University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Doctor of Philosophy

of

BAPTISTE ANGLES

MA (Université de Toulouse, 2015)
BSc (Université de Bordeaux, 2013)

"Geometric Modeling with Primitives"

Department of Computer Science

Thursday, April 18, 2019
8:30 A.M.
Clearihue Building
Room B007

Supervisory Committee:
Dr. Loïc Barthe, Department of Computer Science, Université Paul Sabatier (Co-Supervisor)
Dr. Andrea Tagliasacchi, Department of Computer Science, University of Victoria (Co-Supervisor)
Dr. Brian Wyvill, Department of Computer Science, UVic (Member)
Dr. Mathias Paulin, Department of Computer Science, Université Paul Sabatier (Outside Member)

External Examiner:
Dr. Alec Jacobson, Department of Computer Science, University of Toronto

Chair of Oral Examination:
Dr. Lynneth Stuart-Hill, School of Exercise, Science, Physical & Health Education, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Both man-made or natural objects contain repeated geometric elements that can be interpreted as primitive shapes. Plants, trees, living organisms or even crystals, showcase primitives that repeat themselves. Primitives are also commonly found in man-made environments because architects tend to reuse the same patterns over a building and typically employ simple shapes, such as rectangular windows and doors. During my PhD I studied geometric primitives from three points of view: their composition, simulation and autonomous discovery.

In the first part I present a method to reverse-engineer the function by which some primitives are combined. Our system is based on a composition function template that is represented by a parametric surface. The parametric surface is deformed via a non-rigid alignment of a surface that, once converged, represents the desired operator. This enables the interactive modeling of operators via a simple sketch, solving a major usability gap of composition modeling.

In the second part I introduce the use of a novel primitive for real-time physics simulations. This primitive is suitable to efficiently model volume-preserving deformations of rods but also of more complex structures such as muscles. One of the core advantages of our approach is that our primitive can serve as a unified representation to do collision detection, simulation, and surface skinning.

In the third part I present an unsupervised deep learning framework to learn and detect primitives. In a signal containing a repetition of elements, the method is able to automatically identify the structure of these elements (i.e. primitives) with minimal supervision. In order to train the network that contains a non-differentiable operation, a novel multi-step training process is presented.