# Mesh Modelling with Curve Analogies

Steve Zelinka* Michael Garland†

University of Illinois at Urbana–Champaign

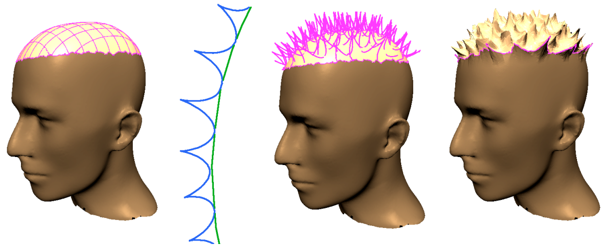

Figure 1: Left to right: original mesh, with unfiltered target curves; sample curves: unfiltered green, filtered blue; filtered target curves; transformed mesh.

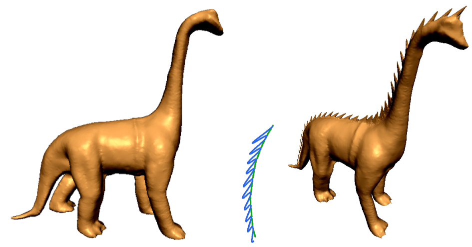

Figure 2: Silhouette modification.

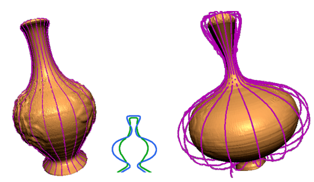

Figure 3: Low-frequency enhancement.

## 1 Introduction

True *Mesh Analogies*, in which a mesh is transformed by producing an example of the desired transformation, would be a useful modelling tool. Analogies support a very wide range of transformations without having to write specific code for each, as well as allowing unskilled users to make relatively complex transformations so long as they can find or create an example of the transformation. However, generalizing analogies from images [Hertzmann et al. 2001] or curves [Hertzmann et al. 2002] to meshes, beyond the technical challenges, puts an increasing burden on the user in creating or finding the example transformation; while even novices may be comfortable editing images or curves, few methods allow novice users to easily edit a mesh. We therefore develop an alternate, less powerful approach using Curve Analogies directly.

First, the user selects a set of target curves embedded in the surface. The user then specifies a transformation to be applied to the curves by sketching a pair of sample curves. Using Curve Analogies, we reproduce the transformation between the two sample curves on all of the surface curves. Finally, these transformed curves are used to drive a transformation of the surface.

## 2 Curve Selection

The space of filters which may be applied to a mesh using our approach is contingent on the set of curves selected to be transformed. Typically, we simply slice the surface by sets of parallel or rotating planes, and use the resulting intersection curves. Note that one set of parallel planes would preclude control over features emergent over the direction of the plane normal, so we typically use two or more (usually orthogonal) sets of parallel planes. Rotating planes can be useful for objects which are (or nearly are) rotationally symmetric. Other useful sets of target curves include iso-parameter lines, for parameterized surfaces, and silhouette curves.

## 3 Surface Transformation

Our surface transformation procedure is inspired by the Wires system [Singh and Fiume 1998]. Each curve influences all mesh vertices within a user-specified distance. Each influenced vertex is moved in the direction its closest point on the untransformed curve is moved, with the magnitude of the change a function of the approximate geodesic distance of the vertex to the curve. When multiple curves influence a vertex, its final position is a weighted average of the positions suggested by each curve, using the same distance-based weighting. Note that we assume the sample density of the original mesh is high enough to support the transformation, and we may produce some smoothing at vertices with multiple influences.

*e-mail: zelinka@uiuc.edu

†e-mail: garland@uiuc.edu

## 4 Discussion

We have used our approach to apply a number of different filters to meshes, including local feature additions, smoothing, and low frequency enhancements. Results typically take a few minutes, depending on the number of curves and the required sample densities.

Rotationally invariant Curve Analogies can be difficult to control, as the orientation of a filter can change (e.g., from adding bumps to creating indentations). We are addressing this by incorporating the orientation of the surface into the Curve Analogy generation. Also, we may create self-intersections in the surface, though this should be relatively easy to avoid.

## References

HERTZMANN, A., JACOBS, C. E., OLIVER, N., CURLESS, B., AND SALESIN, D. H. 2001. Image analogies. In *Proceedings of ACM SIGGRAPH 2001*, ACM Press / ACM SIGGRAPH, New York. E. Fiume, Ed., Computer Graphics Proceedings, Annual Conference Series, ACM, 327–340.

HERTZMANN, A., OLIVER, N., CURLESS, B., AND SEITZ, S. M. 2002. Curve analogies. In *Proceedings of the Thirteenth Eurographics Workshop on Rendering*, 233–245.

SINGH, K., AND FIUME, E. 1998. Wires: A geometric deformation technique. In *Proceedings of ACM SIGGRAPH 98*, ACM Press / ACM SIGGRAPH, New York. M. Cohen, Ed., Computer Graphics Proceedings, Annual Conference Series, ACM, 405–414.