Robotics Toolbox

# **Team Members –**

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# **Contributions –**

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| Homogeneous Transformation (Description of Frame, Transform Operator, Transform Mapping, Rotation Matrix) | Tanmay Dhanote |
| Euler Angles | Amaan Khan |
| Forward Kinematics | Laukik Mujumdar |
| Workspace | Malay Nagda |
| Inverse Kinematics | Ravendra Raghavendra |
| Differential Kinematics | Malay Nagda |
| Inverse Diff. and Inverse using Jacobians | Ravendra Raghavendra |
| Manipulator Dynamics | Laukik Mujumdar |
| Manipulator Control | Laukik Mujumdar |
| GUI | Tanmay Dhanote, Ravendra Raghavendra |

Firstly, please ensure that you have MATLAB R2019 and robotics toolbox 9.10 by Peter Corke. To initialize the Graphical User Interface, open the main\_window.mlapp, after you open the main window you see number of options to go with. The step by step guide about the use of toolbox and the operations it supports are given below.

# **How to use the Toolbox –**

1. Description of Frame
   1. First enter the number of rotations to be performed.
   2. Then enter the rotation number.
   3. Enter the axis and angle of rotation and press update.
   4. Repeat step b-c for each rotation to be performed.
   5. Enter the translational position of the frame (i) with respect to (i-1)
   6. Press Fixed Frame or Current Frame button to obtain the transformation matrix and plot.
2. Transformation Operator
   1. First enter the number of rotations to be performed.
   2. Then enter the rotation number.
   3. Enter the axis and angle of rotation and press update.
   4. Repeat step b-c for each rotation to be performed.
   5. Enter the Vector A position
   6. Press Transform Vector button to obtain the transformation matrix and plot.
3. Transformation Mapping
   1. First enter the number of rotations to be performed.
   2. Then enter the rotation number.
   3. Enter the axis and angle of rotation and press update.
   4. Repeat step b-c for each rotation to be performed.
   5. Enter the position vector of frame B with respect to A
   6. Enter vector position in frame B
   7. Press map button to obtain the transformation matrix and plot.
4. Rotation Matrix
   1. First enter the number of rotations to be performed.
   2. Then enter the rotation number.
   3. Enter the axis and angle of rotation and press update.
   4. Repeat step b-c for each rotation to be performed.
   5. Press Fixed Frame or Current Frame button to obtain the rotational matrix and plot.
5. Euler Angles

TAB 1: Euler Angle from Rotation Matrix

* 1. Enter rotational matrix
  2. Select the Current frame or Fixed frame from drop down menu
  3. Press Run button to obtain the Phi, Theta and Psi Value and the Plot

TAB 2: Rotation Matrix from Euler Angle

1. Enter Phi, Theta and Psi Value
2. Select the Current frame or Fixed frame from drop down menu
3. Press Run button to obtain the rotational matrix and the Plot
4. Forward Kinematics
   1. First Select either you know DH parameters of robot or not before clicking on Forward Kinematics button
   2. Enter the robot definition accordingly that is being asked under link definition panel, remember value of link type is case sensitive.
   3. Click update after entering each links definition, when the link no. reaches same value as number of links the DH parameters will be displayed.
   4. After that enter the joint variables one by one and run after each, when joint number reaches same value as number of links transformation will give and plots will be plotted.
5. Inverse Kinematics
   1. First Select either you know DH parameters of robot or not before clicking on Forward Kinematics button
   2. Enter the robot definition accordingly that is being asked under link definition panel, remember value of link type is case sensitive.
   3. Click update after entering each links definition, when the link no. reaches same value as number of links the DH parameters will be displayed.
   4. Enter the end effector pose and select which Euler angles describe the end pose and click on run
   5. The values for the joint variables will be displayed accordingly from joint 1 – n
6. Differential Kinematics
   1. First Select either you know DH parameters of robot or not before clicking on Forward Kinematics button
   2. Enter the robot definition accordingly that is being asked under link definition panel, remember value of link type is case sensitive.
   3. Click update after entering each links definition, when the link no. reaches same value as number of links the DH parameters will be displayed.
   4. Click on run above Jacobian to display it
   5. Then enter a pose of end effector to calculate singularity for that defined pose.
7. Inverse Differential Kinematics
   1. First Select either you know DH parameters of robot or not before clicking on Forward Kinematics button
   2. Enter the robot definition accordingly that is being asked under link definition panel, remember value of link type is case sensitive.
   3. Click update after entering each links definition, when the link no. reaches same value as number of links the DH parameters will be displayed.
   4. Enter the end effector Final velocities, and click on run
   5. The values for the joint velocities will be displayed from joint 1 - n
8. Inverse Kinematics using Jacobians
   1. First Select either you know DH parameters of robot or not before clicking on Forward Kinematics button
   2. Enter the robot definition accordingly that is being asked under link definition panel, remember value of link type is case sensitive.
   3. Click update after entering each links definition, when the link no. reaches same value as number of links the DH parameters will be displayed.
   4. Enter the end effector POSITION and POSE as time functions and as row vectors only. E.g.-[sin(t) cos(t) t], also select the end effector orientation Euler angle.
   5. The values for the joint velocities will be displayed from joint 1 – n and click on run.
9. Workspace
   1. First Select either you know DH parameters of robot or not before clicking on Forward Kinematics button
   2. Enter the robot definition accordingly that is being asked under link definition panel, remember value of link type is case sensitive.
   3. After DH parameters are displayed click on run.
10. Manipulator Dynamics
11. Manipulator Control