

Appendix B

SYNTHETICA User's Guide

SYNTHETICA is a computer graphics based interactive program for synthesizing spatial robots. The goal is to provide a platform for researchers to collaborate on the mechanism synthesis and analysis. SYNTHETICA is written in Java therefore is platform independent and runs on multiple operation systems such as Windows and Mac OS X.

B.1 System Requirements and Usage

Operation Systems:	Windows 98/2000/XP or Mac OS X
Software Packages:	Java 2(1.3 or above), GL4Java(2.8.2.0), OpenGL libraries
Computer:	Apple G3 or PC Pentium III (minimum) Apple G4 or PC Pentium IV (recommended)
RAM:	128MB minimum, 256MB recommended

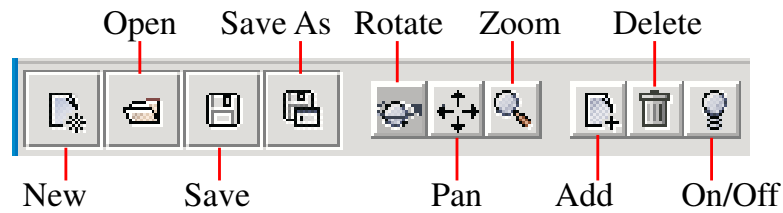


Figure B.1: The toolbar for manipulating files, viewer and objects

B.2 Graphical User Interface Components

The toolbar consists of three groups of icons, an file I/O group for loading and saving data from and to the local files, a dynamic viewer group for rotating, panning, and zooming the display scene and an object operation group consists of adding, deleting and turning on/off objected displayed in the scene. See Figure B.1.

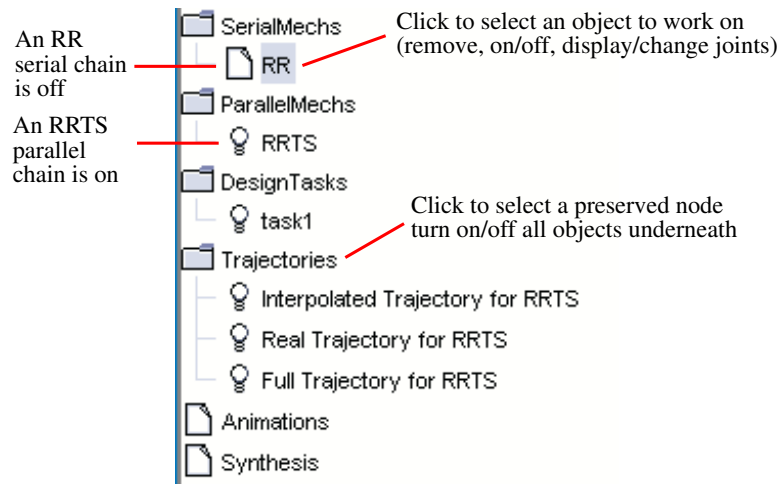


Figure B.2: The object tree structure

The object tree organizes the objects displayed in the graphical scene. Users can select an object using mouse clicking. The data associated with the selected object is displayed in the information panel (the lower left corner). Users can modify and

