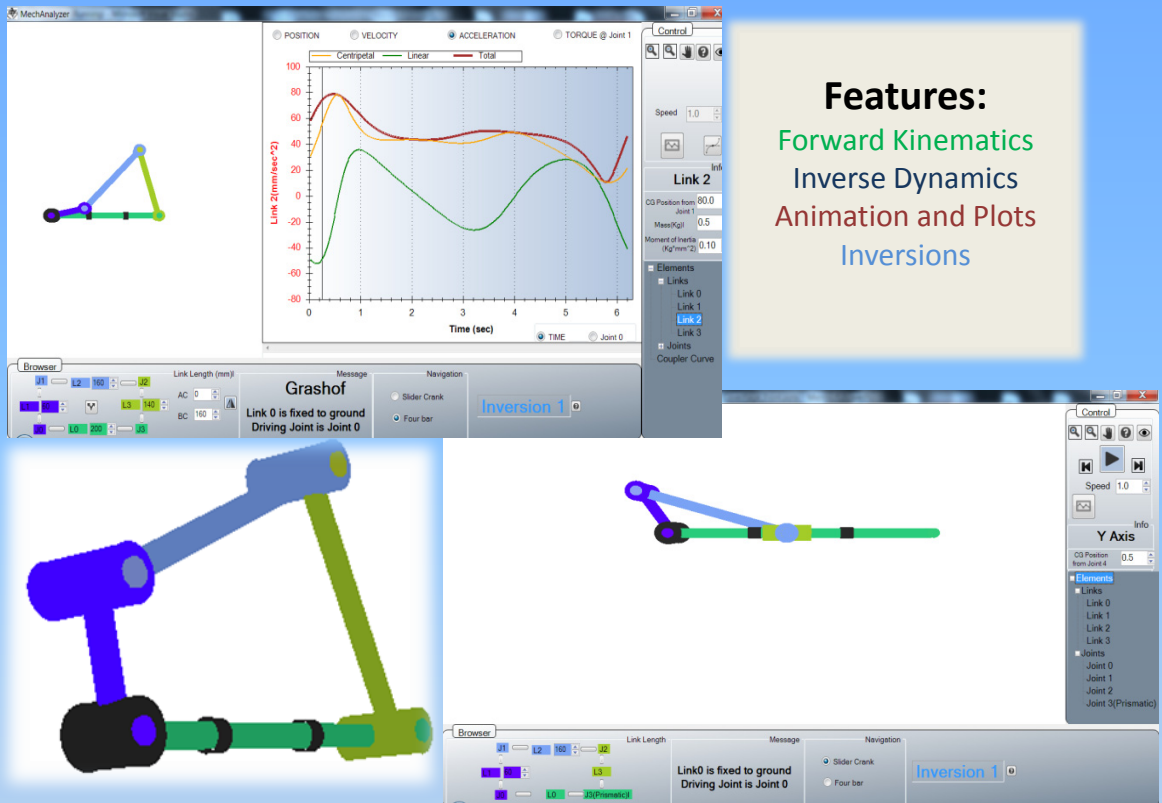
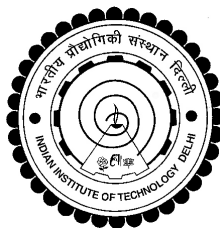


MechAnalyzer

3D Model Based Mechanisms Learning Software User Manual (Version 1)



Freely Available for Academic Use !!!



January 2014

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<http://www.roboanalyzer.com/mechanalyzer.html>

PREFACE

Study of various planar linkages is covered in Mechanism design which is a basic course taught to most mechanical engineering students. Starting with the theory behind them, students learn the dynamic equations to analyze different types of mechanisms, and eventually solve design problems. A computer-based approach to solve these equations becomes imminent when the number of equations increases and also for a quick and better understanding through visualization. Currently, there are many commercially available softwares which can help students in this matter. Unfortunately, a considerable time has to be spent to train a student in use of these programs. Hence, there is a need for a Mechanism learning software.

The new educational computer software “Mechanalyzer” is developed to simulate and analyze the mechanisms that are already preloaded. Developed in C#, Mechanalyzer renders 3D OpenGL graphics with an easy-to-use interface. Presently, Mechanalyzer can simulate two mechanisms, i.e., Four-bar and slider crank and performs forward kinematics and inverse dynamics for all the configurations. After selecting a mechanism, its link lengths can be easily changed the same is reflected instantly in the 3D model of the mechanism. One can also switch between its different inversions. The software has a functionality to plot the kinematic and inverse dynamic analyses results in the form of graphs which provide a detailed picture of the analyses performed by plotting all the components involved rather than just the final value.

