

Controlled Metamorphosis of Animated Meshes Using Polygonal-Functional Hybrids

Kravtsov D.*, Fryazinov O., Adzhiev V., Pasko A. and Comminos P.
NCCA, Bournemouth University, UK

1 Introduction

Polygonal models are widely used in computer animation. Static polygonal models are commonly animated using an underlying skeleton controlling the deformation of the mesh. This technique known as skeletal animation allows the artist to produce complex animation sequences in a relatively easy way. However, performing complex transitions between arbitrary animated meshes remains a challenging problem. There is a set of established techniques to perform metamorphosis (3D morphing) between static 3D meshes [Lazarus and Verroust 1998], but most of these can not be easily applied to animated meshes. The approach presented in this poster allows us to produce with great ease metamorphosing transitions between animated meshes of arbitrary topology using polygonal-functional hybrids [Kravtsov et al. 2010].

2 Method Outline

The key idea of our method is the integration of polygonal and functional objects [Pasko et al. 1995] within one model. This involves approximating the animated meshes by convolution surfaces that are defined by a set of line segments. This is done using a single pose of each mesh. The actual metamorphosis is then performed between the generated convolution surfaces. Thus, for the metamorphosis between the source and destination animated meshes we perform:

1. A smooth transition from the animated source mesh to its functional approximation;
2. A continuous transition from the functional approximation of the source mesh to the functional approximation of the destination mesh;
3. A transition from the functional approximation of the destination mesh to the animated destination mesh.

In order to produce a smooth transition from the mesh to the convolution surface (step 1), we project the vertices of the mesh onto the approximating convolution surface. We use the per-vertex skinning and normal information to retrieve an appropriate position for every vertex of the mesh on the resulting convolution surface. After the projection step, every vertex is assigned an offset to its position on the convolution surface as well as the resulting normal vector. Then we use this information to perform the local deformation of the skinned mesh. When the positions and normals of all the vertices are aligned with the convolution surfaces we switch from the polygonal object to the functional object. In step 2, we have the functional approximations of both animated meshes and we can employ different methods to generate the intermediate shapes. This method can be a straightforward FRep metamorphosis, space-time blending or a complex user-controlled transition employing the skeletons defining the convolution surfaces. The result of this metamorphosis is a functional object approximating the animated destination mesh. In step 3, we apply an inverse deformation to that applied in step 1.

Since we perform the metamorphosis using FReps all topological

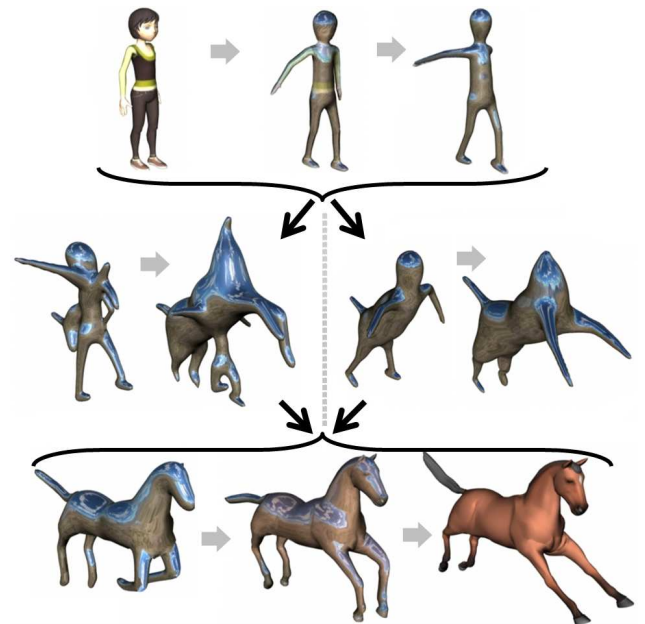


Figure 1: Metamorphosis

changes are handled automatically and we do not need to specify any additional constraints on the topology of the original meshes.

We have implemented our approach in Maya™. Our plug-in allows the animator to produce metamorphosis sequences with great ease. The animator can fine-tune the metamorphosis using a low resolution model in near-real time, while the final sequence is produced using a higher resolution model. Moreover, when the parameters of the transition have been evaluated, real-time playback of the metamorphosis sequence can be performed using either geometry shaders or CUDA SDK. The resolution of the model can be varied depending on the available hardware resources.

We believe that the incorporation of techniques such as this and the underlying hybrid modelling technology into existing modelling software and games engines will greatly enhance the ability of artists to generate complex models and animations.

References

- KRAVTSOV, D., FRYAZINOV, O., ADZHIEV, V., PASKO, A., AND COMMINOS, P. 2010. Embedded implicit stand-ins for animated meshes: a case of hybrid modelling. *Comput. Graph. Forum* 29, 1, 128–140.
- LAZARUS, F., AND VERRROUST, A. 1998. Three-dimensional metamorphosis: a survey. *The Visual Computer* 14, 8/9, 373–389.
- PASKO, A., ADZHIEV, V., SOURIN, A., AND SAVCHENKO, V. 1995. Function representation in geometric modeling: Concepts, implementation and applications. *The Visual Computer*, 11, 429–446.

*dkravtsov@bournemouth.ac.uk