operate the object through information panel and tool bar. See Figure B.2

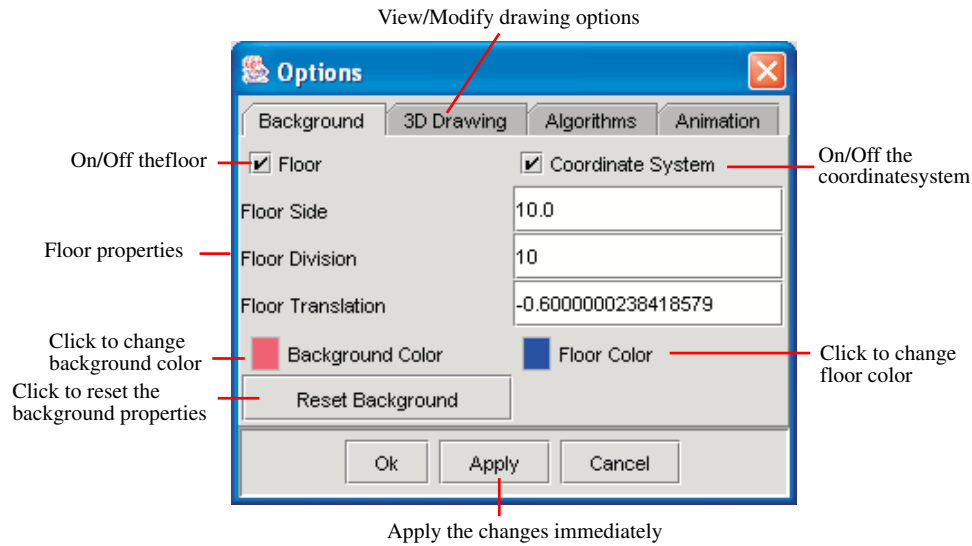


Figure B.3: The option dialog

The option dialog is for updating various options used by SYNTHETICA at run time. For example, users can change the property of the background such as floor position, color etc. Also a factor for scaling the geometric objects in the viewer panel can specified in the “3D Drawing” panel.

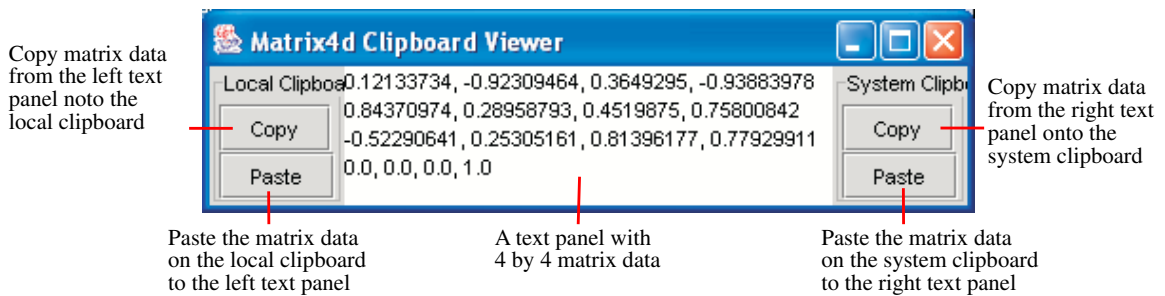


Figure B.4: The Matrix4d clipboard

The matrix clipboard viewer is used for exchanging 4 by 4 homogeneous matrices with external programs. With the matrix clipboard, users can conveniently cut and paste matrices within SYNTHETICA interface as well as the external programs. See Figure B.4.

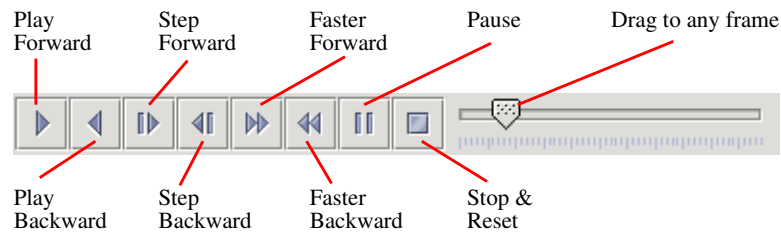


Figure B.5: The animation toolbar

The animation toolbar allows users fully control the animation playback (Figure B.5). Users can play continuously or step, forward or backward and change animation speed. The animation toolbar is enabled when an animation object is selected by the users. The curve of each joint angle is shown in the DataViewer panel (Figure B.6). A frame indicator shows the joint data of the current frame.

