Shapeshift: Topology-Aware 3D Mesh Interpolation

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Team Number: 51

Webpage Link

CS 184, Computer Graphics and Imaging

Links

Slides

Video

Milestone Progress

Vertex Pairing with the Hungarian Algorithm

To begin, we match vertices from two different meshes. We treat the problem like an assignment problem and use the Hungarian Algorithm to pair each vertex from the first mesh to a vertex from the second mesh. The goal is to minimize the total distance between corresponding vertices.

Linear Interpolation of Vertices

After the vertices are paired, we move each vertex from its starting position to its final destination. We use linear interpolation over time, ensuring a smooth and direct transition between the two meshes.

Rebuilding Faces and Half-Edges

Once the vertices are moved we rebuild the mesh connectivity. This involves reassigning faces and half-edges based on the new vertex positions, ensuring the structure of the mesh remains coherent after the morph.

(Future Work) Smoother Interpolation with Physics Based Forces

To further improve the smoothness of the transition, we are considering adding physics-based motion. What this means more specifically is that we would be assigning velocity and acceleration to each vertex and introducing forces between initial and final positions. This would allow for more natural interpolation instead of a linear path.

Progress Reflection

Current Limitations in Efficiency

While our current approach successfully pairs and interpolates meshes it isn't the most efficient. The reliance on the Hungarian Algorithm for vertex pairing, while effective, can be computationally expensive for larger meshes.

Future Exploration: MAPS

We plan to explore alternative methods like MAPS to improve performance and scalability. However, we did not have enough time to implement MAPS during this initial milestone.

Schedule Reflection

Overall our schedule stayed mostly on track. We were able to implement a basic mesh interpolation between two topologically equivalent meshes within the first two weeks as originally planned.

Updated Schedule

Week 3 (April 21 - April 27):

Focus on interpolation between meshes with differing topologies by implementing resampling techniques (e.g., subdivision or simplification). In parallel, begin working on normal interpolation and per-frame shading to improve visual smoothness.

Week 4 (April 28 - May 4):

Refine the morphing pipeline and address any bugs. Implement additional extension features if time permits (e.g., texture interpolation, better vertex matching). Begin preparing the final deliverable, generating polished images and animations to showcase results, and writing up the final report.

The website design is adapted from here.