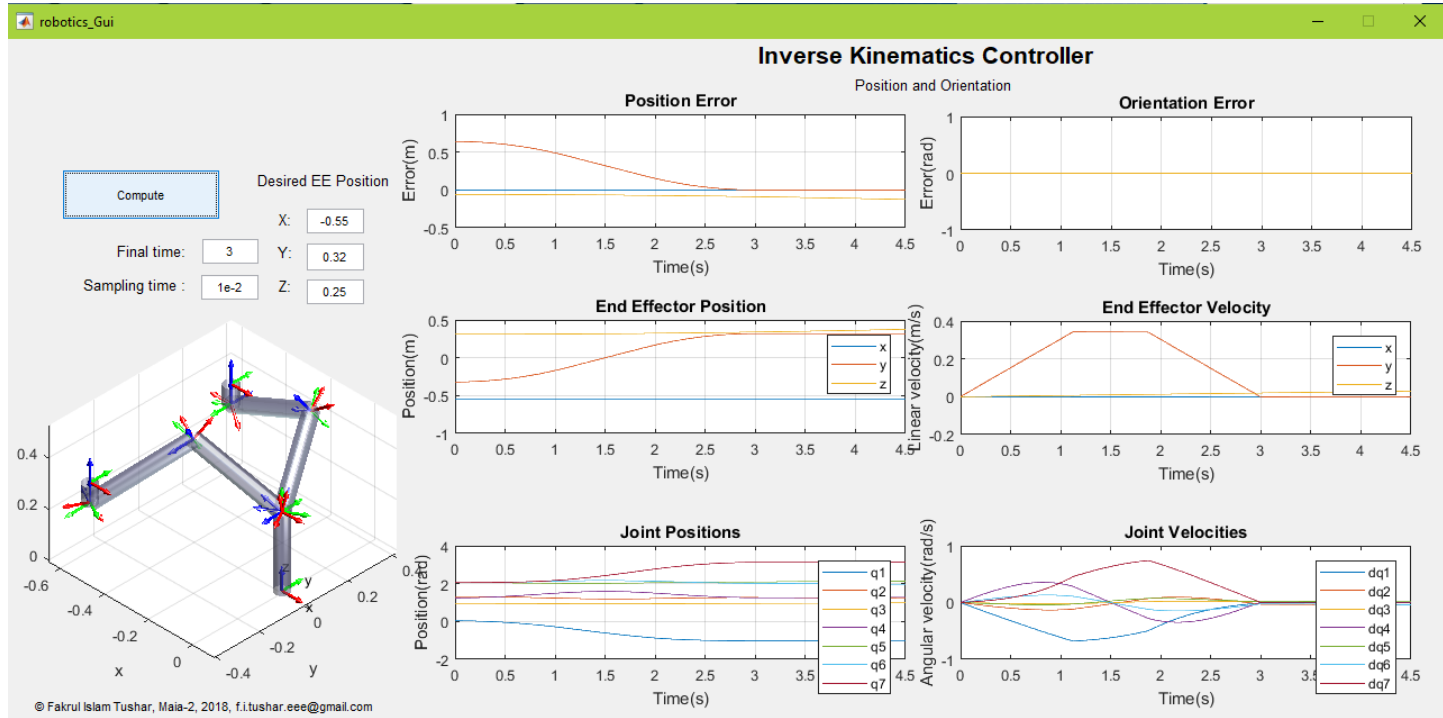


Fig.9: Block diagram for manual Segmentation.

