

NAME

etruscanvenus – Draws a 3d immersion of a Klein bottle that smoothly deforms between the Etruscan Venus surface, the Roman surface, the Boy surface surface, and the Ida surface.

SYNOPSIS

etruscanvenus [--display *host:display.screen*] [--install] [--visual *visual*] [--window] [--root] [--window-id *number*] [--delay *usecs*] [--fps] [--mode *display-mode*] [--wireframe] [--surface] [--transparent] [--appearance *appearance*] [--solid] [--distance-bands] [--direction-bands] [--colors *color-scheme*] [--onesided-colors] [--twosided-colors] [--distance-colors] [--direction-colors] [--no-change-colors] [--view-mode *view-mode*] [--walk] [--turn] [--no-deform] [--deformation-speed *float*] [--initial-deformation *float*] [--etruscan-venus] [--roman] [--boy] [--ida] [--orientation-marks] [--projection *mode*] [--perspective] [--orthographic] [--speed-x *float*] [--speed-y *float*] [--speed-z *float*] [--walk-direction *float*] [--walk-speed *float*]

DESCRIPTION

The *etruscanvenus* program shows a 3d immersion of a Klein bottle that smoothly deforms between the Etruscan Venus surface, the Roman surface, the Boy surface, and the Ida surface. You can walk on the Klein bottle or turn it in 3d. Topologically, all surfaces are Klein bottles, even the Roman and Boy surfaces, which are doubly covered and therefore appear to be an immersed real projective plane. The smooth deformation between these surfaces was constructed by George K. Francis.

The Klein bottle is a non-orientable surface. To make this apparent, the two-sided color mode can be used. Alternatively, orientation markers (curling arrows) can be drawn as a texture map on the surface of the Klein bottle. While walking on the Klein bottle, you will notice that the orientation of the curling arrows changes (which it must because the Klein bottle is non-orientable). Since all the surfaces except the Ida surface have points where the surface normal is not well defined for some points, walking is only performed on the Ida surface.

As mentioned above, the Roman and Boy surfaces are doubly covered and therefore appear to be an immersed real projective plane. Since some of the parameter names are based on this interpretation of the surface, the geometry of the real projective plane will be briefly discussed. The real projective plane is a model for the projective geometry in 2d space. One point can be singled out as the origin. A line can be singled out as the line at infinity, i.e., a line that lies at an infinite distance to the origin. The line at infinity is topologically a circle. Points on the line at infinity are also used to model directions in projective geometry. Direction and distance bands refer to this interpretation of the surface. If direction bands are used, the bands extend from the origin of the projective plane in different directions to the line at infinity and back to the origin. If distance bands are used, the bands lie at constant distances to the origin. The same interpretation is used for distance and direction colors. Although there is no conceptually equivalent geometric interpretation for the two Klein bottle surfaces (the Etruscan Venus and Ida surfaces), the smooth deformation between the surfaces results in a natural extension of these concepts to the Klein bottle surfaces.

The immersed surfaces can be projected to the screen either perspective or orthographically. When using the walking mode, perspective projection to the screen will be used.

There are three display modes for the Klein bottle: mesh (wireframe), solid, or transparent. Furthermore, the appearance of the surface can be as a solid object or as a set of see-through bands. The bands can be distance bands or direction bands, as explained above.

The colors with which the surface is drawn can be set to one-sided, two-sided, distance, or direction. In one-sided mode, the surface is drawn with the same color on both sides of the underlying triangles. In two-sided mode, the surface is drawn with one color on one side of the underlying triangles and the complementary color on the other side. Since the surface actually only has one side, the color jumps from red to green along a line on the surface. This mode enables you to see that the surface is non-orientable. In distance mode, the surface is displayed with fully saturated colors that depend on the distance of the points on the projective plane to the origin, as described above. If the surface is displayed as distance bands, each band will be displayed with a different color. In direction mode, the surface is displayed with fully saturated colors that depend on the angle of the points on the projective plane with respect to the origin (see above for an explanation). If the surface is displayed as direction bands, each band will be displayed with a different color. The colors used to color the surface can either be static or can be changed dynamically.