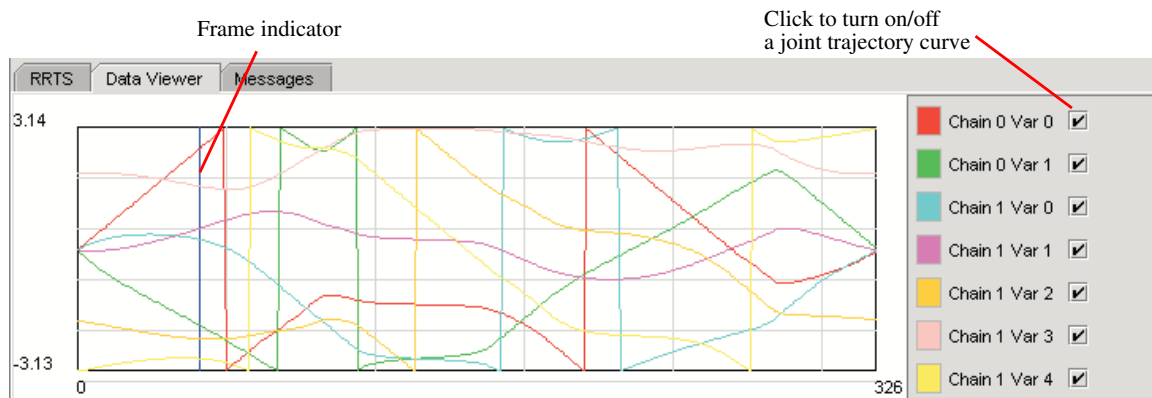


Figure B.6: Data viewer panel for displaying animation frames

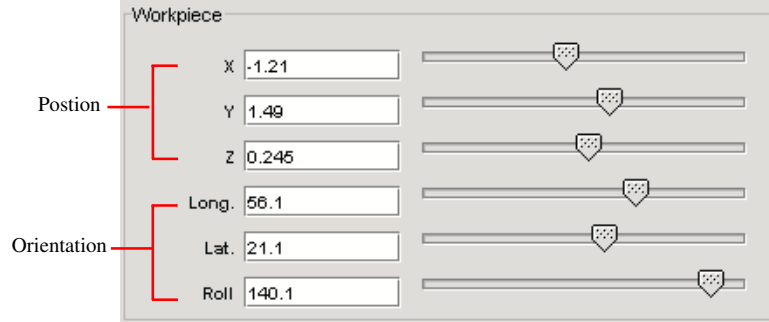


Figure B.7: The workpiece panel

The workpiece panel shows the position and orientation of the unique object “workpiece”. The workpiece object is the gripper drew in wireframe mode. When user select a mechanism, the workpiece will snap to the end-effector. Therefore users can obtain the end-effector data. When a frame of a trajectory is selected, the workpiece will snap to it and shows the information on the frame. The workpiece orientation is constructed from three angles longitude(θ), latitude(ϕ), and roll(ψ) (Figure B.8) defined by

$$\begin{aligned}
 [R(\theta, \phi, \psi)] &= [Y(\theta)][X(-\phi)][Z(\psi)] \\
 &= \begin{bmatrix} c\theta c\psi - s\phi s\theta s\psi & -c\psi s\phi s\theta - c\theta s\psi & c\phi s\theta \\ c\phi s\psi & c\phi c\psi & s\phi \\ -c\psi s\theta - c\theta s\phi s\psi & -c\theta c\psi s\phi + s\theta s\psi & c\phi c\theta \end{bmatrix} \quad (\text{B.1})
 \end{aligned}$$

where $c\theta = \cos \theta$, $s\theta = \sin \theta$ and so on, $[X(\cdot)]$, $[Y(\cdot)]$, $[Z(\cdot)]$ represent the pure rotation around the axes X,Y,Z respectively, defined by formula (2.2) and (2.3) with zero translations.