Mechanalyzer is developed in the Mechatronics Lab, Department of Mechanical Engineering at IIT Delhi, India under the guidance of Prof. S. K. Saha. The following students are given due credits in its development.

- Shamanth Hampali (2013, Summer Intern from NITK Surathkal): User Interface, 3D Modeling of mechanism, Forward Kinematics, Animation, Graph-plot, C# implementation of DeNOC-based Inverse dynamics
- Rajeevlochana C.G. (M.S.(Research), IIT Delhi): Mentoring and coordination

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1. GETTING STARTED

This section helps you get started with the installation of MechAnalyzer, a 3D Model Based Mechanisms Learning Software. It has been developed using OpenGL and Visual C#.

1.1. MINIMUM SYSTEM REQUIREMENT

- Processor: Atleast 1.5 GHz
- RAM: Atleast 512 MB
- Operating System: Windows XP, Windows Vista, Windows 7
- Dependencies: Microsoft .Net 4.0 framework

1.2. INSTALLATION

MechAnalyzer can be installed on a computer by downloading it from our website. The first version of the software is available for free at <http://www.roboanalyzer.com/mechanalyzer.html> . The following are the steps to install MechAnalyzer:

Step 1: Visit <http://www.roboanalyzer.com/mechanaylzer.html>

Step 2: Look for **Downloads** section on the webpage

Step 3: Click on download link for **MechAnalyzer V1** (or latest version) to download a .zip file

Step 4: A popup window will appear. Select the folder where the file has to be saved and click on **Save**

Step 5: After downloading is complete, unzip MechAnalyzer1.zip to any folder on your computer. Open the folder MechAnalyzer1

Step 6: Double-click on MechAnalyzer1.exe to start MechAnalyzer.

2. INTRODUCTION TO MECHANALYZER

MechAnalyzer is a 3D Model Based Mechanisms Learning Software. It has been developed to help the faculty to teach and students to learn the concepts of Mechanisms.

2.1. MODEL A MECHANISM

Double click on MechAnalyzer.exe starts MechAnalyzer. By default, it shows a mechanism model (Four bar). Users can select a mechanism from the options given at the bottom of the application as shown in Figure 1.

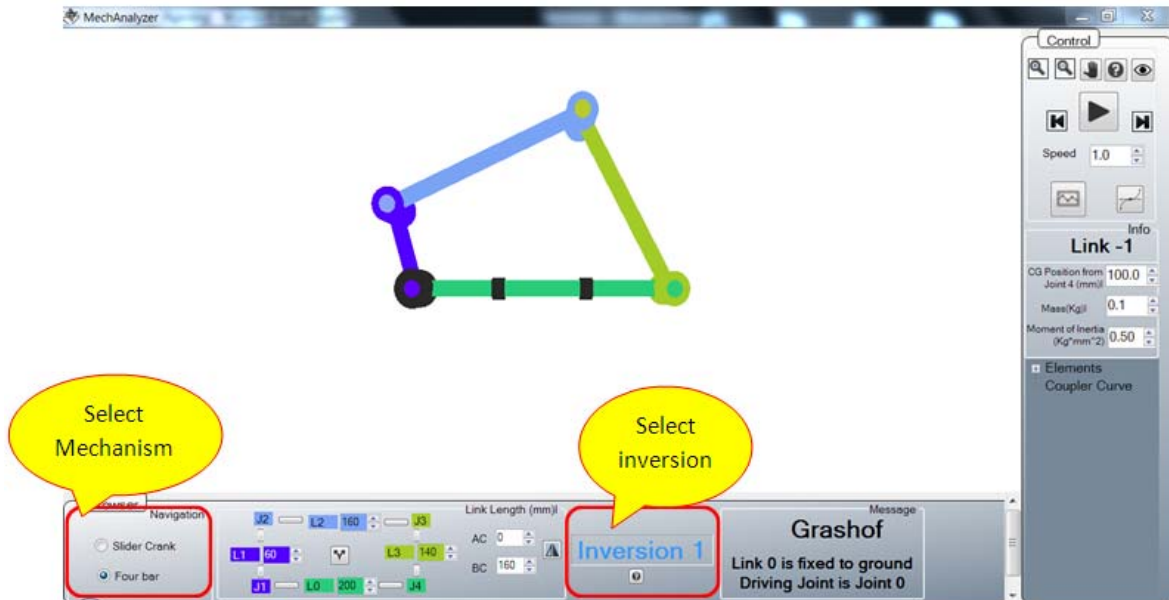


Figure 1: Select Mechanism Model and it's corresponding inversion.