The rotation speed for each of the three coordinate axes around which the Klein bottle rotates can be chosen.

Furthermore, in the walking mode the walking direction in the 2d base square of the surface and the walking speed can be chosen. The walking direction is measured as an angle in degrees in the 2d square that forms the coordinate system of the surface. A value of 0 or 180 means that the walk is along a circle at a randomly chosen distance from the origin (parallel to a distance band). A value of 90 or 270 means that the walk is directly along a direction band. Any other value results in a curved path along the surface. As noted above, walking is performed only on the Ida surface.

By default, the immersion of the Klein bottle smoothly deforms between the Etruscan Venus surface, the Roman surface, the Boy surface, and the Ida surface. It is possible to choose the speed of the deformation. Furthermore, it is possible to switch the deformation off. It is also possible to determine the initial deformation of the immersion. This is mostly useful if the deformation is switched off, in which case it will determine the appearance of the surface. A value of 0 corresponds to the Etruscan Venus surface, a value of 1000 to the Roman surface, a value of 2000 to the Boy surface, and a value of 3000 to the Ida surface.

This program is inspired by George K. Francis's book "A Topological Picturebook", Springer, 1987, by George K. Francis's paper "The Etruscan Venus" in P. Concus, R. Finn, and D. A. Hoffman: "Geometric Analysis and Computer Graphics", Springer, 1991, and by a video entitled "The Etruscan Venus" by Donna J. Cox, George K. Francis, and Raymond L. Idaszak, presented at SIGGRAPH 1989.

OPTIONS

etruscanvenus accepts the following options:

--window

Draw on a newly-created window. This is the default.

--root

Draw on the root window.

--window-id *number*

Draw on the specified window.

--install

Install a private colormap for the window.

--visual *visual*

Specify which visual to use. Legal values are the name of a visual class, or the id number (decimal or hex) of a specific visual.

--delay *microseconds*

How much of a delay should be introduced between steps of the animation. Default 10000, or 1/100th second.

--fps

Display the current frame rate, CPU load, and polygon count.

The following four options are mutually exclusive. They determine how the Klein bottle is displayed.

--mode random

Display the Klein bottle in a random display mode (default).

--mode wireframe (Shortcut: **--wireframe**)

Display the Klein bottle as a wireframe mesh.

--mode surface (Shortcut: **--surface**)

Display the Klein bottle as a solid surface.

--mode transparent (Shortcut: **--transparent**)

Display the Klein bottle as a transparent surface.

The following four options are mutually exclusive. They determine the appearance of the Klein bottle.

--appearance random

Display the Klein bottle with a random appearance (default).

--appearance solid (Shortcut: **--solid**)

Display the Klein bottle as a solid object.

--appearance distance-bands (Shortcut: **--distance-bands**)

Display the Klein bottle as see-through bands that lie at increasing distances from the origin (see above for an explanation).

--appearance direction-bands (Shortcut: **--direction-bands**)

Display the Klein bottle as see-through bands that lie at increasing angles with respect to the origin (see above for an explanation).

The following five options are mutually exclusive. They determine how to color the Klein bottle.

--colors random

Display the Klein bottle with a random color scheme (default).

--colors onesided (Shortcut: **--onesided-colors**)

Display the Klein bottle with a single color.

--colors twosided (Shortcut: **--twosided-colors**)

Display the Klein bottle with two colors: one color on one "side" and the complementary color on the "other side."

--colors distance (Shortcut: **--distance-colors**)

Display the Klein bottle with fully saturated colors that depend on the distance of the points on the projective plane to the origin (see above for an explanation). If the Klein bottle is displayed as distance bands, each band will be displayed with a different color.

--colors direction (Shortcut: **--direction-colors**)

Display the Klein bottle with fully saturated colors that depend on the angle of the points on the projective plane with respect to the origin (see above for an explanation). If the Klein bottle is displayed as direction bands, each band will be displayed with a different color.

