A System for Interative Building Placement on Irregular Terrain

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Abstract. This paper describes an environment to build virtual models of terrain occupancy. Our purpose is to combine terrain models (given by meshes) with buildings, represented by polyhedral models. The system is designed to show visually how the buildings fit together and to provide relevant numerical data, such as the volume of land that must be removed when a building is positioned. We adopt a four-step approach: acquisition of terrain data, mesh generation, building placement and rendering.

1 Introduction

This paper describes an environment to build virtual models of terrain occupancy. Our purpose is to combine terrain models (given by meshes) with buildings, represented by polyhedral models. Although much has been done in modeling techniques for both types of objects [2], the problem of obtaining joint representations has not been sufficiently studied.

The system described here allows positioning a set of buildings and special objects (e.g. streets) on a given terrain, showing visually how the buildings fit together and providing relevant numerical data, such as the volume of land that must be removed when a building is positioned. The methodology used consists of four steps, given in figure 1.

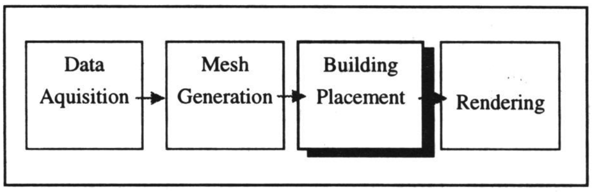

Figure 1: methodology adopted

2 Data acquisition

In most cases, the terrain is given by a topographical map representing heights through contour lines. Usually, the map is not available in digital form and has to be digitized through a tablet or scanner. In the latter case, the data needs to be vectorized and one has to take into account several possible sources of errors: scanner scale calibration, image binarization and contour identification. There are several methods to vectorize iso-lines images[5,9]; we use a program described in [5].

3 Mesh generation

The second step is to reconstruct a tridimensional surface from the contour lines. Several approaches are described in the literature [3,5]. We use an algorithm described in [3] with modifications to obtain a more regular mesh. The main idea is to create a bidimensional Delaunay Triangulation on each pair of adjacent contour lines. If necessary, extra points are added on the edges to force the contour edges to be part of the triangulation. The next step is to create tetrahedra which fill the volume between the slices corresponding to adjacent contour lines. Finally, the surface representation is obtained from the external faces of the three-dimensional mesh.

4 Building placement

The main phase is the interactive placement of buildings on the terrain. For our purposes, a building is a prism, hence characterized by its base polygon and its height. In order to place a building, the user must specify its X, Y, Z position and its orientation. When a building is placed in position, the terrain mesh has to change in order to accommodate the new building and to allow computation of numerical data, such as volume of land removed when the building is positioned. Therefore, the mesh must be stored in a data-structure which supports efficient mesh modification. In order to achieve this goal, the terrain mesh is stored in a half-edge data structure [7], implemented through the HED library [1].

The current user interface for building manipulation works with two projection views (XY, XZ). The users can translate the foundation in the XY (figure 2) and perspective view (figure 3) and rotate it only in the XY plane. We are also considering providing direct three-dimensional manipulation, using the ideas in [4]. The placement of multiple buildings requires special care, since building intersection must be monitored and disallowed.

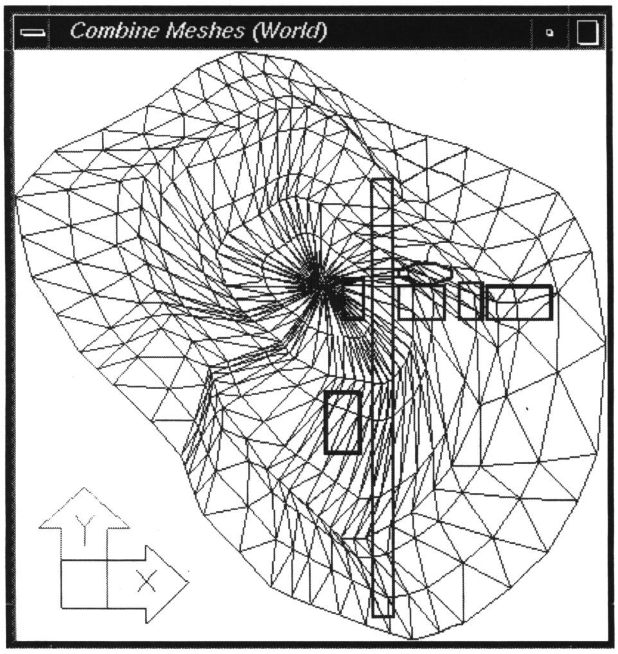

Figure 2. A top view of terrain and buildings

4 Rendering

In order to give the user a realistic view of the terrain, the buildings and other special objects like streets, the system must have walk-through capabilities. Thus, it should be able to provide real-time dynamic rendering of scenes. We intend to use the ideas in [8] to reduce scene complexity by eliminating faces whose projections are too small in the current view.

5 Conclusion

We have described an on-going project to develop a system for interactive placement of buildings on irregular terrain. The system gives efficient support for the interaction between terrain models and other geometric models, providing both visual and analytical information about this interaction.

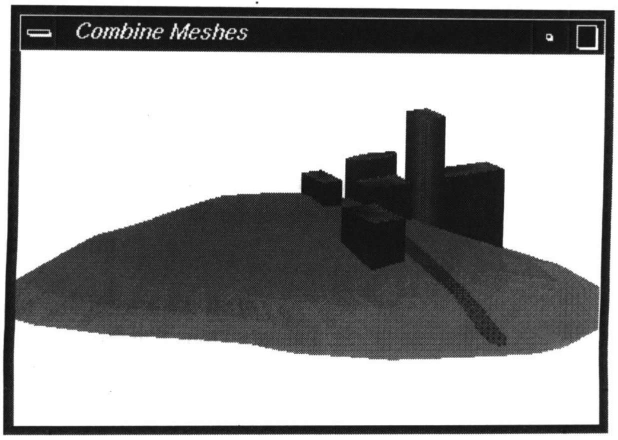

Figure 3. A perspective view

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