2.2. FEATURES OF MECHANALYZER

MechAnalyzer can be used to perform kinematic and dynamic analyses of linkage mechanisms. The following are the main features of MechAnalyzer:

- Forward Kinematics
- Inverse Dynamics
- Inversions
- Graph plots

2.3. OVERVIEW OF USER INTERFACE

MechAnalyzer's easy to use Graphical User Interface (GUI) consists of the following as shown in Figures 2 and 3.

1. 3D Model View
2. 3D Model Browser
3. Link length selection
4. Message box
5. Graph Plot Window
6. Selection of type of analysis
7. X axis type selection
8. Static properties of the chosen link
9. Graphic tree window

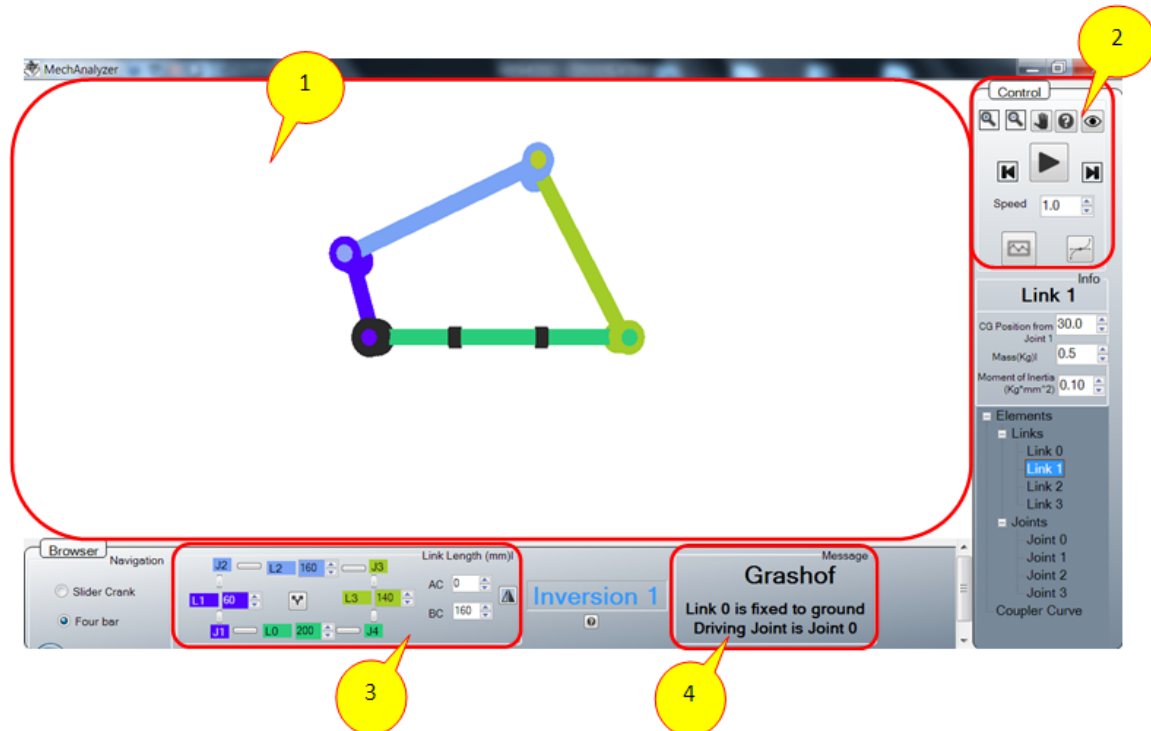


Figure 2: User Interface of 3D Model View

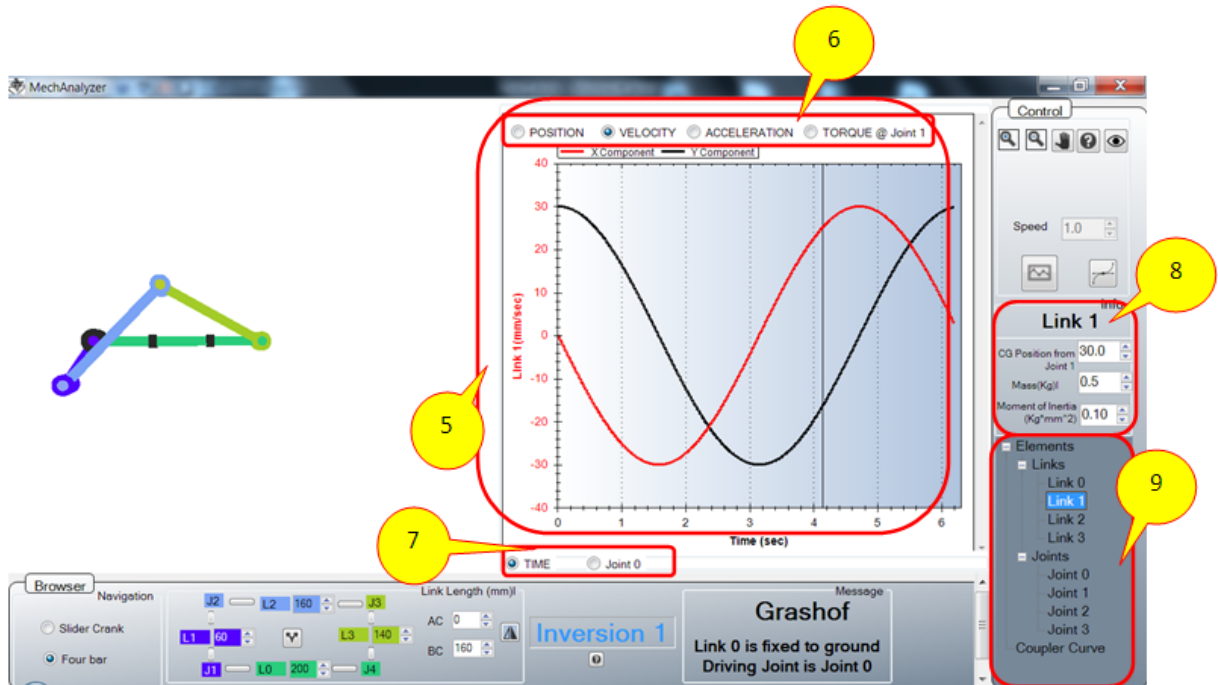


Figure 3: User Interface of Graph Plot View

2.4. 3D MODEL VIEW OPTIONS

MechAnalyzer lets the user to zoom, rotate and pan the 3D model to have better visualization. These can be used as explained below and shown in Figure 4.