The following options determine whether the colors with which the Klein bottle are displayed are static or are changing dynamically.

--change-colors

Change the colors with which the Klein bottle is displayed dynamically (default).

--no-change-colors

Use static colors to display the Klein bottle.

The following three options are mutually exclusive. They determine how to view the Klein bottle.

--view-mode random

View the Klein bottle in a random view mode (default). The walking mode will be randomly selected in approximately 10% of the cases.

--view-mode turn (Shortcut: **--turn**)

View the Klein bottle while it turns in 3d.

--view-mode walk (Shortcut: **--walk**)

View the Klein bottle as if walking on its surface.

The following options determine whether the surface is being deformed.

--deform

Deform the surface smoothly between the Etruscan Venus surface, the Roman surface, the Boy surface surface, and the Ida surface (default).

--no-deform

Don't deform the surface.

The following option determines the deformation speed.

--deformation-speed *float*

The deformation speed is measured in percent of some sensible maximum speed (default: 10.0).

The following options determine the initial deformation of the surface. As described above, this is mostly useful if **--no-deform** is specified.

--initial-deformation *float*

The initial deformation is specified as a number between 0 and 4000. A value of 0 corresponds to the Etruscan Venus surface, a value of 1000 to the Roman surface, a value of 2000 to the Boy surface, and a value of 3000 to the Ida surface. The default value is 0.

--etruscan-venus

This is a shortcut for **--initial-deformation 0**.

--roman

This is a shortcut for **--initial-deformation 1000**.

--boy This is a shortcut for **--initial-deformation 2000**.**--ida** This is a shortcut for **--initial-deformation 3000**.

The following options determine whether orientation marks are shown on the Klein bottle.

--orientation-marks

Display orientation marks on the Klein bottle.

--no-orientation-marks

Don't display orientation marks on the Klein bottle (default).

The following three options are mutually exclusive. They determine how the Klein bottle is projected from 3d to 2d (i.e., to the screen).

--projection random

Project the Klein bottle from 3d to 2d using a random projection mode (default).

--projection perspective (Shortcut: **--perspective**)

Project the Klein bottle from 3d to 2d using a perspective projection.

--projection orthographic (Shortcut: **--orthographic**)

Project the Klein bottle from 3d to 2d using an orthographic projection.

The following three options determine the rotation speed of the Klein bottle around the three possible axes. The rotation speed is measured in degrees per frame. The speeds should be set to relatively small values, e.g., less than 4 in magnitude. In walk mode, all speeds are ignored.

--speed-x *float*

Rotation speed around the x axis (default: 1.1).

--speed-y *float*

Rotation speed around the y axis (default: 1.3).

--speed-z *float*

Rotation speed around the z axis (default: 1.5).

The following two options determine the walking speed and direction.

--walk-direction *float*

The walking direction is measured as an angle in degrees in the 2d square that forms the coordinate system of the surface of the Klein bottle (default: 83.0). A value of 0 or 180 means that the walk is along a circle at a randomly chosen distance from the origin (parallel to a distance band). A value of 90 or 270 means that the walk is directly along a direction band. Any other value results in a curved path along the surface. As noted above, walking is performed only on the Ida surface.

--walk-speed *float*

The walking speed is measured in percent of some sensible maximum speed (default: 20.0).

INTERACTION

If you run this program in standalone mode in its turn mode, you can rotate the Klein bottle by dragging the mouse while pressing the left mouse button. This rotates the Klein bottle in 3d. To examine the Klein bottle at your leisure, it is best to set all speeds to 0. Otherwise, the Klein bottle will rotate while the left mouse button is not pressed. This kind of interaction is not available in the walk mode.

ENVIRONMENT

DISPLAY

to get the default host and display number.

XENVIRONMENT

to get the name of a resource file that overrides the global resources stored in the RESOURCE_MANAGER property.

XSCREENSAVER_WINDOW

The window ID to use with *--root*.

SEE ALSO

X(1), *xscreensaver*(1)

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