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GEOTOOL: A Tool to Manage Polygonal Meshes and Build Multiresolution Models

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Abstract: - In applications such as video games, real-time visualization becomes essential to maintain the quality and performance of the application by managing the geometry of the scenes. Among the different techniques to achieve that balance, we highlight simplification and level of detail techniques. In this paper, we present a standalone application useful to quickly simplify and generate multiresolution models for arbitrary geometry and for trees.

Key-Words: - Level of detail, simplification, triangle strips, multiresolution, geometry modeling, meshes

1 Introduction

GeoTool is a multiplatform, portable and engine independent tool that allows us to manipulate meshes and build multiresolution models. It can also perform more operations such as mesh simplification, (approximate meshes) or stripification (convert a mesh in triangles to triangle strips). This application uses the FLTK toolkit[1] to provide a portable graphical user interface, and the OpenGL real-time rendering API, see a screenshot in Figure 1.

Our application uses the Ogre3D mesh file format[2] to load and store geometry data. This file format supports mesh models composed by any number of sub-meshes. Each sub-mesh can be represented by any rendering primitive (a triangle list or a triangle strip). This is useful to store trees with a LODTree model such as [3], because the trunk must be represented by triangle strips and the leaves by triangle lists. Moreover, the Ogre file format supports bones and skeletal animations.

GeoTool allows the user to perform three different types of operations:

- Basic operations: these operations involve file, edit and render operations. The rendering primitive can be changed (wire mode, solid mode) as well as the lighting surface parameters (flat and smooth). The rendering viewpoint can also be changed in order to focus on the desired region of the model. Moreover, the application can load a previously computed LODStrips[4] or LODTree[3] model and render it.

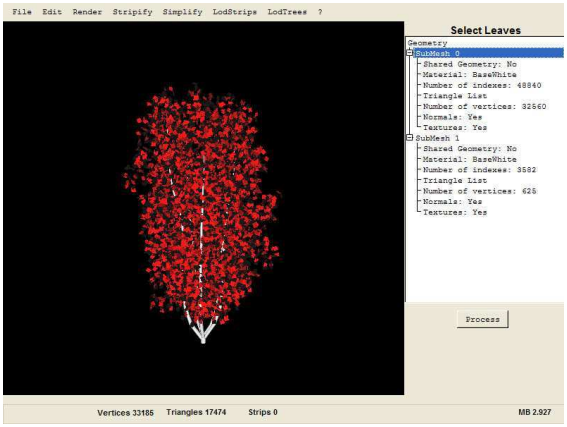

Fig 1. Screenshot of the GeoTeool application.

- Simple operations: these operations involve mesh stripification and simplification. These are catalogued as simple operations because they are done in a single step and return a transformed standalone mesh. Two different simplification approaches are available: geometry-driven simplification and viewpoint-driven simplification.

- Complex operations: these operations are LODStrip construction and LODTree construction. Internally, these complex operations perform some simple operations such as stripification, simplification and vertex

reordering. It is important to note that they are much more time consuming than basic operations. They take a mesh as input, then they construct a new mesh with the associated multiresolution sequence, and save the result to disk. We will explain this process in more detail in the following sections.

2 The GeoTool application

The user interface of GeoTool has been designed to be easy to use. The menu bar across the top manages all the operations that can be performed on a mesh.

The main window in the center shows the current render state, which can be changed using the Render menu. The panel on the right shows a more detailed view of the current selected action. For example, when the simplify option becomes selected, the panel on the right shows more information and options about the selected action.

The status bar on the bottom of the application shows some information about the loaded model, such as its vertices, strips and triangle count.

2.1 Basic Operations

- File Menu (see Fig. 2)

  Open: shows a dialog to open an Ogre mesh file and load it into the application. (see Figure 2).
  Save (As): Saves the current mesh into an Ogre mesh file.
  Load Textures: Allows to select the texture of the entire model. In addition, it allows us to select the texture of for a single submesh.
  Quit: Terminates the application.

