IN PARTNERSHIP WITH:
CNRS

Université de Lorraine

Activity Report 2018

Project-Team ALICE

Geometry and Lighting

IN COLLABORATION WITH: Laboratoire lorrain de recherche en informatique et ses applications (LORIA)

RESEARCH CENTER
Nancy - Grand Est

THEME
Interaction and visualization

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Project-Team ALICE

Creation of the Project-Team: 2006 January 09, end of the Project-Team: 2018 December 31

Keywords:

Computer Science and Digital Science:

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A5.5.2. - Rendering
A6.2.8. - Computational geometry and meshes
A8.1. - Discrete mathematics, combinatorics
A8.3. - Geometry, Topology

Other Research Topics and Application Domains:

B3.3.1. - Earth and subsoil
B5.1. - Factory of the future
B5.7. - 3D printing
B9.2.2. - Cinema, Television
B9.2.3. - Video games

1. Team, Visitors, External Collaborators

Research Scientists

Bruno Lévy [Team leader, Inria, Senior Researcher, HDR]
Laurent Alonso [Inria, Researcher]
Samuel Hornus [Inria, Researcher, until Feb 2018]
Sylvain Lefebvre [Inria, Senior Researcher, until Feb 2018, HDR]
Jonas Martinez Bayona [Inria, Researcher, until Feb 2018]
Nicolas Ray [Inria, Researcher]

Faculty Members

Dobrina Boltcheva [Univ de Lorraine, Associate Professor]
Dmitry Sokolov [Univ de Lorraine, Associate Professor, HDR]

PhD Students

Justine Basselin [Inria, from Oct 2018]
Jimmy Etienne [Inria, until Feb 2018]
Maxence Reberol [Inria, until Apr 2018]
Julien Renaudeau [Univ de Lorraine, until Oct 2018]

Technical staff

Yamil Salim Perchy Bocanegra [Inria, until Feb 2018]
Noemie Vennin [Inria, until Feb 2018]
Erica Schwindt [Inria, until Apr 2018]
Haichuan Song [Inria, until Jan 2018]

Interns

Agathe Herrou [Inria, until Jul 2018]
Emile Hohnadel [Inria, from Jun 2018 until Jul 2018]
Hussein Houdrouge [Univ de Lorraine, from Apr 2018 until Aug 2018]
Samuel Humeau [Univ de Lorraine, from Jun 2018 until Aug 2018]

Administrative Assistants

Virginie Priester [CNRS]
Céline Simon [Inria]

2. Overall Objectives

2.1. Overall Objectives

ALICE is a project-team in Computer Graphics. The fundamental aspects of this domain concern the interaction of *light* with the *geometry* of the objects. The lighting problem consists in designing accurate and efficient *numerical simulation* methods for the light transport equation. The geometrical problem consists in developing new solutions to *transform and optimize geometric representations*. Our original approach to both issues is to restate the problems in terms of *numerical optimization*. We try to develop solutions that are *provably correct*, *numerically stable* and *scalable*.

To reach these goals, our approach consists in transforming the physical or geometric problem into a numerical optimization problem, studying the properties of the objective function and designing efficient minimization algorithms. Besides Computer Graphics, our goal is to develop cooperations with researchers and people from industry, who test applications of our general solutions to various domains, comprising CAD, industrial design, oil exploration, plasma physics... Our solutions are distributed in both open-source software (Graphite, OpenNL, CGAL) and industrial software (Gocad, DVIZ).

Since 2010, we started to develop techniques to model not only virtual objects, but also real ones. Our "modeling and rendering" research axis evolved, and we generalized our results on by-example texture synthesis to the production of real objects, using 3D printers. In February 2018, Sylvain Lefebvre created the MFX team (Matter from Graphics); new results for the fabrication axis are described in a separate report.

As compared to virtual objects, this setting defines higher requirements for the geometry processing techniques that we develop, that need to be adapted to both numerical simulation and computer-aided fabrication. We study how to include *computational physics* into the loop, and simulation methods for various phenomena (*e.g.*, fluid dynamics).

3. Research Program

3.1. Introduction

Computer Graphics is a quickly evolving domain of research. These last few years, both acquisition techniques (*e.g.*, range laser scanners) and computer graphics hardware (the so-called GPU's, for Graphics Processing Units) have made considerable advances. However, despite these advances, fundamental problems still remain open. For instance, a scanned mesh composed of hundreds of millions of triangles cannot be used directly in real-time visualization or complex numerical simulation. To design efficient solutions for these difficult problems, ALICE studies two fundamental issues in Computer Graphics:

- the representation of the objects, *i.e.*, their geometry and physical properties;
- the interaction between these objects and light.

Historically, these two issues have been studied by independent research communities. However, we think that they share a common theoretical basis. For instance, multi-resolution and wavelets were mathematical tools used by both communities [25]. We develop a new approach, which consists in studying the geometry and lighting from the *numerical analysis* point of view. In our approach, geometry processing and light simulation are systematically restated as a (possibly non-linear and/or constrained) functional optimization problem. This type of formulation leads to algorithms that are more efficient. Our long-term research goal is to find a formulation that permits a unified treatment of geometry and illumination over this geometry.

3.2. Geometry Processing for Engineering

Keywords: Mesh processing, parameterization, splines

Geometry processing emerged in the mid-1990's as a promising strategy to solve the geometric modeling problems encountered when manipulating meshes composed of hundreds of millions of elements. Since a mesh may be considered to be a *sampling* of a surface - in other words a *signal* - the *digital signal processing* formalism was a natural theoretic background for this subdomain (see *e.g.*, [26]). Researchers of this domain then studied different aspects of this formalism applied to geometric modeling.

