Volumetric mesh creation using Delaunay tetrahedralization

CS-116B: Computer Graphics Algorithms
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Volumetric mesh creation using Delaunay tetrahedralization

Two ways to represent a surface:

- Surface exterior is only represented.
- Surface exterior and interior is represented.

Representing both exterior and interior of a surface makes it easier to detect collisions between objects (especially objects that penetrate or collide with a surface).

Source: *Real Time Physics Class Notes*, p. 17

Volumetric mesh creation using Delaunay tetrahedralization

How to create a volumetric surface?

- Use a mass spring model with Delaunay tetrahedralization

Imagine a mesh comprised of tetrahedrons:
The edges of the tetrahedron are interconnected with invisible springs.
The vertices of each tetrahedron contain a mass.

This is exactly like the 2D polygonal meshes we created with for cloth simulation in a Mass Spring model.

Source: *Real Time Physics Class Notes*, p. 18

Volumetric mesh creation using Delaunay tetrahedralization

How do we implement a tehredral mesh?

”...we distribute a certain number of particles, p_i, evenly inside the volume defined by the surface mesh and on the surface mesh itself. To do this, we need an inside-outside test. The traditional way is to create a ray originating from the particle and count the number of surface triangle intersections. If the number is odd, the particle is inside the surface. This procedure requires the surface to be watertight. Then we run Delaunay tetrahedralization on these points and only keep tetrahedra with centers inside the surface” (p. 18).

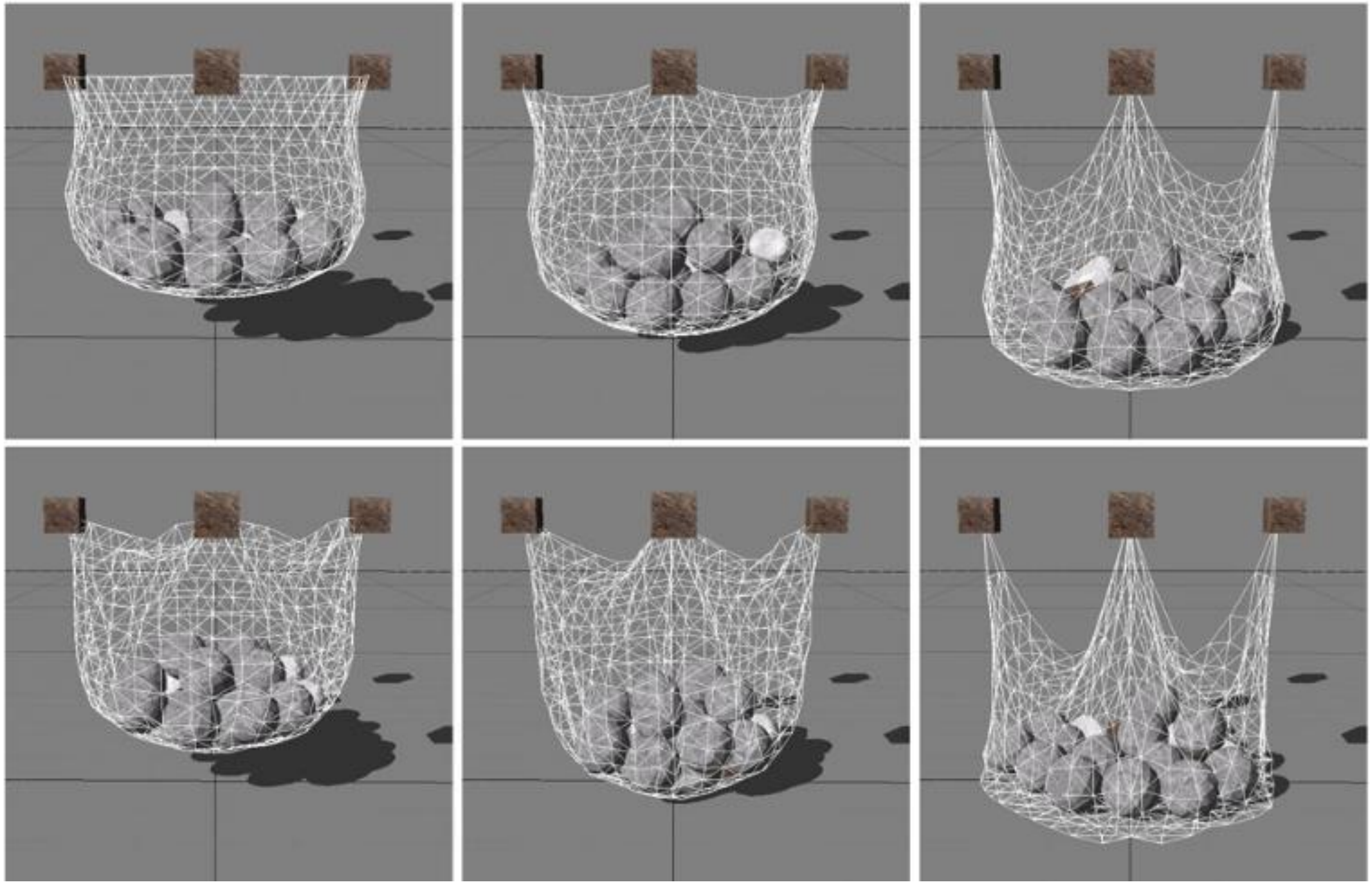
Source: *Real Time Physics Class Notes*, p. 18

Procedure for volumetric mesh creation

1. create large tetrahedron that contains all points $p_1,...,p_n$
2. **forall** points p_i
3. clear face list l
4. **forall** tetrahedra t_j the circumsphere of which contains p i
5. **forall** faces f_k of t_j
6. **if** *l* contains f_k remove f_k from *l*
7. **else** add f_k to *l*
8. **endfor**
9. delete t_j
10. **endfor**
11. **forall** faces f_k in *l*
12. create a tetrahedron from f_k to p_i
13. **endfor**
14. **endfor**
15. remove all tetrahedra that contain vertices of the large tetrahedron created in step (1)

Source: *Real Time Physics Class Notes*, p. 18

Simulating a cloth bag



Source: *Real Time Physics Class Notes*, p. 42