Material Parameter Editing System for Volumetric Simulation Models

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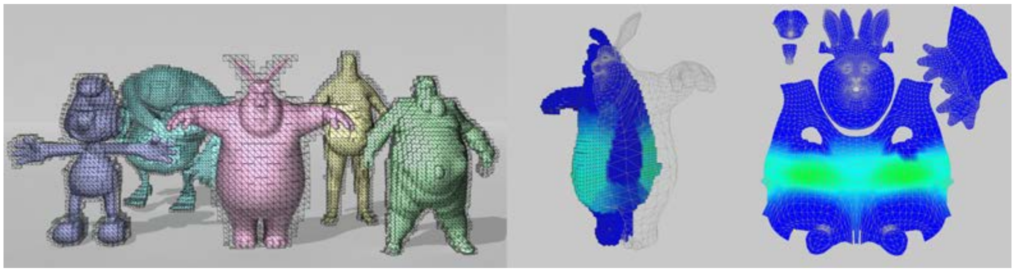

Figure 1: *In order to adjust interior material parameters for volumetric character model, our texture-based system (i.e. "material map") requires only painting on texture-space. The painted value is automatically propagated into the interior-space and set as material parameters.*

1 Introduction

This poster presents a novel editing system for the material parameters of volumetric models. Physically-based character animation is a trend for film making. Most recent approaches require volumetric lattices for simulation using finite element method such as [Hahn et al. 2012]. These approaches can represent secondary deformation and volume preservation in character animation. However, the anatomical structures for human-like characters are not considered, because it is difficult for rigging artists to edit anatomical features or material parameters to interior vertices enclosed in skin meshes. Our system can allow artists to adjust interior deformable parts (such as muscle, flesh, and skin) or material parameters using a texture-based approach (i.e. using a "material map") in Figure 1. In this poster, we demonstrate the effectiveness using various characters.

2 Intuitive material editing system

Our system is divided into three parts: surface distance calculation, normal direction calculation, and interior material editing. Our system requires a skin mesh model and regular lattice structure vertices that are enclosed within the skin mesh.

Surface distance calculation:
For surface distance calculation, we compute the Manhattan distance from boundary voxels to interior voxels. Boundary voxels are defined as voxels having less than six neighboring vertices of a lattice. The surface distance value of the boundary voxel is set 1, and it increases with the increasing Manhattan distance value from the boundary voxel.

Normal vector calculation:
For calculating the normal direction, we define a normal direction for each voxel, which is computed by the relation with neighbor voxels. We denote the six neighbor vertices of a vertex $\mathbf{k}_i$ and a normal vector $\mathbf{n}_i$. $\{\mathbf{k}_i^{x+}, \mathbf{k}_i^{x-}, \mathbf{k}_i^{y+}, \mathbf{k}_i^{y-}, \mathbf{k}_i^{z+}, \mathbf{k}_i^{z-}\} \in \{1, ..., n\}^6$, $\mathbf{n}_i = -\frac{1}{m}\sum_1^m \mathbf{k}_i^{x\pm,y\pm,z\pm}$, where m is the sum of neighboring vertices. The interior normal direction is defined as an average of the six-neighbored normal vector which the surface distance value is less than its own value.

Interior material editing system:
For editing interior material, we address the inconvenient exchange between skin surface and interior vertices, and we register each skin vertex into each enclosed voxel. According to the traditional painting weights and skinning approach, artists can paint material map over a skin mesh or use a UV map to select interior deformable parts or set material parameters. The material value set on the mesh is related some material parameters and propagated to interior vertices considering the surface distance value and normal direction. We denote a maximum surface distance value d_max and material value s_i for each vertex. $s_i = 1 - \frac{d_i - 1}{d_{max} - 1}$. Normal directions are related to the threshold of influence area. Finally, the influence of each voxel is calculated as the inner product of the surface normal and interior normal directions.

3 Conclusion

We propose an intuitive approach for selecting deformable parts and editing material parameters. The demonstration is an example of how our animation system can be used to manipulate multiple character models. The result is verified in the change of interior material parameters using a material map by changing secondary motion. Our system fits in a regular lattice structure volumetric model because a regular lattice can be reconstructed easily and neighbor relations are accessible and easy to understand than a tetrahedral lattice. This approach allows artists to control physically-based character animation systems for volumetric models. The main limitation is the problem of lattice resolution. As the sum of voxels grows, computational cost grows. Reducing the resolution of interior vertices can further improve performance while maintaining the quality of the character appearance.

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SIGGRAPH 2014, August 10 – 14, 2014, Vancouver, British Columbia, Canada.

ACM 978-1-4503-2958-3/14/08

References

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