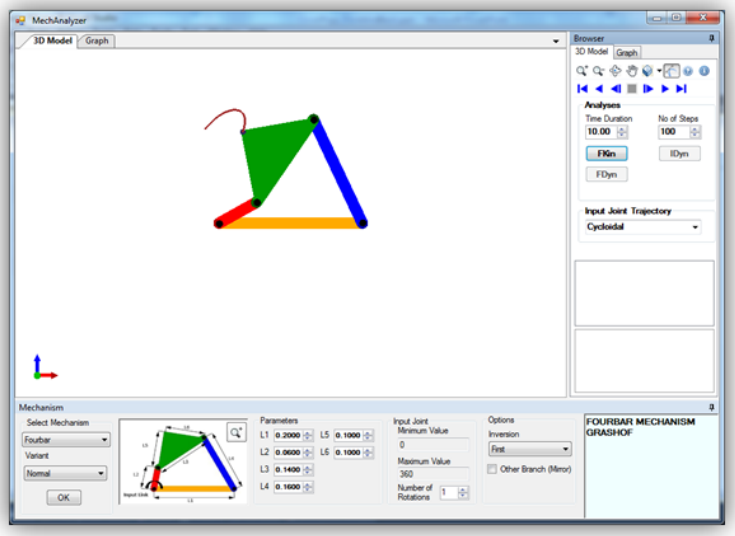
MechAnalyzer

3D Model Based Mechanisms Learning Software

User Manual (Version 3)

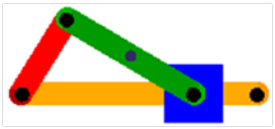


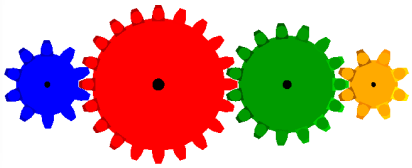
Features:

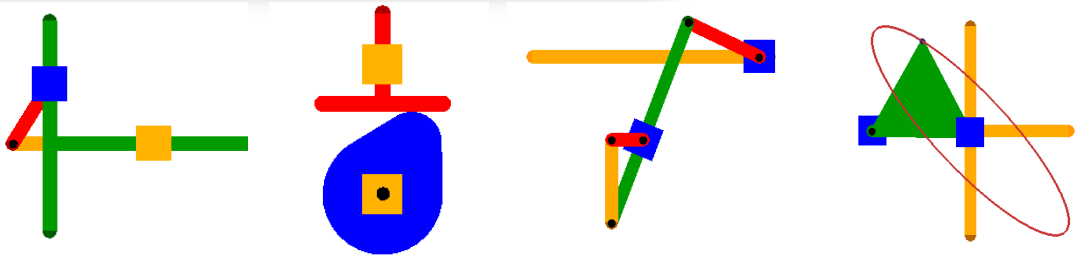
Forward Kinematics

More than 10 Mechanisms

Inversions







Freely Available for Academic Use !!!

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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 software which can help students in this matter. Unfortunately, a considerable time has to be spent to train a student to use these programs. Hence, there is a need for a Mechanism learning software.

In this user manual, the third version of the educational computer software "Mechanalyzer" is presented. It has been 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 ten mechanisms. 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 and select variants of the mechanisms. Mechanalyzer was 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): Version 2 comprising of kinematic and dynamic analysis of four-bar, slider crank and five-bar mechanisms.
- Rakshith Lokesh (2014, Summer Intern from NITK Surathkal): Version 3 with forward kinematics of around 10 mechanisms.
- Rajeevlochana G. Chittawadigi.(M.S.(Research), IIT Delhi, Asst. Professor, Amrita University Bangalore): Architect/Framework design for Version 3, coordination and mentoring

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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, Windows 8.
- Dependencies: Microsoft .Net 2.0 framework

1.2. INSTALLATION

MechAnalyzer can be installed on a computer by downloading it from our website. The third 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 **MechAnalyzerV3** (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 MechAnalyzer3.exe to start MechAnalyzer (No need to install to use)

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. OVERVIEW OF USER INTERFACE

The version 3 of Mechanalyzer has been presented to the user in such a way that the user can easily get started with it. The user interface of the software as shown in Figure 1, can be divided into the following sections:

1. Mechanism Selection Panel – The desired mechanism and its corresponding variant can be loaded.
2. Mechanism Description Window – Displays a labeled image of the mechanism showing its various parameters. An enlarged image is shown in a separated window when the zoom button is clicked.
3. Input Parameters Panel – The user can set the input parameters pertinent to the mechanism.
4. Output Parameters Box – Some of the important output parameters related to the mechanism are displayed.
5. Mechanism Options – Other options related to the mechanism if any are shown here.
6. Message Window – Displays the name of the mechanism, its variant and warning messages if any.
7. Animation Controls – The speed, play forward, play backward controls are enabled in this toolbox.

8. Analysis Options – The analysis needed to be performed can to selected.
9. Viewing Toolbar - The basic CAD viewing options like zoom, pan, orbit etc. are provided.
10. Graphic Window – This is the window where the mechanism is rendered and simulation is shown.

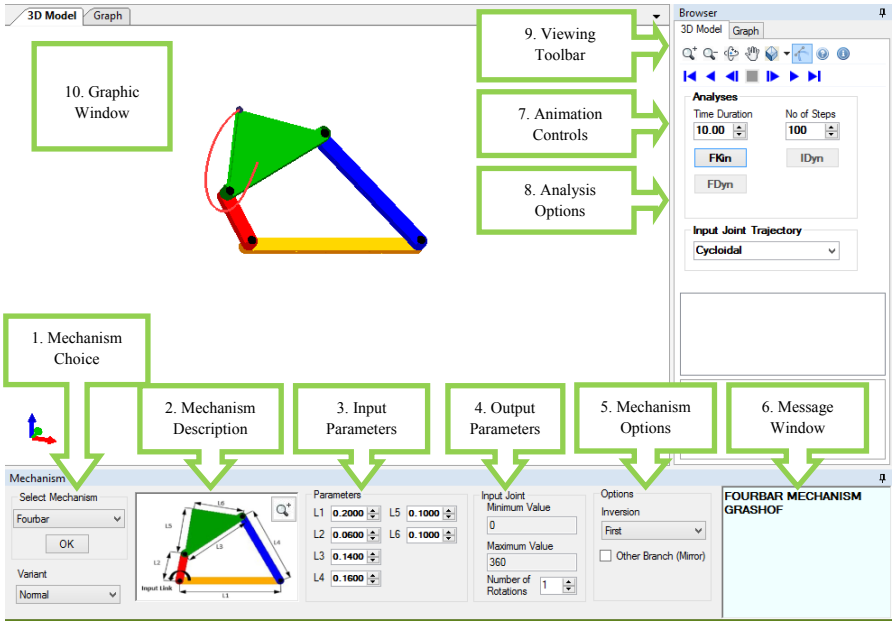

Figure 1:The user interface of Mechanalyzer v3.

2.2. FEATURES OF MECHANALYZER

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

- Mechanism Animation
- Curve Trace for coupler point.
- Inversions for Fourbar and Slider Crank.

Note : Graph Plot, Inverse Dynamics and Forward Dynamics haven't been incorporated yet. They will be reported in the future versions of the software.

Mechanalyzer comes with the following ten preloaded mechanisms and the mentioned special variants of the respective mechanism;

- **Fourbar Mechanism**, its inversions and the following straight line mechanisms derived from Fourbar; Robert's Mechanism, Watt's Mechanism, Evan's Linkage, Tchebyshev's Mechanism and Hoeken's Linkage.
- **Slider Crank Mechanism**, its inversions and a straight line mechanism derived from slider crank; Scott Russel Mechanism.
- **Double Slider Mechanism,** variations of double slider; Elliptical Trammel, Oldhams Coupling and Scotch Yoke Mechanism.
- **Steering Mechanism**, Ackermann Steering and Davis Steering.

- **Wiper Mechanism.**
- **Whitworth Quick Return Mechanism.**
- **Fourbar Quick Return Mechanism.**
- **Pantograph Copier Mechanism.**
- **Cam Follower Mechanism,** Flat Face follower and Knife Edge Follower.
- **Spur Gear Mechanism,** Simple Gear Train, Compound Gear Train.