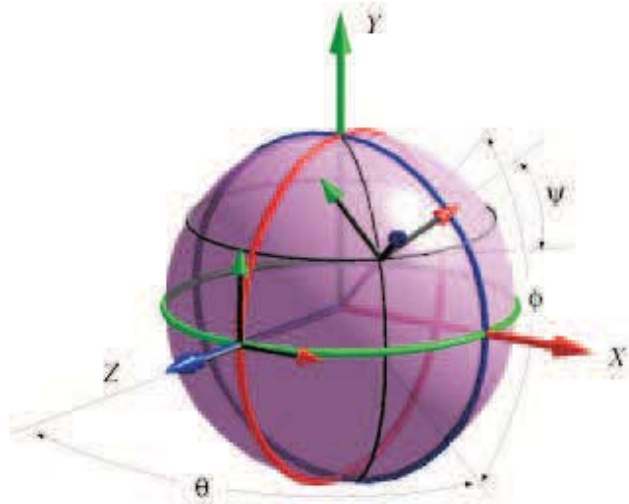


Figure B.8: Longitude(θ), latitude(ϕ), and roll(ψ) coordinates defining an orientation

The mechanism teach panel displays the joint data for a serial or parallel mechanism. For a serial mechanism, driving the joints will cause the forward kinematics executed. The end-effector data is updated dynamically in the workpiece panel (Figure B.7). For a parallel mechanism, driving a joint will execute our general solver. Users can lock a joint and allow other joints free to change. When the “Approach” button is clicked, the mechanism will modify the joint parameters so that the end-effector can reach as close to the position shown in the workpiece panel as it can. When the “Generate” button is clicked, the mechanism will approach the goal trajectory using the algorithm presented in Chapter 2.

The matrix4d specifier dialog is for modifying 4 by 4 homogeneous matrices. See Figure B.10. This is the most often used GUI component in SYNTHETICA. It can be launched by many panels specifying matrices. For example, users can use it to modify

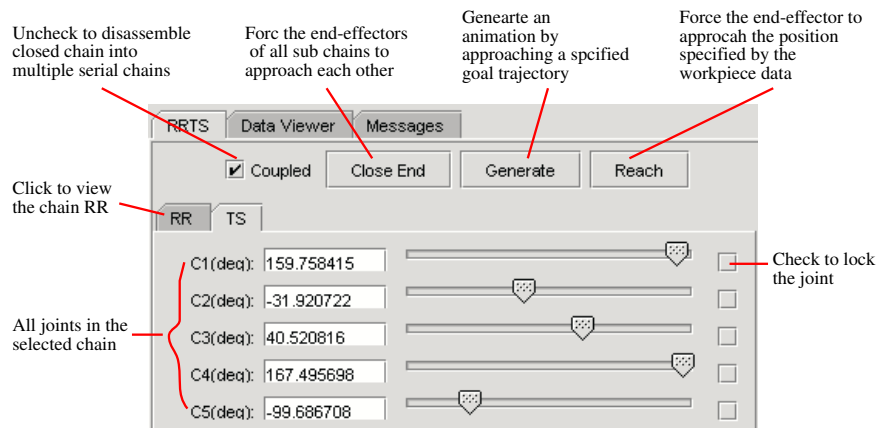


Figure B.9: Mechanism teach panel for driving joint parameters.

the base frame of a mechanism object. The matrix4d specifier dialog consists of a standard matrix4d panel which is reused in other panels such as trajectory panel. The matrix4d panel consists of two parts, one is for position, the other is for orientation. The orientation part is a 3 by 3 rotation matrix defined by (B.1). Users can convert the orientation matrix from and to the longitude, latitude and roll.

The trajectory panel shows the trajectory data which consists of key frames and full list of frames. The full list of frames are obtained through the built-in interpolation code using the key frames. See Figure B.11.