- **Zoom:** Place the mouse cursor anywhere on 3D Model View and use the mouse-wheel to zoom in and zoom out. It can also be done by clicking on **Zoom In** and **Zoom Out** buttons.
- **Rotate:** Click on **Rotate** button to make it active. Place the mouse cursor anywhere on the 3D Model View and rotate the model by clicking on left-mouse button and dragging the mouse.
- **Pan:** Click on **Pan** button to make it active. Place the mouse cursor anywhere on the 3D Model View and translate the model by clicking on left-mouse button and dragging the mouse.

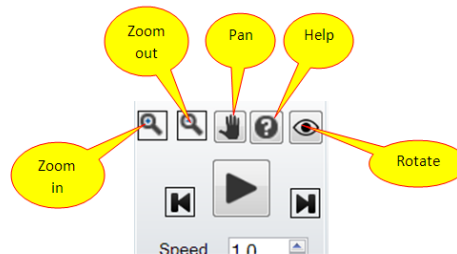


Figure 4: 3D Model View Options

3. NOTATIONS USED

The architecture of industrial mechanisms is usually represented by standard parameters and notations. It forms the basis for performing kinematic and dynamic analyses of mechanisms. The standards used in the Mechanalyzer to define link and joints is shown in fig 5. Different inversions achieved in Mechanalyzer are shown in fig5 and fig 6

