Non-realistic expressive modeling

Ran Gal Olga Sorkine
Tel Aviv University

Tiberiu Popa Alla Sheffer
University of British Columbia

Daniel Cohen-Or
Tel Aviv University

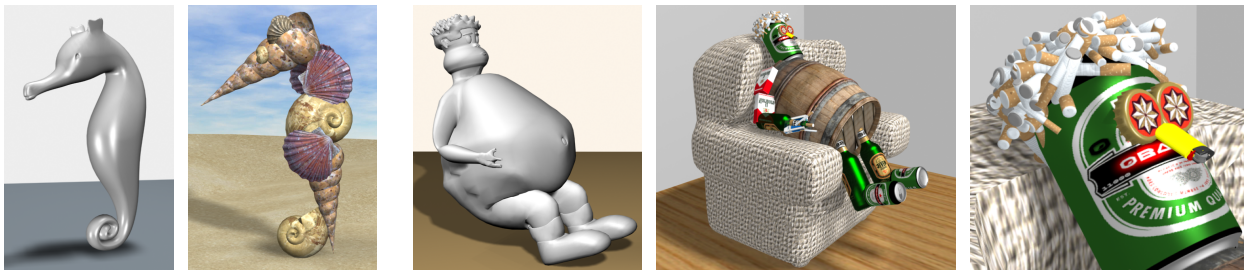

Figure 1: (left) Hippocampus boticelli. (right) Lazy boy (the couch was added manually).

Keywords: non-realistic modeling, expressive imagery

1 Introduction

The ability of computer graphics to represent images symbolically has so far been used mostly to render existing models with greater clarity or with greater visual appeal. In this work, we present a method aimed at harnessing this symbolic representation power to increase the expressiveness of the 3D models themselves. We achieve this through modification of the actual representation of 3D shapes rather than their images.

Our research is inspired by the expressive ability of surrealist art, most notably the "path-blazing" work of Giuseppe Arcimboldo (1527-1593). As early as in the middle of the 16th century, Arcimboldo noticed that human visual perception can separate shape from content. His allegorical figures composed of vegetables and fruit demonstrate the assertion of the surrealist movement that a single image or statue can convey more than one concept, providing a more expressive medium [Janson and Janson 1991]. However, the technical difficulty of modeling a complex 3D shape from other shapes meant that both artistic [Janson and Janson 1991] and computerized [Kim and Pellacini 2002] composition works typically dealt only with 2D representations such as images. Our work addresses this challenge, presenting an algorithm for 3D collage generation based on partial matching using local shape descriptors. Our algorithm serves as an artistic tool, providing the artist with the means to remain engaged in the creative process by maintaining high-level control through several interface options.

2 Algorithm

Our expressive modeling tool is meant to create a compound 3D model (a collage) of a *target* geometric shape from *elements* or shapes taken from a given database. We devise an algorithm that finds a collection of elements and places them in such a way that both the target shape that we wish to model, and the parts are *recognizable*.

The algorithm is based on the following criteria: (1) Since the collage must resemble the target shape, each element in the collage should fit well some region on the target surface, and protrusion of collage parts outside the target shape should be minimal. (2) Since the elements should be recognizable, each element should approximate a large part of the target shape. (3) For the collages to resemble physically plausible constructions, the amount of intersection between the different parts in the collage should be limited, and relative proportions between elements should be roughly preserved.

It is infeasible to provide an algorithm for computing collages that are optimal in terms of all three criteria at once. However, we found that a greedy approach, where the collage is built by adding the best element at any give time, gives us very good results. In each step, our method first retrieves the elements such that some portion of each element approximates well some not yet covered part of the target. The quality of the approximation is measured using local surface descriptors (local geometric moments) computed on the target shape and the database elements. The advantage of using moments is that they provide not only a matching score, but also a similarity transformation that enables the best fit. This transformation is used to place the element into the collage. Next, our fitting scheme evaluates the quality of each match based on a score function and a number of constraints. To compute the score, the method measures the increase in coverage provided by the potential element; bigger coverage implies better fit in terms of the first criterion above. The constraints enable rejection of fits that do not cover a sufficient portion of the model, or that overlap too much with previously placed elements. The fitting places the element with the highest score that satisfies the constraints into the collage.

We provide the artist with several ways to influence the algorithm and maintain creative control. Global parameters may be set to control the tightness of the fitting, shape proportions, etc. Local control is achieved by defining different parameters for different regions of the target. We have created several collages with various element databases. The "hipocampus boticelli" was created in a fully automatic mode with the same parameters used across the entire model. For the "Lazy boy," the user restricted the database matches for the hair to contain only cigarettes, and required a tighter fit for the facial features.

3 Conclusion

Computer-aided artistic tools serve as powerful paintbrushes of the 21st century. Our work adds a new, conceptually different brush to the artist's existing arsenal of tools. While previous tools focused on rendering existing models, our work directly addresses expressive modeling, creating 3D art pieces.

References

JANSON, H., AND JANSON, A. F. 1991. *A Basic History of Art*. Prentice, Englewood Cliffs, NJ.

KIM, J., AND PELLACINI, F. 2002. Jigsaw image mosaics. In *Proceedings of ACM SIGGRAPH 2002*, 657–664.