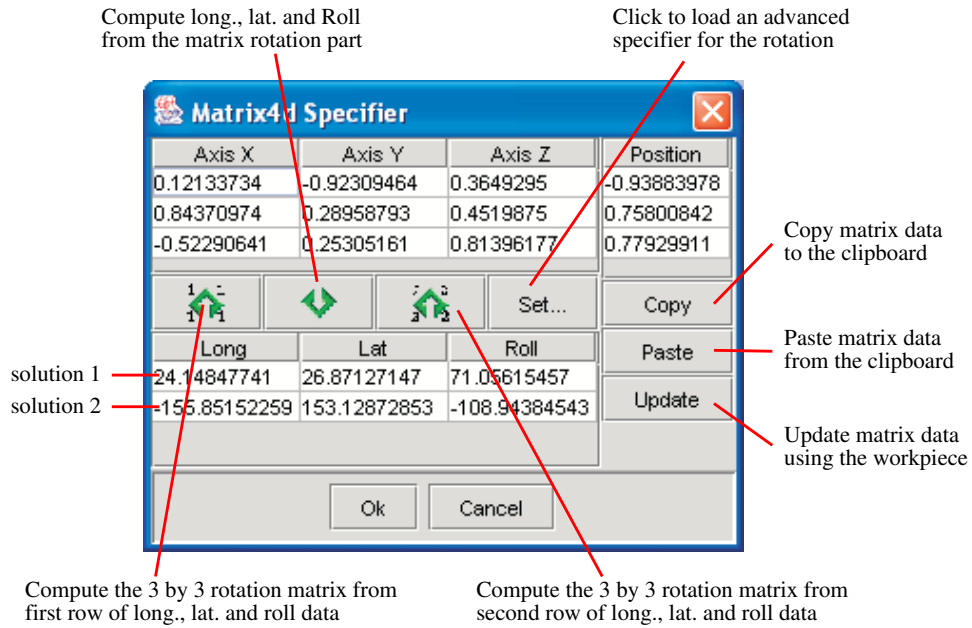


Figure B.10: Matrix4dSpecifier dialog for specifying 4×4 homogeneous matrices

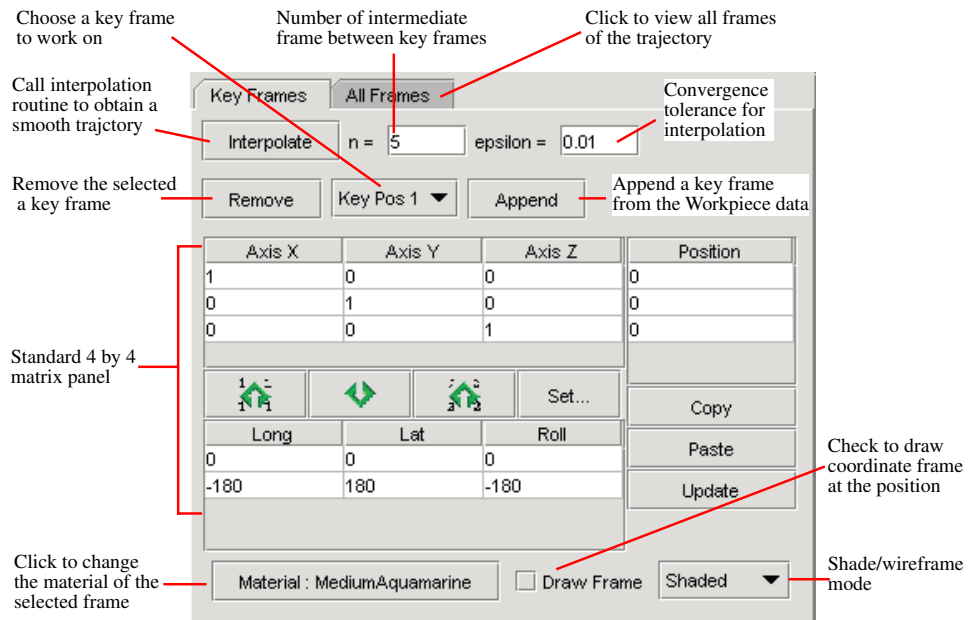


Figure B.11: The trajectory panel