3.1. FOUR BAR

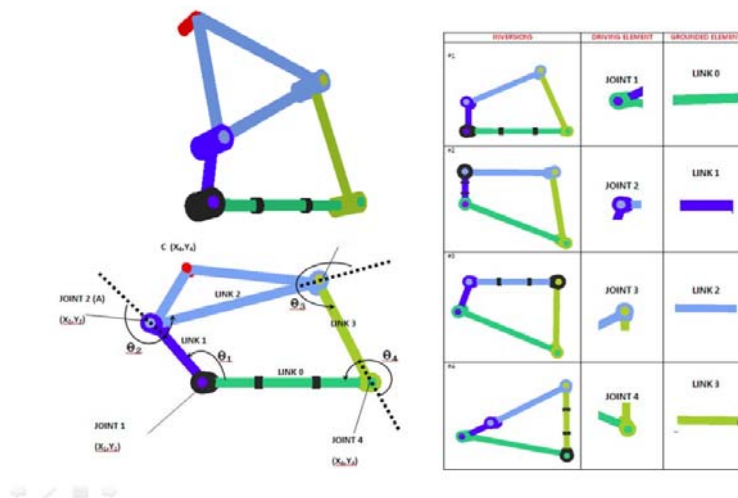


Fig 5: Different inversions and standard notations used in Four bar linkage mechanism

3.2. SLIDER CRANK

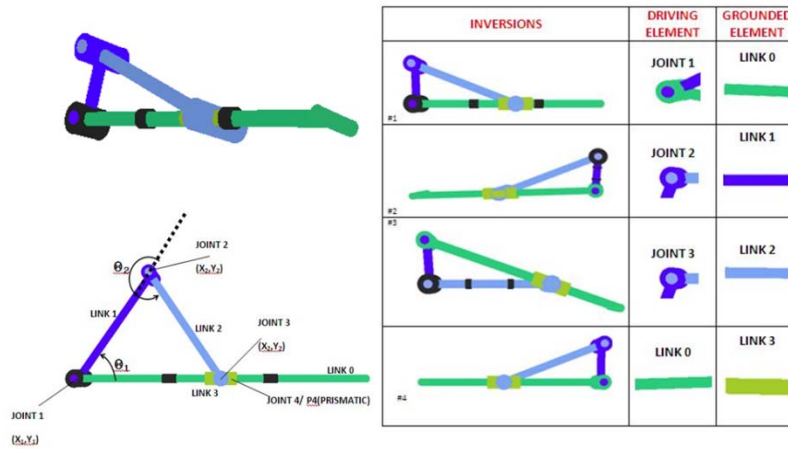


Fig 6 Different inversions and standard notations used in slider crank mechanism

To perform animation of the mechanism motion between user has to simply click the play button. The speed of the animation can be changed by varying the numeric stepper. The user can animate frame by frame by clicking the buttons that are placed either side of Play/Pause button as shown in Fig 7

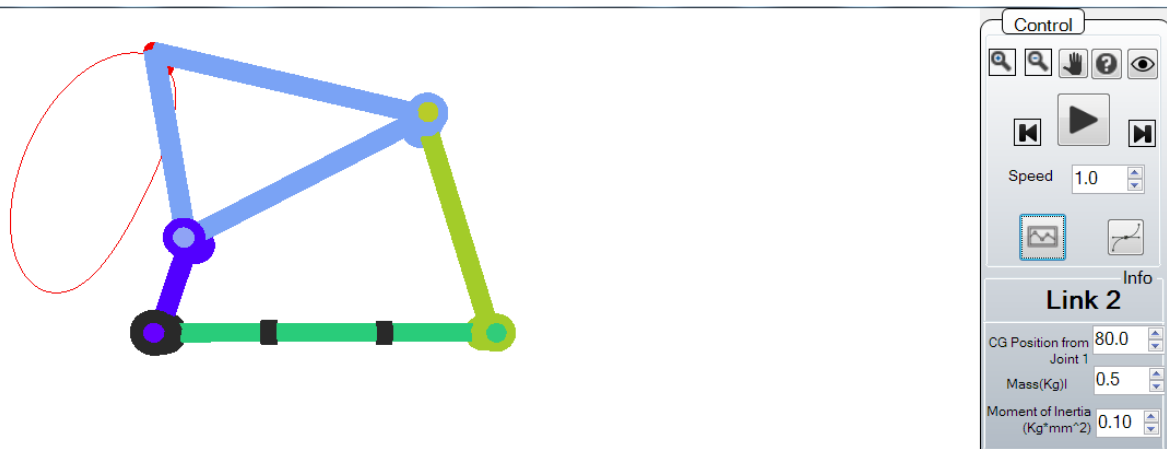


Figure 7: Coupler curve

4. GRAPH PLOT OPTIONS

The analyses results for FKIn, IDyn can be viewed as graph plots as explained in Sections 2.3,. Several options for graph plot functionalities are explained below and as shown in Figure 8 .

