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M. Campen and M. Spagnuolo
(Guest Editors)

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Keynote

Towards Structured Geometric Understanding for 3D Perception

Angela Dai
Technical University of Munich

Abstract

Semantic perception of 3D environments has seen remarkable advances in recent years, with a significant focus on object-based understanding. We propose to learn structured, intermediary representations, such as object parts, in order to provide a robust understanding of diverse 3D geometric structures from observations of real-world environments. This can enable more effective geometric reconstruction of objects in 3D scenes, enabling inter- and intra-object reasoning, as well as establish efficient structured representations for reconstruction and tracking of objects undergoing complex deformations.

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Keynote

Computational 3D Visual Art Design

Ligang Liu
University of Science and Technology of China

Abstract
3D visual arts are highly diverse, including sculpture, architecture, ceramics, etc., in our lives. Traditionally, artists use their rich imagination and experience to design 3D objects to give the audience a memorable experience. The design process takes a lot of trial and error, so it is often very time-consuming. It has attracted the attention of many researchers in the community of geometry processing and computer graphics, proposing various algorithms to simplify the initial complicated design process and help artists quickly realize the art in their minds. Moreover, the advent of digital modeling and 3D printing enables artists to create more complex 3D visual artworks. In this talk, we will show a few interesting 3D visual art works and propose automatic methods to solve various problems in the design process of these art works. From these examples, we reveal the close connection between geometry processing techniques and various 3D visual art design problems. Moreover, we will discuss about the current research trends and provide an outlook for future research directions and solutions.

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Keynote

Geometry for Design and Construction of High-performance Architecture

Caitlin Mueller
MIT Architecture

Abstract
Design and construction in the built environment present significant challenges and opportunities for impact: Buildings contribute to about 40% of global carbon emissions through their materials and operations, often due to inefficiencies stemming from a lack of integration between architectural design, engineering, and construction processes. While this disconnect has been critiqued for decades, today's emerging techniques in computation, and in particular, geometry, can allow for a new layer of interdisciplinary communication and collaboration that transforms traditional workflows and empowers novel visual languages for high-performance architecture. In this talk, Mueller will share recent work that contributes to this goal, demonstrating new techniques for computational design that integrate engineering principles and sustainability goals without overriding creative autonomy, and new fabrication methods that can materialize efficient geometries economically. In particular, the talk will demonstrate how techniques developed in geometry processing and related fields can empower significant innovation in architectural domains, and will propose emerging problem spaces and applications for future geometry research.

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Keynote

Robust Geometry Processing for Physical Simulation

Daniele Panozzo
New York University

Abstract

The numerical solution of partial differential equations (PDE) is ubiquitously used for physical simulation in scientific computing, computer graphics, and engineering. Ideally, a PDE solver should be opaque: the user provides as input the domain boundary, boundary conditions, and the governing equations, and the code returns an evaluator that can compute the value of the solution at any point of the input domain. This is surprisingly far from being the case for all existing open-source or commercial software, despite the research efforts in this direction and the large academic and industrial interest. To a large extent, this is due to lack of robustness and generality in the geometry processing algorithms used to convert raw geometrical data into a format suitable for a PDE solver. I will discuss the limitations of the current state of the art, and present a proposal for an integrated pipeline, considering data acquisition, meshing, basis design, and numerical optimization as a single challenge, where tradeoffs can be made between different phases to increase automation and efficiency. I will demonstrate that this integrated approach offers many advantages, while opening exciting new geometry processing challenges, and that a fully opaque meshing and analysis solution is already possible for heat transfer and elasticity problems with contact. I will present a set of applications enabled by this approach in reinforcement learning for robotics, force measurements in biology, shape design in mechanical engineering, stress estimation in biomechanics, and simulation of deformable objects in graphics.