Thursday, February 12, 2004

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Midterm:

Thursday, February 19, 2004

Closed book, one page (single-sided) Cheat Sheet

2-D Compression: Hausdorff distance, Entropy, Huffman, Arithmetic Encoding, Subdivision, Quantization, Prediction, Curve Compression Algorithms, Simplification, Tradeoff between Compression and Simplification

3-D Compression: Triangle Meshes: Corner Tables construction, operators, traversal, Formulae (T=2V-4+4H etc), Organizing triangle soups – making shells, genus (handle), shells contained (cavities), Interpolation of samples (Construction of meshes by rolling balls), Non-manifold meshes topology

Simplification: Vertex Clustering, Edge Collapse, Preserve Topology

Compression: MPEG4 (TST, VST), Edgebreaker

Guest Lecture contents not included.

Discussions:

Reducing time complexity for finding radius of ball by using a range:

A naïve algorithm for finding radius of a ball that is neither too small nor too big is of order n4. Performance can be significantly improved by caching min-max range of radii –minimum radius fitting the three neighboring vertices, maximum touching the nearest fourth vertex – for all triangles and calculating the radius at the end of the pass.

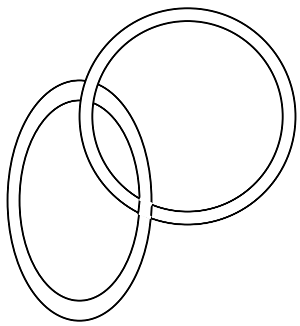
Voronoi, Delaunay Triangulation partition

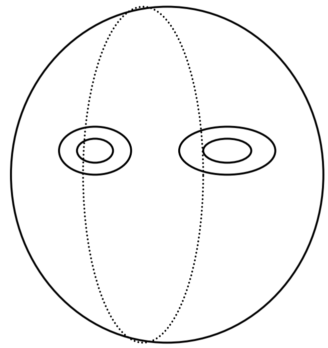
+ The Voronoi diagram of a collection of geometric objects is a partition of space into cells, each of which consists of the points closer to one particular object than to any others.
+ The Delaunay triangulation of a point set is a collection of edges satisfying an "empty circle" property: for each edge we can find a circle containing the edge's endpoints but not containing any other points.
+ The Voronoi diagram is dual to a Delaunay triangulation.
+ By using a sweeping line, the complexity to construct the Voronoi diagram for a given set of points on a planar surface is O(N*log(N)), N is the number of points
+ The corresponding complexity (unconfirmed) for the 3D points is O(N*N*log(N)).

Do Genus+shell specify the topology completely?

+ As to two dimensional shape, the answer is Yes.
+ Three dimensional shape, the answer is NO.

For example, two interlocked torii has the same number of genus and shell with two holes in one sphere. But topologically, they are different!





Sphere – interlocked torii may not work well

How is topology defined?

Topology is sometimes used to specify the triangle-vertex incidence in a model. Connectivity is a more appropriate term for this.

Topology, more correctly, is used to mean the classification of shapes.

Presentations

Maintaining the order of contents should generally be preferred and jumping across should be avoided. Generally, give an overview, talk in detail, summarize.

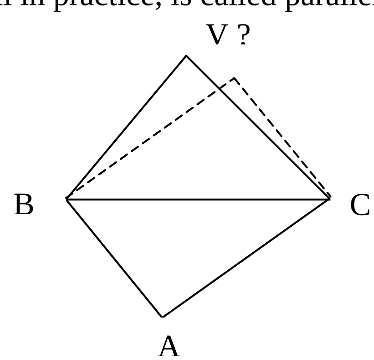
As a guideline, presenting one idea per 15 minutes is a good idea.

Taking some time to clearly understand the question is important. Question can be strategically rephrased in the mean time; this clarifies the question, buys some time and sometimes makes the answer trivial.

Predictions

Along with compression schemes for connectivity, vertex prediction can be used to achieve further compression.

A simple scheme, works well in practice, is called parallelogram prediction [Touma & Gotsman].



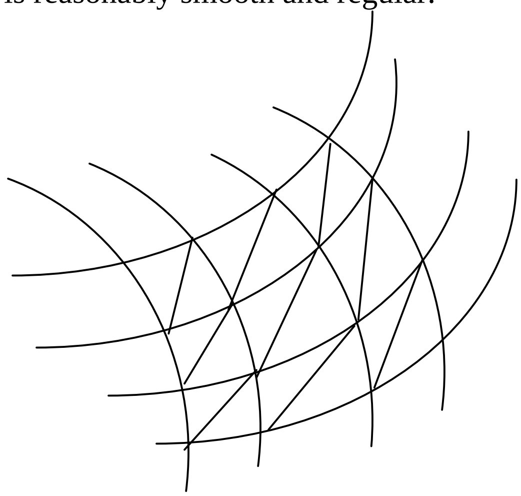
From above,

v = a+ac+ba
v = a+(c-a)+(b-a)
v = b+c-a

The prediction scheme works with the assumption that models are smooth and reasonably regular.
To simplify the decompression of vertices, connectivity information can be completely decompressed first, and then vertices can be guessed with available information.

Is parallelogram prediction good enough for scientific models with dense data samples?

Yes, scientific models are generally tessellated B-spline surfaces. Triangulation of such tessellations is reasonably smooth and regular.

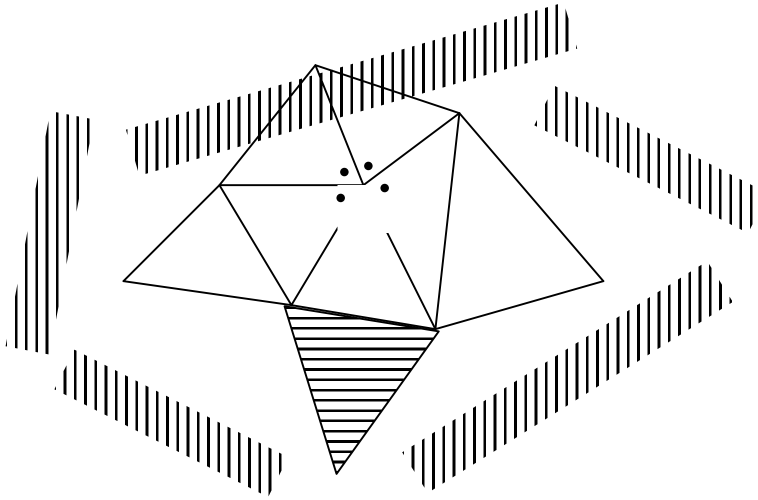


Can we get regular, smooth model by controlling sampling density and radius of ball?

It depends, an irregular distribution of vertices to start with may not be necessarily be regularized.

Compression Algorithm:

Algorithm for compression presented in slides is designed for manifold models. It needs to be altered to work with non-manifold models. In particular, marking vertices may not work well as same vertex may be shared by non-manifold triangles.
For example, for a sheet triangulated on both the faces, marking the vertex while traversing one face will give incorrect information while processing other face. Marking the vertex to indicate the sheet may also not help, as a traversal might transition between faces making it difficult to distinguish between them.



One approach could be using the marks on fan of triangles incident upon the vertex. If either of them is marked, the vertex can be considered visited.