Position and Orientation

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Position and Orientation

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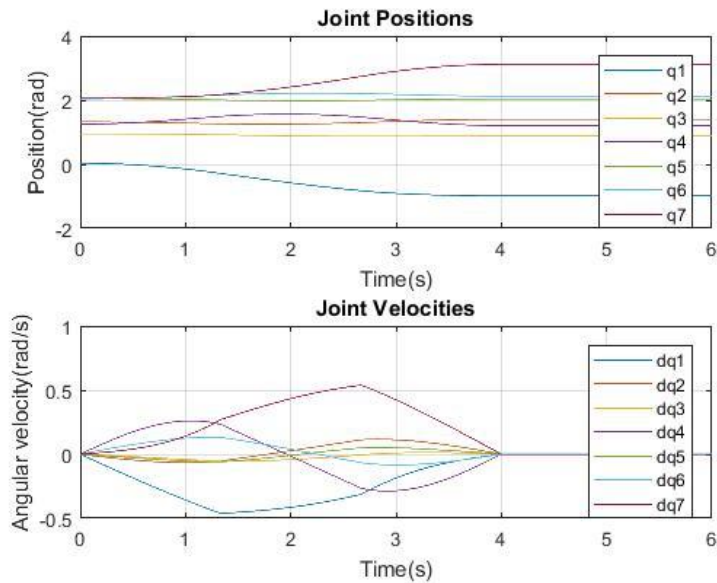
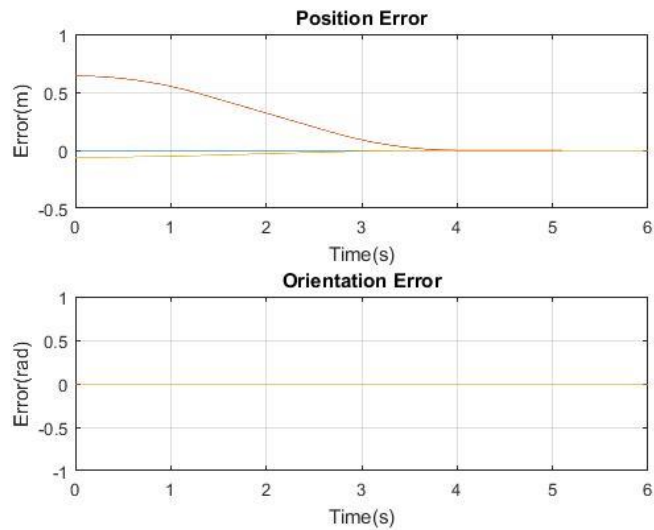


Fig.9: Block diagram for manual Segmentation.

