Fun With Cloth

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CIS 563 - Final Project

Aspects of Simulation :

1. Cloth Balloons (OBJ cloth and Pressure Constraints):

Our simulation can now import closed meshes and turn them into cloth balloons. To implement this we created pressure constraints and OBJ importing for cloth. When the cloth balloon collides with an object, it maintains its pressure. Because our cloth cannot self interact, the balloons will often twist around itself to maintain its volume, but pressure is maintained. When a cloth is no longer watertight due to tearing, the pressure constraint is removed.

2. Tearing:

Whenever the length of an edge in the cloth surpasses a certain threshold, the cloth tears at that edge. This is achieved by choosing one point P on the edge and duplicating it (P'), assigning the surrounding triangles to P or P' depending on which side of the perpendicular plane the triangle falls on. After that, adjacent edges and constraints are reassigned. The tearing detection is done in the projection of each stretch constraint. Once the edge is marked as "broken", the edges are torn by reassigning the edges, then reassigning the constraints. Constraints are removed only after the main loop of projecting each constraint to avoid altering the main loop.

3. OBJ Intersection:

Our simulation can now import arbitrary OBJ files for the cloth to interact with. The presence of an obj object is specified in the scene file. In order to interact with the object, each vertex on the cloth casts a ray using its projected point as the direction. If the ray intersects with a triangle on the obj, we then perform static and continuous collision testing and create a collision constraint.

Challenges faced :

Cloth Balloons:

One of the first challenges we faced was finding a closed mesh to test our OBJ cloth importing. We did however manage to find a sphere and a gourd OBJ that worked for our purposes. Another challenge was understanding the mathematical notation of the pressure constraint denoted in the paper. We also had to make additions to the data structure to keep track of adjacent edges to each vertex. This was necessary for both cloth balloons and also tearing.

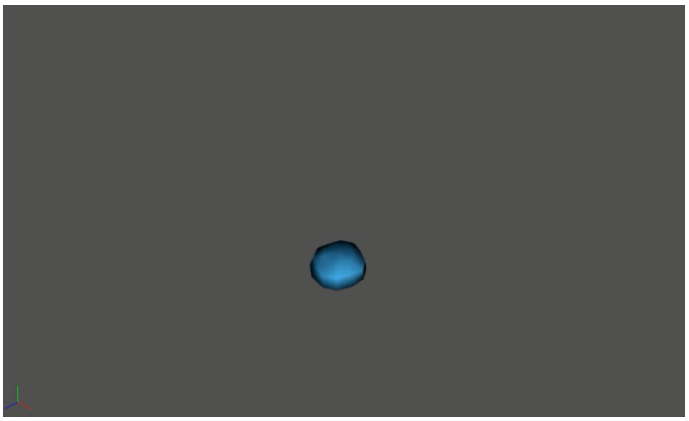
Tearing:

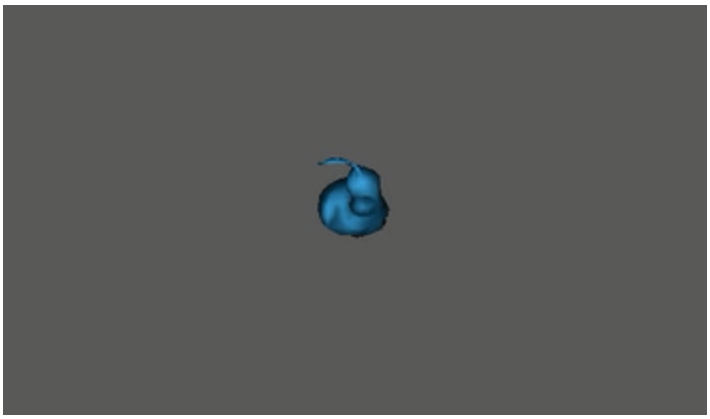
The most difficult part of tearing was the reassignment of edges and the removal of constraints. This required a lot of labeled diagrams to figure out how to rearrange the edges after a point is split. The adjacent edges data structure also had to be updated. Debugging was also particularly difficult because it required extensive diagramming and stepping through the debugger while watching many different variables. It took a long time to figure out exactly which constraints needed to be removed and which ones needed to be added.

Removing the constraints was a big challenge because it had to be done in such a way that does not affect the project constraints loop that this was happening in. Since most of the constraints are stored by their indices, constraints cannot be removed or the indexing will be messed up. This was resolved by setting the constraint to be removed as an empty constraint, then removing all the empty constraints at the completion of the project constraints loop. During the project constraints loop, if an empty constraint is encountered, we simply skip over to the next one.

