Virtual Labs Graphics Manual

Installing and Running
Download the toolkit from site.

The tool demonstrates the concepts of Computer Graphics with a total of seven experiments.
1. Points and Coordinate Systems.
2. Transformations: Translation
3. Transformations: Rotation
4. Transformations: Scaling
5. Hierarchical Transformations
      5a. 2D Demo
      5b. Articulated Arm
6. Projections and Cameras.

On Windows:
1. Unzip the downloaded archive.
2. Open the *VirtualLabGraphics* folder.
3. Run by double clicking the corresponding *Experiment.bat* file.
    For eg. Run the *Experiment5b.bat* file for the Articulated arm experiment.

On Linux or Mac OSX:
1. Unzip the downloaded archive.
2. Go to the VirtualLabGraphics directory.
      $ cd VirtualLabGraphics/
3. Run the experiment using the command below.
      $ ./Experiment.sh <exp. no.>
    For eg. Run the experiment 5b as
      $ ./Experiment.sh 5b

Canvas
The Canvas displays the geometry loaded by the application. It allows to view the geometry and their relative coordinate systems from different angles. It also supports navigation through the scene and modification of the vertices.

Canvas: Navigation
Pan through the scene by dragging the mouse with the middle button pressed or with left mouse button pressed. (see Display tab options).
Scroll the mouse wheel to **zoom in** or **out** of the scene.
Rotate the view by dragging the mouse with the right button pressed.
Disable *Lock vertices* option in Display tab to **move selected vertices** with left mouse button.

Display Tab
The display tab provides configurable settings for the UI and navigation.
3D - Enable/Disable 3D view in canvas.
Lock vertices - Enable to use left mouse button to pan through the scene in the canvas. Disable to allow editing vertices by moving them around in the canvas using left mouse button.

Show animation - Enable to allow animation in the scene using the animation slider at the bottom. Disable to make the scene static with no animation even with slider.
Transform coordinate systems - Enable to show the transformations to the coordinate system with the geometry fixed in place. Disable to transform the geometry with the coordinate system fixed.
Draw XY grid - Enable to display the grid in XY plane
Draw YZ grid - Enable to display the grid in YZ plane
Draw ZX grid - Enable to display the grid in XZ plane
Reset View - Reset the view of the scene in the canvas to the initial camera settings.

World Tab
The world tab has three sections. Theory space, Hierarchical structure display, Vertex info display.

Theory Space
The Theory space provides the theory required for the current experiment and guides through the experiment with hands on experience. Use the *next* and *previous* links to browse through theory and guide.

Hierarchical structure display
This section displays the different cameras and instances created in the scene and the entire hierarchical structure under the world title.

Each node in the hierarchical structure is called an instance. Each instance in the hierarchical structure is shown as a node under the world title. The final instance in the list of instances under world title is the complete hierarchical model. An instance consists of three sections and two options.
- **Coordinate system** - This is the local coordinate system of the instance relative to the parent instance. The editable options in the coordinate system are
  - X-axis, Y-axis, Z-axis - Axis vectors for the corresponding axis.
  - Origin - Location of origin for this coordinate system. The three axis vectors above emerge from the origin.
  - Axes size - Length of axes displayed
  - Show units - Enable to display the units when tracking a vertex of the current instance.
  - Draw - Enable/Disable the visibility of the coordinate system in the canvas.
- **Shape / Instance** - These could be shapes if the current instance is a leaf node or other instances if the current instance is an intermediate node or could be a set of shapes and instances.
  - Shapes have Vertices which can be edited and the tracking enabled/disabled for each individual vertex. Any vertex can be selected by clicking on it. Shapes could also have Triangles which is a list of triplets each representing a triangle with the values of the triplets being indices of vertices that form the triangle. These again can be edited by clicking on any value.
  - Instance is again a new node with all the features explained here.
- **Transformation** - This has a list of transformations applied to the shapes and instances above in the local coordinate system. The order of transformation can be modified. More transformations can be added, edited or deleted. The duration setting for each transformation is the number of frames in which the transformation is animated from the frame specified as start frame.

- Translate does a translation of the above mentioned shapes and instances in the local coordinate system. This could be animated from no translation to the specified translation.
- Rotate does a rotation of the shapes and instances about the specified axis or any custom vector by the specified angle in the local coordinate system. This could be animated from zero rotation angle to the specified rotation angle.
- Scale does a scaling on the shapes and instances by the specified ratio along the specified axis in the local coordinate system. This could be animated from zero scale to the specified scale.
- Animation of each transformation could be set by specifying the number of frames over which the animation is done in the *duration* input. Starting frame for the animation can be specified in the *Starting frame* input in the transformation window.
- Order of the transformation can be modified by selecting the transformation and clicking the move up button in the window showing the list of transformations.
- **Active** - This option specifies whether the current instance is highlighted in the canvas.
- **Draw** - Enable/Disable the visibility of the current instance (along with the child instances) in the canvas.

Camera is another node type under the world title. This provides the settings of the camera placed in the scene.
- **Type** - Toggle between Orthographic or Perspective camera.
- **Near, Far, Bottom, Top, Left, Right** - Frustum parameters (clip planes) for the selected camera type.
- **Transformation** - List of transformations applied to the camera. This is similar to the transformation section in the Instance.
- **Coordinate System** - Local coordinate system of the camera. This is similar to the coordinate system section in the Instance. The camera is always placed at Origin looking in the direction of negative z-axis.
- **Show View** - Toggle camera view in a new window.
- **Switch Axis to Camera** - Align the world coordinate system to the camera coordinate system and show the transformations of the models wrt the camera's coordinate system in the canvas. By default *Global coordinate system* is selected under world title.

Global coordinate system is an option provided under the world title. This is selected by default. The world coordinate system is aligned to the global coordinate system in the canvas. The global coordinate system is always fixed, orthogonal and cannot be modified.

The buttons in the Hierarchical structure display section provide ways to add New instances, Edit any selected feature, Delete a node and Add a camera to the scene. Each of these buttons open a new window where the parameters for the corresponding node are entered.

Vertex Info Display
This section displays the homogeneous and normalized absolute coordinates of the vertex selected. The absolute coordinates are always in the global coordinate system. Note that the coordinate system of the top level node in the hierarchical structure is relative to a fixed global coordinate system.

Animation Slider
The **Animation Slider** resides at the bottom of the experiment window. Slide it to view any animation provided in the model . The animation can be seen only if the *Show animation* option is enabled in the display tab. (*see Display Tab options*).

Experiments
Different preloaded experiments are provided along with the application. Start the respective application to understand the concepts practically. Each application comes preloaded with required geometry and the corresponding theory and guidance to understand the concepts better. Please refer the website for the list of experiments.
You can however use the entire features of the application and try your own experiments by just starting with any provided experiment.