Position and Orientation

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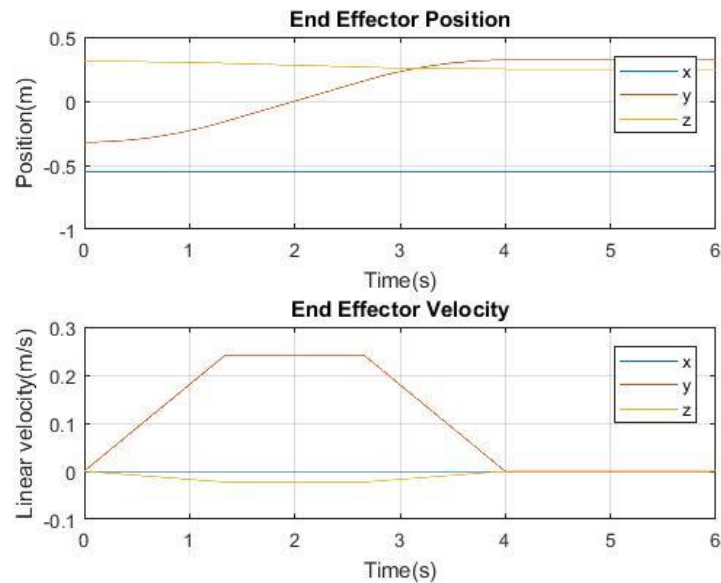
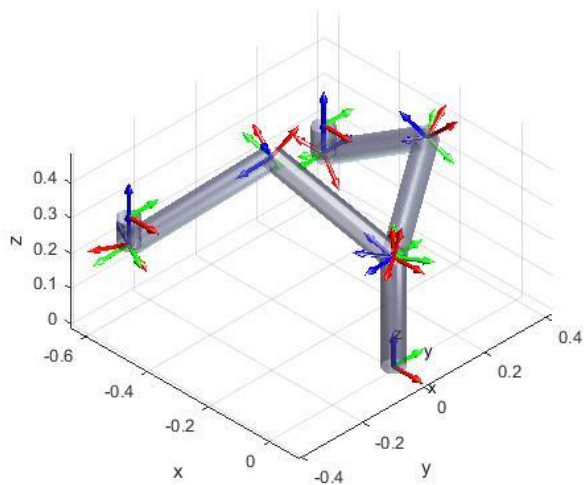
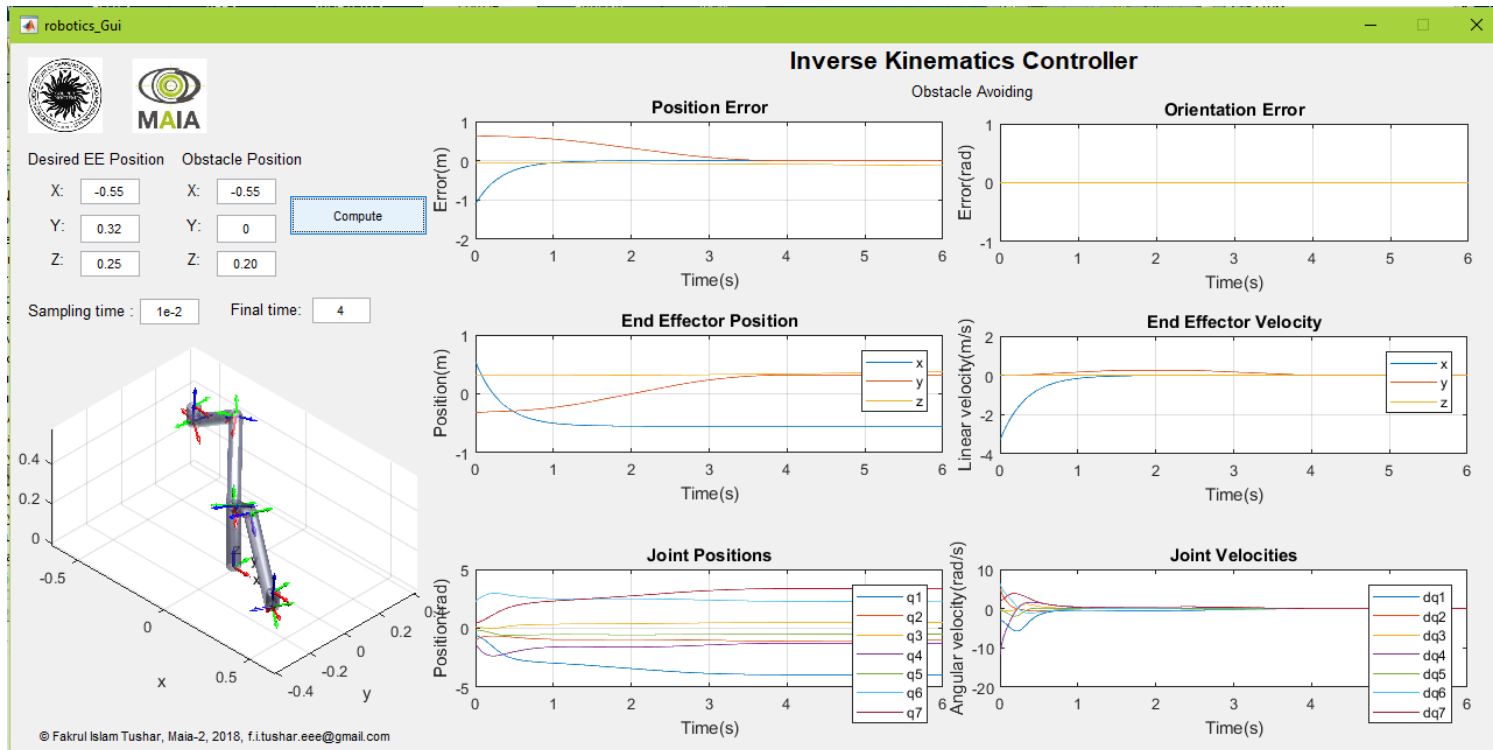


Fig.9: Block diagram for manual Segmentation.