- Edit Menu

  Undo: Gets the current mesh back to its previous state.
  Fit: Modifies the current view to fit the loaded mesh inside the screen.
  Rotate/Pan: Selects the action to be taken when the user drags the mouse pointer.
  Mesh info: Configures the right panel to show mesh information, such as its vertex and triangle counts, the rendering primitive type and its sub-mesh count.
  Select leaves: Configures the right panel to show a sub-mesh selector. This allows the user to select the sub-mesh that represents the treetop. Pushing the process button the foliage is selected.

- Render Menu (see Fig. 3)

  Wire / Solid: Selects the geometry rendering mode: wireframe or solid.
  Flat / Smooth: Selects the surface **shading mode**: flat or smooth (Gouraud).

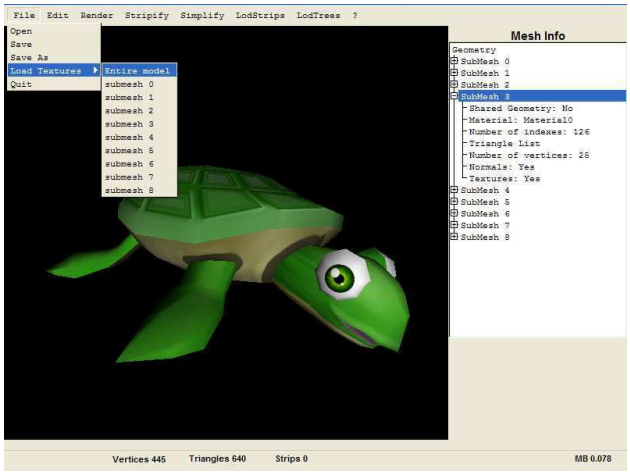

Fig 2. The File Menu.

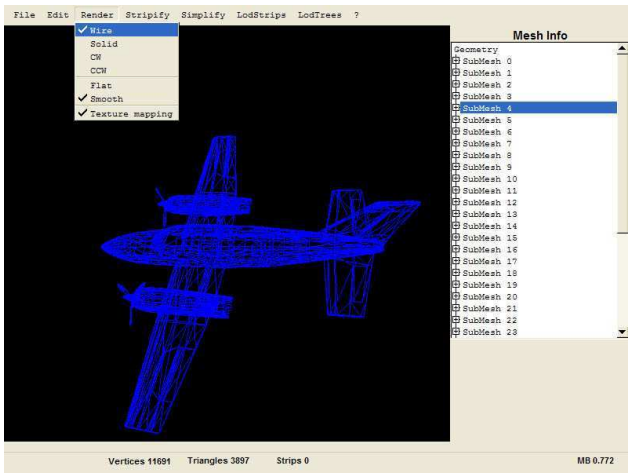

Fig 3. The Render Menu.

2.2 Simple Operations

The simple operations are performed in a single step of the Geometry Game Tools Library and modify the given mesh.

- Stripify Menu. (See Fig. 4). This menu has no popup menu associated. Instead, it immediately

opens the Stripification panel. The process button will start the stripification. The progress bar will show the stripification status. Only manifold meshes can be stripified. If a mesh is not manifold an error message is shown.

- Simplify Menu. (See Fig. 5). The simplification of a mesh object can be accomplished with one of the two following simplification modes:

  Mesh simplification: Performs edge collapse simplification. Moreover, there are two ways to perform simplification in edge collapse.
  Geometry-based: Fast method of simplification. Simplify mesh objects based on geometry relation between triangles.
  Viewpoint-based: Simplify the mesh object based on image processing.
  Leaves simplification: Performs leaves collapse simplification. Only simplifies the mesh that was chosen as foliage with the Edit/Select Leaves menu.

In addition, the mesh reduction factor can be chosen as a percentage value or as a number of vertices.

2.3 Complex Operations

The complex operations visually need several of simple geometry operations.