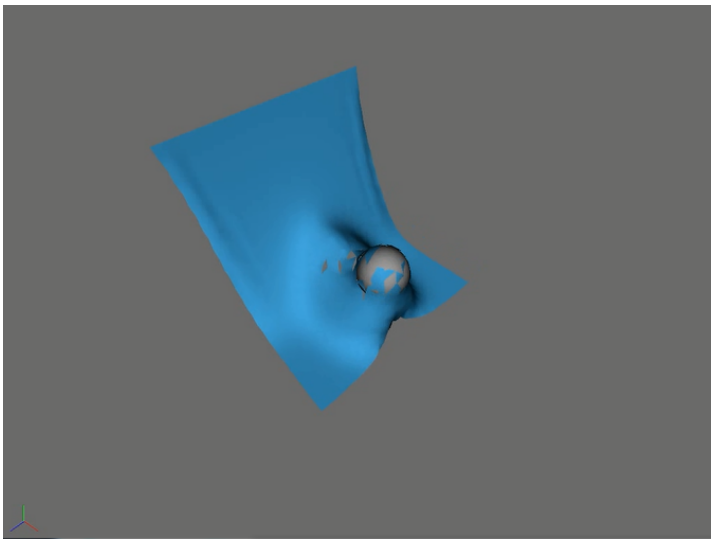
OBJ Intersection: When first trying to implement OBJ intersection, we faced an issue where the cloth would intersect with an object, but it would not stay above the surface. The cloth would slow down, but it would continue falling through the OBJ. It was then we realized that the collision tests we were running were not exhaustive enough. We also noticed that when the cloth and object were of completely different mesh densities, the cloth would sometimes fall through the object. Objs with sharp points with very dense faces were also an issue.

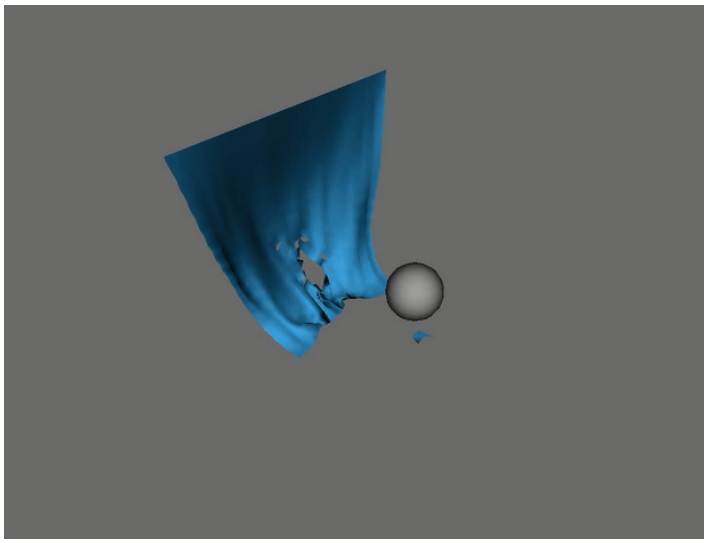
Results Obtained : Results obtained can be found in our attached video.



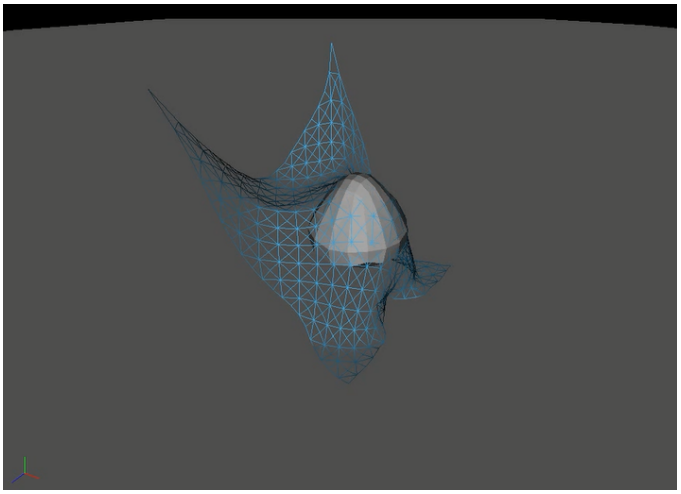
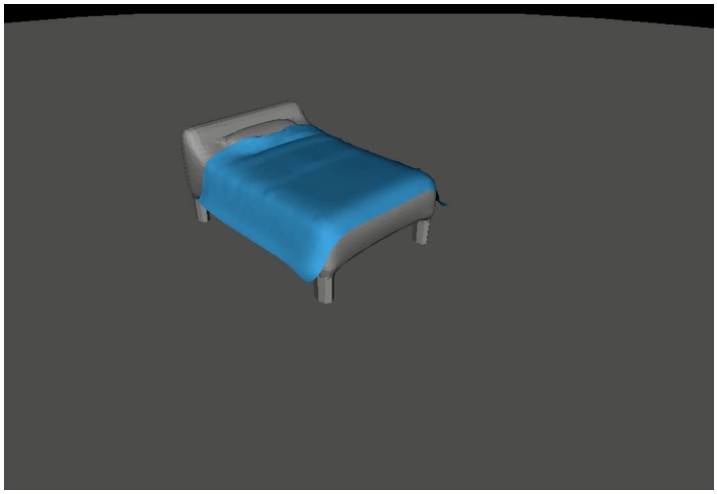


