Column Modeling

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Modeling shapes with a large number of holes and handles while requiring minimal human interaction is a difficult problem in computer graphics. Such shapes are common in classical architecture in many parts of the world. Figure 1 shows two examples from Roman architecture. Notice that these forms are dominated by columns, beams and arches. This type of construction in architecture is not restricted to classical architectural styles but is also prevalent in modern architectural designs.

Figure 1: Columns in classical Roman architecture.

It is not easy to create such architectural shapes using existing modeling software. One has to tediously model every individual column and beam, and also make sure that they are connected to each other. There are other indirect methods, like texture mapping and use of displacement maps, which unfortunately are not able to create the detailed geometry that we desire.

In this work we have developed a new tool which allows users to create such complex and architecturally interesting models with extreme ease. The tool extends the capabilities of our existing topological mesh modeler [1] and is designed to be interactive and easy to use.

Given a manifold mesh the algorithm replaces each edge of the mesh by a "column" thus generating a framework of beams and columns. The columns have cross-sections which are approximations of a circle. The user can specify the number of circumferential segments in the column as well as its thickness. Increasing the number of segments produces smoother looking columns as they become closer approximations to cylinders, while using a small number of segments produces angular columns. By varying the thickness one can create thin wire-like structures or thick pillar-like columns (see Figure 2).

At each vertex of the original mesh, a "joint" is created which connects all the columns corresponding to the edges incident on that vertex. The shape of the joint is determined by the cross-section and the thickness of the columns which it connects. Essentially the joint will have a matching face for every column which it connects. To produce the geometry for the joint, the algorithm uses the cross-sectional polygons of each column ending at the joint and creates a convex shape to which the columns can be connected. The convex shape is cleaned-up to simplify the geometry of the joint before the columns are connected to it.

The algorithm always produces a fully connected shape and the meshes created by the algorithm are guaranteed to be valid 2-manifolds, which allows one to easily apply smoothing subdivision schemes to the mesh.

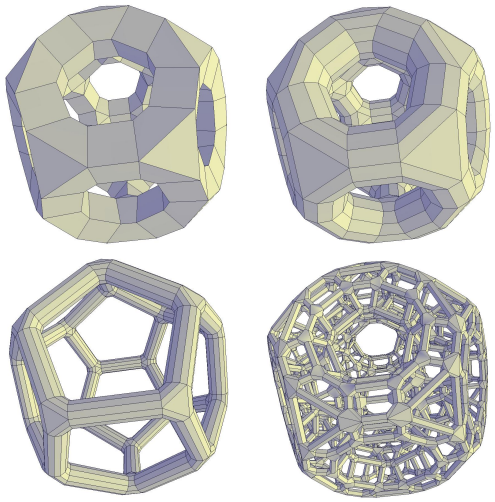

Figure 2: Column modeling applied to a dodecahedron with varying thickness and number of segments.

Our tool is geared towards use by artists and architects. It can be used to create interesting architectural forms, either to create real and virtual environments or represent existing architectural forms in a stylized manner, as shown in Figure 3. It can also be used to create various other artistic shapes that would be difficult to generate using traditional modeling methods.

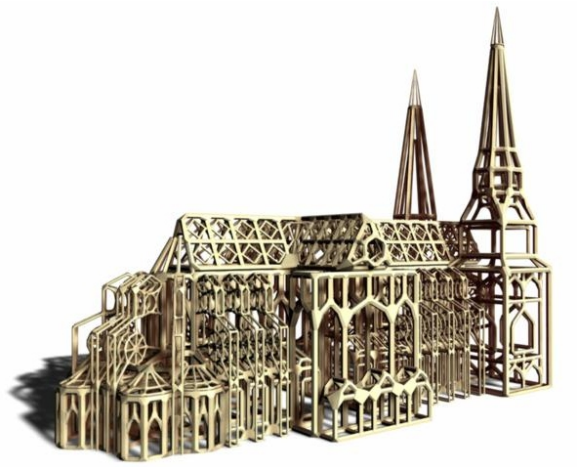

Figure 3: A cathedral created using the column modeling tool.

References

[1] http://www-viz.tamu.edu/faculty/ergun/topology