2.3.1 LODStrips

- **Generate:** Generate a mesh with its correspondent LOD (Level Of Detail) sequence. The process to accomplish this is similar to the simplification, but a new step is added. In the right panel appear a new Build button that performs the stripification and the build process. The build process gets the simplification sequence done by the simplification and the stripified model, then generates the new mesh with its correspondent LOD sequence. See Fig. 6.

- **Visualize:** This allows us to see the result of the LODStrip process. The level of detail of the object can be changed with a slide bar that appears in right panel. See Fig 7.

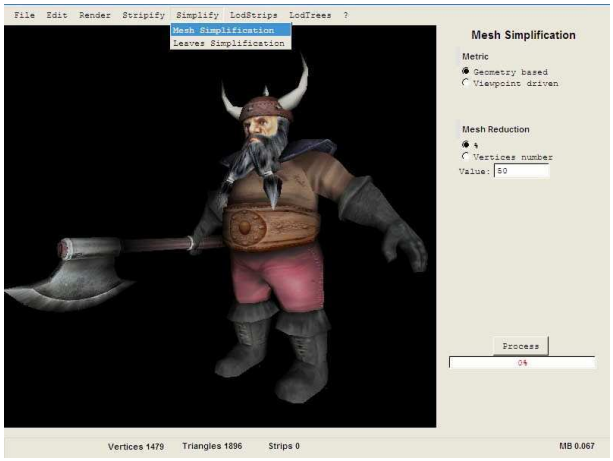

Fig 4. The Simplify Menu.

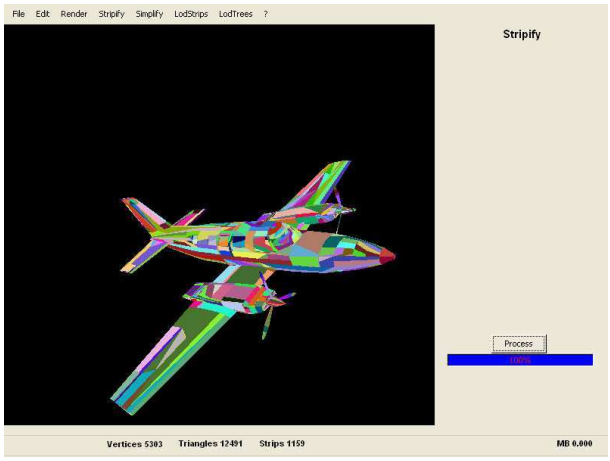

Fig 5. The Stripify Menu.

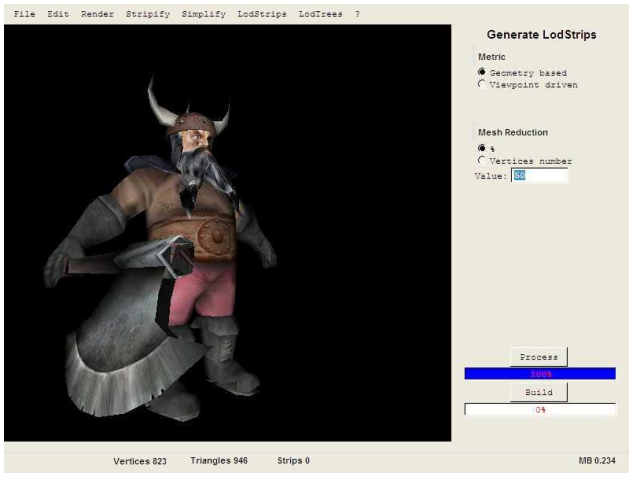

Fig 6. Generation of the multiresolution model LodStrips.

2.3.2 LODTrees

- **Generate**: This process gets a tree object with the LODStrip of the trunk. The foliage should be selected the {\it Edit/Select Leaves} menu. The user interface operation is the same that the LODStrips one. First, simplify the foliage selecting the percent or the number of triangles desired. Finally pushing the build button the LODTree is generated.

- **Visualize**: Two slidebars appears in right panel. One to change the level of detail of the trunk and the other to change the level of detail of the foliage. See Fig. 8.

