Numerical Issues in a Geometric Problem
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1. Contact Information

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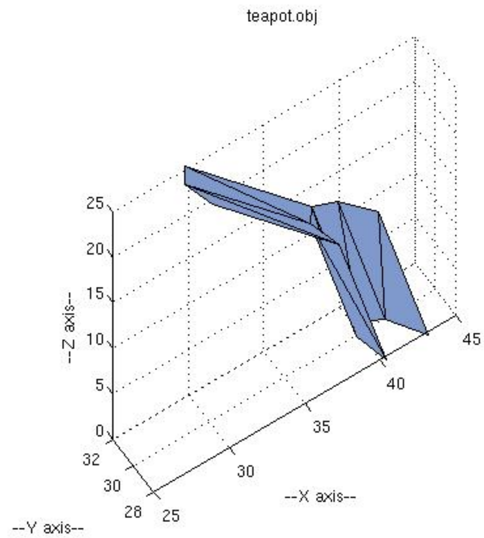

Figure 1. Triangles in $\mathbb{R}^3$.

2. Abstract

The polyhedral unfolding problem can be described as follows: Can a polyhedron in $\mathbb{R}^3$ be unfolded into a simple polygon in $\mathbb{R}^2$? A vertex unfolding finds a solution such that the faces are connected at vertices, but the interiors are potentially disjoint. In the paper Vertex Unfoldings of Simplicial Manifold, the authors present such a method for any triangulated two-manifold. We have implemented this algorithm, and we have also explored the possibility of reconnecting disjoint interiors. Our modular implementation of this algorithm incorporates the areas of geometry, topology, numerical analysis, graph theory, visualization, and software engineering. In this talk, we investigate the implications of a concrete application of computational mathematics, and introduce an open problem in computer science.

3. Discussion Problem

A triangle is defined by three vertices. Suppose we have a list of faces (as in Table 2) and a list of vertex coordinates (such as the list in Table 1). These triangles are embedded in $\mathbb{R}^3$, as shown in Figure 1. Consider the following alternating ordering of the triangles and vertices:

Table 1. The coordinates of the vertices

	x	y	z
v1	40.6266	28.3457	-1.10804
v2	40.0714	30.4443	-1.10804
v3	40.7155	31.1438	-1.10804
v4	42.0257	30.4443	-1.10804
v5	43.4692	28.3457	-1.10804
v6	37.5425	28.3457	14.5117
v7	37.0303	30.4443	14.2938
v8	37.6244	31.1438	14.5466
v9	38.8331	30.4443	15.0609
v10	40.1647	28.3457	15.6274
v11	29.0859	28.3457	27.1468
v12	28.6917	30.4443	26.7527
v13	29.149	31.1438	27.2099
v14	30.0792	30.4443	28.1402
v15	31.1041	28.3457	29.165
v16	16.4508	28.3457	35.6034

Table 2. The face information

f1	v7	v6	v1
f2	v1	v2	v7
f3	v8	v7	v2
f4	v2	v3	v8
f5	v9	v8	v3
f6	v3	v4	v9
f7	v10	v9	v4
f8	v4	v5	v10
f9	v12	v11	v6
f10	v6	v7	v12
f11	v13	v12	v7
f12	v7	v8	v13

$$f12 - v13 - f11 - v12 - f9 - v6 - f10 - v7 - f1 - v1 - f2 - v7 - f3 - v2 - f4 - v8 - f5 - v3 - f6 - v9 - f7 - v4 - f8$$

This is an ordering such that between two consecutive faces, there is a vertex that is incident on both faces. We wish to embed these faces in $\mathbb{R}^2$ such that the chain above remains a connected chain in the embedding, but none of the faces overlap. How can we do this?

4. Questionaire

Question 4.1. *What year are you and what is your major?*

Question 4.2. *Did Brittany speak clearly and convey the material in an understandable manner?*

Question 4.3. *Did David speak clearly and convey the material in an understandable manner?*

Question 4.4. *If you attempted to read the paper before class, what was your initial reaction to reading it?*

Question 4.5. *What is one thing that you learned during this talk?*

Question 4.6. *What is one thing that we could have done better during this presentation?*

Question 4.7. *Would you be interested in taking a class that explored different research areas and involved a large project such as the one described in today's talk?*

Question 4.8. *Is polyhedra unfolding as an interesting problem for you?*

Question 4.9. *Do you have any other comments/questions/suggestions?*