2.3. LOADING AND ANIMATING A MECHANISM

- The desired mechanism can be selected from the **Select Mechanism** (refer Figure 1) dropdown menu. The corresponding variant if it applies to the mechanism needs to be selected from the **Variant** (refer Figure 1) dropdown menu.
- The mechanism parameters window using the zoom button as shown in Figure 2 can be opened to relate the various lengths to the parameters of the mechanism. The window also defines any output parameters of the mechanism

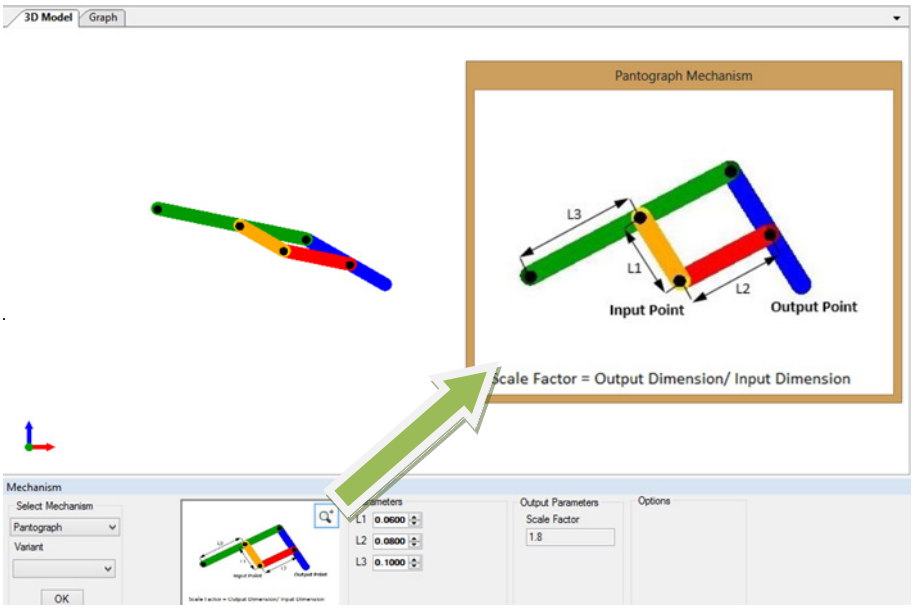

Figure 2: Mechanism description window opened by clicking the zoom button.

- Then the parameters can be defined using the **Input Parameters** numeric controls.
- Then the forward kinematic analysis needs to be run using the **FKin** button in the **Analysis Option** box after which the animation can be observed using the animation controls.

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 3.

- **Zoom:** Use the zoom in and zoom out buttons to enlarge or diminish respectively.
- **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.
- **Model Views:** The dropdown can be used to quickly move to a different view; front view, side view, isometric view etc.
- **Curve Trace:** Click on **curve trace** button to draw trace and click on it again to disable trace.

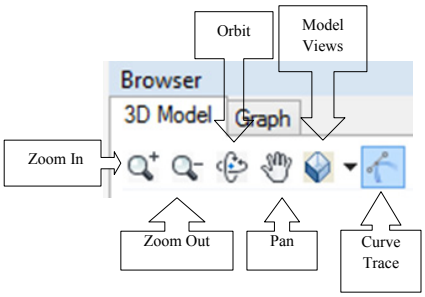

Figure 3: The 3D model view toolbar.

3. NOTATIONS USED

The architecture of industrial mechanisms is usually represented by standard parameters and notations. The following notations are used in Mechanalyzer v3;

- The fixed link is represented yellow in color apart from mechanism when showing inversions.
- Black circles on links represent pin joints at that location and links penetrating into cubes represent prismatic joint at that location.
- The coordinate marker shown at the bottom left corner of the screen uses standard colors, i.e., red for x, green for y and blue for z axes, respectively.
- Lines shown in dotted represent axis lines to show extension of links and do not form a part of the mechanism.
- Fkin implies Forward Kinematics, IDyn implies inverse dynamics.

4. REFERENCES

[1] Robert Norton , “Design of machinery 2nd Edition”

Other Related Research & Software Developed by Prof. S.K. Saha & Team IIT Delhi, New Delhi, India