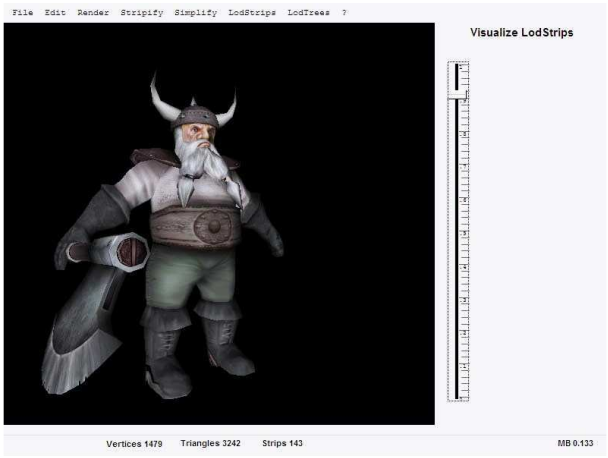

Fig 7. Visualization of LodStrips.

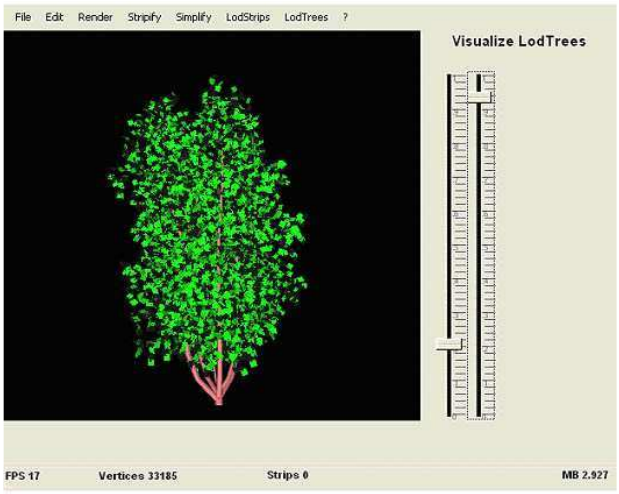

Fig 8. Visualization of LodTrees.

2.4 Level of Detail Generation

This section explains the steps that are necessaries to build a LOD object. The LOD generation involves mesh stripification and mesh simplification.
The first step is to open a mesh object. We do this with the **Open** option of the **File** menu. Next step is select option **Generate** of the **LODStrip** menu to begin the generation process (see Fig. 6). At right appears the **Generate LODStrips** panel, in which we can choose the simplification method between **Geometry based** and **Viewpoint Driven**. In addition, we must specify mesh reduction by percent or by the number of triangles to obtain. Pushing the **Process** button the simplification is performed and its result can be viewed at screen. At this point, if the result of simplification doesn't convince us, we can undo this step and change simplification options. In the other hand, if the results of the simplification are OK, we can build the LOD object pushing the **Build** button and filling the name of this one. If we can view the result of build process can do this by selecting the option **Visualize** of the menu **LODStrips** that makes a slide bar appear in the right panel (see Fig. 7). By moving the slide bar we can change the Level Of Detail of the object.

First of all to perform **LODTree** we must select the **Select Leaves** option of the Edit menu (see Fig. 1). This makes that the **Select Leaves** panel appears. In this panel there is a mesh info browser that shows the submeshes in which is divided the object and relevant geometric information. Clicking a submesh in the browser paints it in red in the view window. We must choose the treetop submesh and push the button Process to make the selection of leaves. Next we can go to do the LODStrip procress as described before (see Fig. 6). Finaly the result of the LODStrip process is used as input of the LODTree one. Using the **LODTree** menu we can perform the LODTree building following the same steps than a LODStrip process.

3 Conclusions

We have presented a tool for efficient geometry processing of meshes. It allows us to simplify and convert a mesh into triangle strips. Moreover, it is capable of generating a multiresolution model for arbitrary geometry and for trees and plants.

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