2D sketching for the interactive design of 3D shapes

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The creation of digital content has recently been identified as one of the grand challenges in the field of Computer Graphics: many applications, from entertainment industry to simulators, require the design of complex 3D worlds including many elements of different nature, from plausible landscape and buildings to vegetation, animals and complex characters, including specific details such as clothes and hair. In the domain of feature films, large teams of computer artists typically spend one to four years creating all the elements needed for a given movie, using dedicated software for manipulating a variety of geometric models. Learning to use these softwares also takes some years. Moreover, they do not allow shape creation through gesture. In consequence, computer artists still rely on real media such as paper and pen to quickly express their ideas of a shape at the early stages of design. As Rob Cook, the vice-president of Pixar studios recently emphasized in his key-note talk at SIGGRAPH Asia 2008, the big challenge in our field is now to *make the (mathematical) tools as invisible for artists as the technical methods were made for the public*. This talk reviews some recent advances in this direction: it presents the use of 2D sketching interfaces, combined with adapted geometric models, for quickly designing complex 3D shapes. What makes real sketching so popular is that humans tend to naturally interpret a 2D sketch into a 3D shape. A good question is: how does it work, and could we implement the same rules, so that a digital modelling system directly generates 3D from a sketch? People basically use two main strategies for interpreting a sketch: if they recognize the general features of a well known shape, they rely on their a priori knowledge to imagine what the full shape should be in 3D (think of a sketch of a tree, or of a character); when the shape is totally unknown, people rather tend to imagine the simplest 3D shape fitting the sketched contours, as shown by recent perception studies.

The first part of the talk presents some recent work based on the first strategy, where dedicated systems rely on both an adapted geometric representation and geometric to physical constraints to reconstruct a well known shape. We illustrate this by discussing three examples: sketch-based fashion design [2, 4, 3] with the possible use of a developability constraints on the reconstructed surface, sketch-based styling of human hair [5], and sketch-based generation of trees [6], where a multi-resolution sketching interface is combined with geometric computations and a priori knowledge from botany.

The second part of the talk tackles the problem of sketch-based design of an unknown smooth shape, of arbitrary geometry and topological genius [1]. We show that the computation of medial axes and the use of adapted implicit surfaces, based on a closed form convolution integral, allow us to reconstruct a plausible 3D shape in a purely geometric way. A novel blending algorithm is presented to progressively add surface parts and smaller details by over-sketching the shape from arbitrary viewpoint and at any zoom factor.

We conclude by discussing the use of sketching v.s. sculpting metaphors for respectively creating and editing 3D shapes.

Références

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