LoCoStreaming - Lossy compression for 3D geometry streaming

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1 Introduction

We have become used to audio and video streaming for instant messaging all the way up to high end cinematic experiences in our homes. Current trends in the consumer market already offer 3D stereo TV, but the perspective is predetermined by the director and is not chosen by the viewer. In our opinion the next big step in this area will be real-time 3D geometry streaming. The user will be able to freely determine his perspective in the transmitted scene. Examples of that would be taking the strikers perspective while scoring a goal in a soccer match, the goalkeeper's perspective in defending his shot or the spectator's view on the scene. The challenges for 3D geometry streaming to become reality are the limited bandwidth on the last mile to the customer as well as real-time photorealistic rendering and interaction capabilities.

In this poster, we present a lossy compression approach for 3D geometries using its convex hull that allows to drastically reduce the size of transmitted geometric scenes, re-mesh and render the outcome on-the-fly on the receiving side in a level of detail depending on the current viewpoint.

2 Exposition

Our algorithm is based on using the convex hull of a given 3D object. Data obtained from scanning a 3D object is usually in the form of a 3D point cloud or 3D triangular surfaces. Most of the current 3D mesh compression algorithms use some form of text or hierarchical compression, which are not very efficient for our applications since they involve transmitting huge chunks of data [Kim et al. 2011]. We approximate an object's shape by a tri-axial ellipsoid, all semi-axis being distinct in length. It engulfs the entire object in an optimal way computed using existing methods such as *Principal Component Analysis*. Further we also exploit the possibility of using composite convex hulls, a set of multiple tri-axial ellipsoids, for modelling motion and/or higher levels of detail in the environment (see Figure 1).

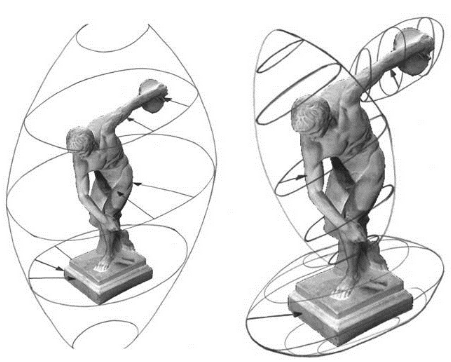

Figure 1: *Using convex hulls for LoCoStreaming*

Our **Ellipsoidal Convex Hulls** consist of an equidistant finite number of rings with an equidistant finite number of points in each ring from which rays are cast on to the surface of a given 3D object. We store the lengths of each ellipsoidal axis, the distance between the rings along the longest axis and the distance between adjacent points. These parameters adequately define the geometry of the convex hull.

A single **Ellipsoidal Convex Hull** as shown on the left side in the previous figure is used as a base set for coarse compression. The method involves casting rays from points on the surface of the convex hull on to the given 3D object to record their lengths. This information is stored and it is said to be lossy since the maximum resolution possible is governed by the number of points on the convex hull and is totally independent of the actual size of the given 3D object. We can choose from two methods to define the ray casting direction. The first one is to always direct the ray from the surface to the centroid of the convex hull. The second method is to cast rays anti-parallel to the surface normal from a given surface point on the convex hull. While the first method requires less computation than the second, the second method will result in smaller recorded lengths hence enhancing the compression ratio, once statistical compression for streaming is applied. **Composite Convex Hulls** as shown on the right side of the figure above can be used for modelling higher levels of detail, motion or animation of given objects. Relations between adjacent convex hulls are stored as transformations between their centroids. We propose an automated 3D segmentation algorithm to identify the optimum number of convex hulls to be used [Cheng et al. 2010].

After recording a geometry-scene-frame it is compressed and streamed to the receiver-side where it is decoded and re-meshed. The stream consists of multiple levels of detail for each object. Thus, when the user interactively chooses his personal viewpoint, the level of detail of the objects rendered depends on their distance to it. This allows one 3D geometry broadcast to simultaneously support multiple viewpoints.

3 Conclusion

The authors propose a novel algorithm for lossy compression of 3D geometry meshes using ellipsoidal convex hulls. The algorithm has applications in the field of 3D Geometry streaming, Interactive web applications and real time scene rendering. Combining 3D geometry broadcasting with social networks will allow users to meet, interact and eventually "see" each other as virtual avatars while sharing the same broadcast.

References

CHENG, S.-C., KUO, C.-T., AND WU, D.-C. 2010. A novel 3d mesh compression using mesh segmentation with multiple principal plane analysis. *Pattern Recognition 43*, 1, 267 – 279.

KIM, Y.-J., OH, Y.-T., YOON, S.-H., KIM, M.-S., AND ELBER, G. 2011. Coons bvh for freeform geometric models. In *Proceedings of the 2011 SIGGRAPH Asia Conference*, ACM, New York, NY, USA, SA '11, 169:1–169:8.

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