Obstacle Avoiding

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Obstacle Avoiding

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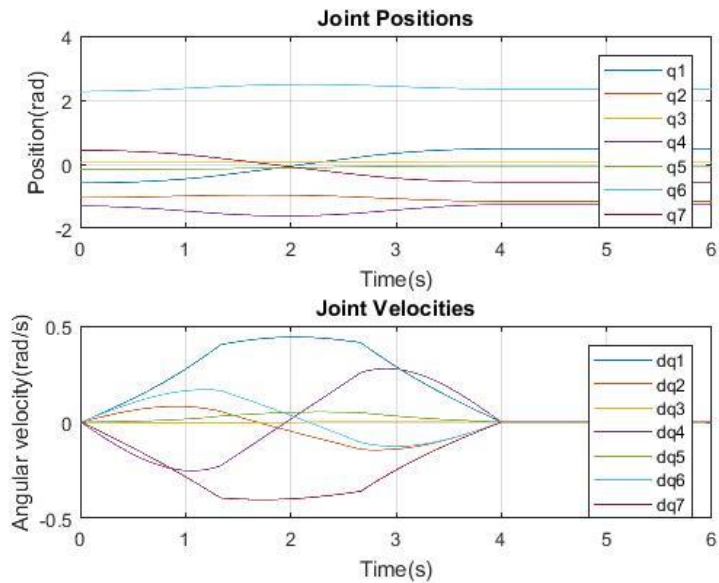
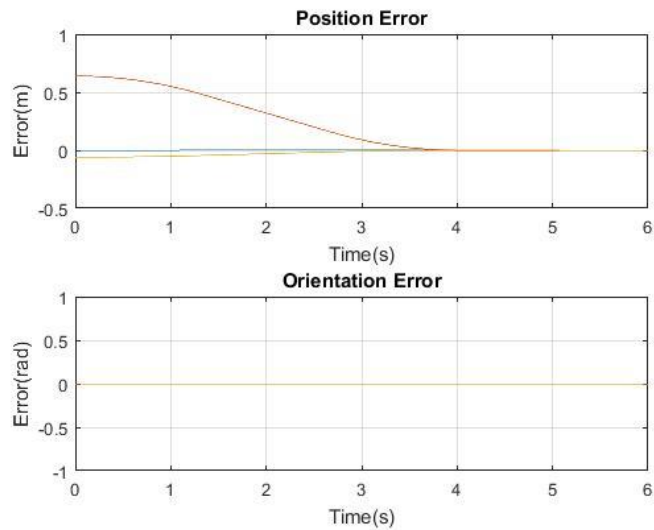


Fig.9: Block diagram for manual Segmentation.

Obstacle Avoiding

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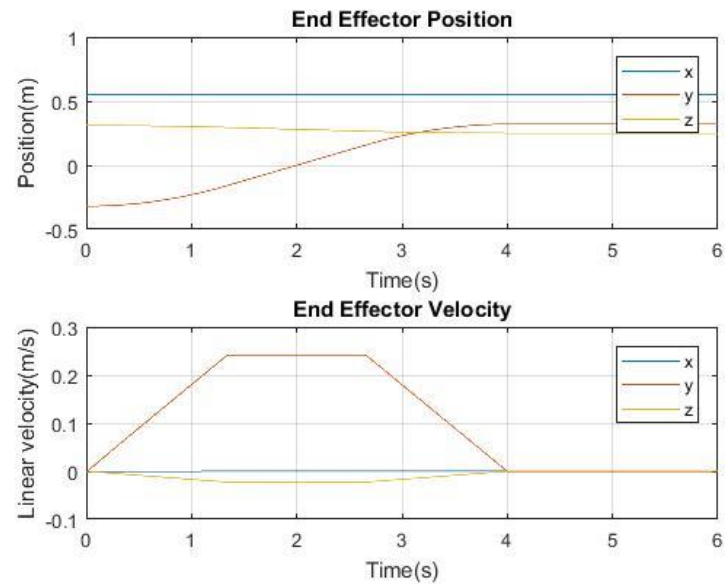
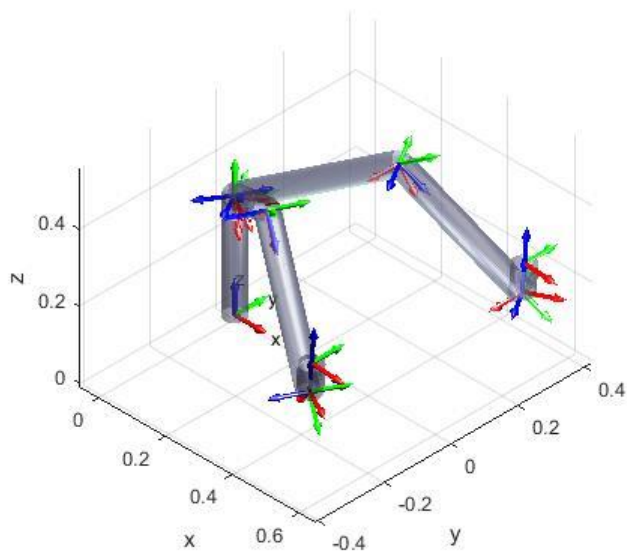


Fig.9: Block diagram for manual Segmentation.

Project Outcomes

Reference

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[1] Introduction to robotics Course Slides.

[2] Edx Introduction to Robotics Course [1-6 week]

Thank you !!!😊

ANY Question ???😊