1. Select a graph plot node
2. Right click on graph to show a menu. Here you can use various options to zoom, print etc
3. Export Data as CSV: Export plot data that can be opened in a spreadsheet such as MS Excel
4. Use Mouse wheel to zoom in and out
5. Press Mouse wheel and drag the mouse to pan around the graph

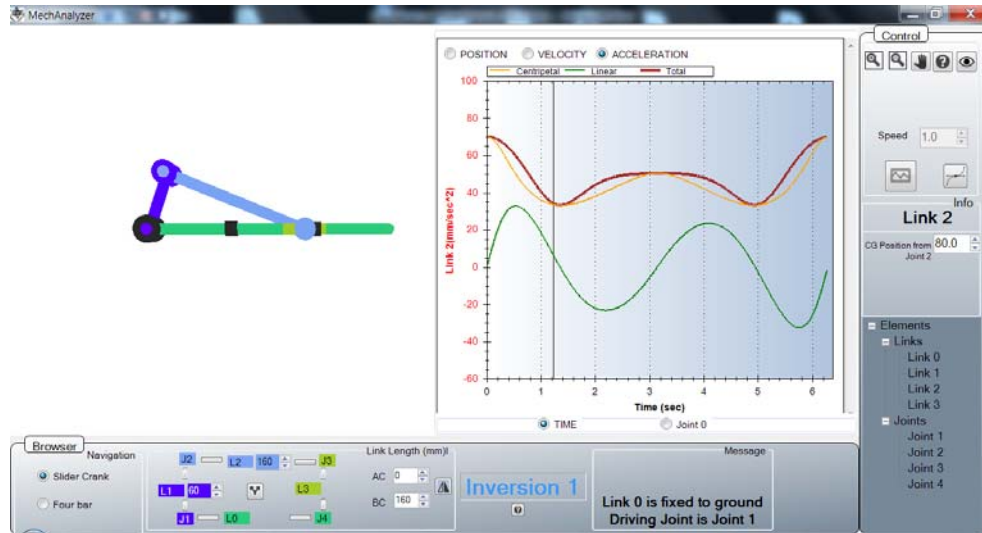


Figure 8: Graph Plot Options

5. REFERENCES

- [1] Robert Norton , "Design of machinery 2nd Edition"
- [2] S. K. Saha, "Introduction to Robotics," Tata McGraw Hill, New Delhi, 2008
- [3] ReDySim, website accessed on December 28, 2011, <http://www.roboanalyzer.com/redysim.html>

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RoboAnalyzer

3D Model Based Robotics Learning Software

17 CAD models of Robots in Virtual Simulation Module

1

- Select a Standard Robot Model or
- Select a Skeleton Model and Vary the Denavit-Hartenberg (DH) Parameters
- Learn and Visualize DH Parameters

2

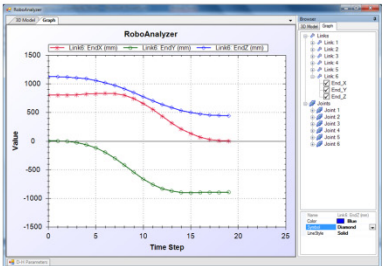
- Forward and Inverse Kinematics
- Forward and Inverse Dynamics*
- Animation and Trace
- Virtual Robot Module
- MATLAB Interface

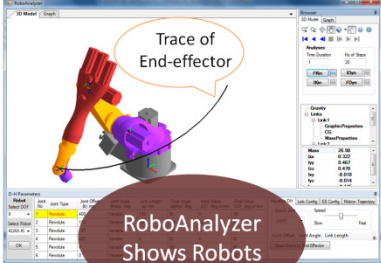
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* Uses ReDySim Algorithm

3

- Analyze and understand with Graph Plots
- Learn the Physics of Robotics first and then its Mathematics

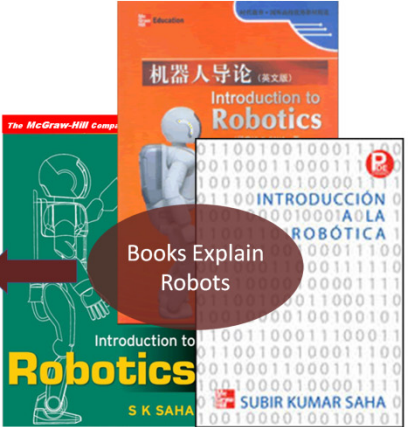




RoboAnalyzer Shows Robots

Trace of End-effector

Together one enjoys Robotics!



Books Explain Robots

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