The above images show pressure balloons

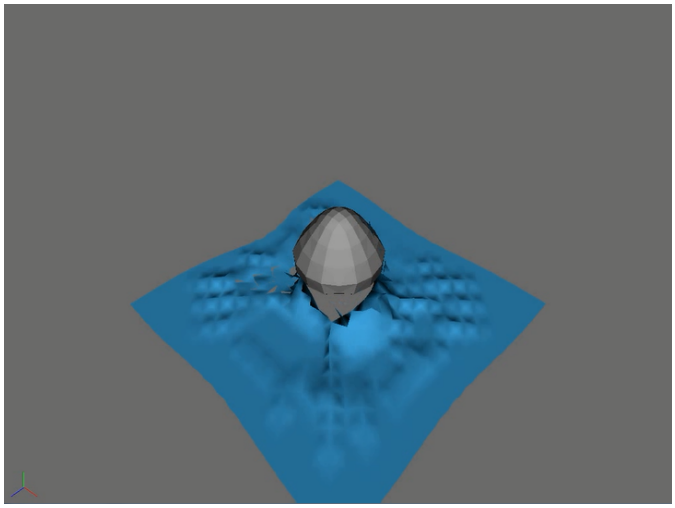
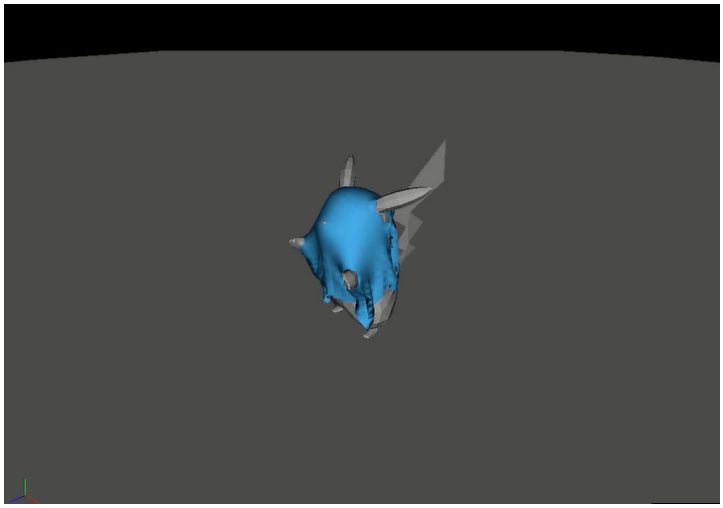




The above images show tearing

The above images show arbitrary OBJ Collision

The above two images show tearing with OBJ

Base Code : The base code we started from was our cloth simulation from Homework 2, Position Based Dynamics. As of the beginning of this project, we only had stretch, hack bend, and collision constraints. For our collision constraints we only had sphere and plane intersection implemented. Our cloth could only start as a plane.

Breakdown of Work :

Cloth Balloons: For cloth balloons, Jessie started by implementing cloth OBJ and Theo added pressure constraints to constraints.h and constraints.cpp. We then worked together through pair programming to solve the volume constraint.

Tearing: Jessie implemented tearing

OBJ Intersection: Theo implemented OBJ importing and intersection

References :

Position Based Dynamics by Matthias Müller:
http://www.matthiasmueller.info/publications/posbaseddyn.pdf

TinyObjLoader: https://github.com/syoyo/tinyobjloader