Although many advances have been made in the geometry processing area, important problems still remain open. Even if shape acquisition and filtering is much easier than 30 years ago, a scanned mesh composed of hundreds of millions of triangles cannot be used directly in real-time visualization or complex numerical simulation. For this reason, automatic methods to convert those large meshes into higher level representations are necessary. However, these automatic methods do not exist yet. For instance, the pioneer Henri Gouraud often mentions in his talks that the *data acquisition* problem is still open [15]. Malcolm Sabin, another pioneer of the "Computer Aided Geometric Design" and "Subdivision" approaches, mentioned during several conferences of the domain that constructing the optimum control-mesh of a subdivision surface so as to approximate a given surface is still an open problem [24]. More generally, converting a mesh model into a higher level representation, consisting of a set of equations, is a difficult problem for which no satisfying solutions have been proposed. This is one of the long-term goals of international initiatives, such as the AIMShape European network of excellence.

Motivated by gridding application for finite elements modeling for oil and gas exploration, within the context of the Gocad project, we started studying geometry processing in the late 90's and contributed to this area at the early stages of its development. We developed the LSCM method (Least Squares Conformal Maps) in cooperation with Alias Wavefront [19]. This method has become the de-facto standard in automatic unwrapping, and was adopted by several 3D modeling packages (including Maya and Blender). We explored various applications of the method, including normal mapping, mesh completion and light simulation [16].

However, classical mesh parameterization requires to partition the considered object into a set of topological disks. For this reason, we designed a new method (Periodic Global Parameterization) that generates a continuous set of coordinates over the object [22]. We also showed the applicability of this method, by proposing the first algorithm that converts a scanned mesh into a Spline surface automatically [18].

We are still not fully satisfied with these results, since the method remains quite complicated. We think that a deeper understanding of the underlying theory is likely to lead to both efficient and simple methods. For this reason, in 2012 we studied several ways of discretizing partial differential equations on meshes, including Finite Element Modeling and Discrete Exterior Calculus. In 2013, we also explored Spectral Geometry Processing and Sampling Theory (more on this below).

3.3. Computer Graphics

Keywords: texture synthesis, shape synthesis, texture mapping, visibility

Content creation is one of the major challenges in Computer Graphics. Modeling shapes and surface appearances which are visually appealing and at the same time enforce precise design constraints is a task only accessible to highly skilled and trained designers.

In this context the team focuses on methods for by-example content creation. Given an input example and a set of constraints, we design algorithms that can automatically generate a new shape (geometry+texture). We formulate the problem of content synthesis as the joint optimization of several objectives: Preserving the local appearance of the example, enforcing global objectives (size, symmetries, mechanical properties), reaching user defined constraints (locally specified geometry, contacts). This results in a wide range of optimization problems, from statistical approaches (Markov Random fields), to combinatorial and linear optimization techniques.

As a complement to the design of techniques for automatic content creation, we also work on the representation of the content, so as to allow for its efficient manipulation. In this context we develop data structures and algorithms targeted at massively parallel architectures, such as GPUs. These are critical to reach the interactive rates expected from a content creation technique. We also propose novel ways to store and access content defined along surfaces [23] or inside volumes [14] [17].

The team also continues research in core topics of computer graphics at the heart of realistic rendering and realistic light simulation techniques; for example, mapping textures on surfaces, or devising visibility relationships between 3D objects populating space.

4. Application Domains

4.1. Geometric Tools for Simulating Physics with a Computer

Numerical simulation is the main targeted application domain for the geometry processing tools that we develop. Our mesh generation tools are tested and evaluated within the context of our cooperation with the Gocad consortium, with applications in oil exploration and geomechanics, through co-advised Ph.D. theses (Arnaud Botella, Julien Renaudeau). We think that the hex-dominant meshes that we generate have geometrical properties that make them suitable for some finite element analyses. We work on evaluating and measuring their impact with simple problems (heat equation, linear elasticity) and then practical applications (unfolding geological layer), with the Ph.D. thesis of Maxence Reberol. In numerical simulation, developing discrete formulations that satisfy the conservation laws (conservation of mass, conservation of energy, conservation of momentum) is important to ensure that the numerical simulation faithfully reflects the behavior of the physics. There are interesting relations with optimal transport theory, as explained by Benamou and Brenier who developed a numerical algorithm for optimal transport that uses a fluid dynamics formulation. Conversely, some dynamics can be approximated by a series of optimal transport problems, as in the Jordan-Kinderlehrer-Otto scheme and in recent works by Mérigot. We started developing efficient geometric algorithms and optimisation methods that may serve as the basis for implementing these numerical methods in 3D. We started discussions / cooperation projects with Quentin Mérigot (MOKAPLAN project).

4.2. Fabrication

Our work around fabrication and additive manufacturing finds applications in different fields. Our algorithms for fast geometric computations on solids (boolean operations, morphological operations) are useful to model a variety of shapes, from mechanical engineering parts to prosthetics for medical applications. Our by-example techniques allow for simpler modeling and processing of very intricate geometries and therefore also find applications in art and design, for unusual shapes that would be very difficult to obtain otherwise. Extensions of these techniques also find applications for reproducing naturally occurring microstructures from a scanned sample.

5. Highlights of the Year

5.1. Highlights of the Year

In February 2018, Sylvain Lefebvre created the MFX team (Matter from Graphics). The new team will focus on synthesizing and designing complex shapes for additive manufacturing.

5.1.1. Awards

Jérémie Dumas, who was advised by Sylvain Lefebvre within the ALICE team, received the 2018 PhD prize from IG-RV https://prixigrv2018.sciencesconf.org/.

6. New Software and Platforms

6.1. Graphite

Graphite: The Numerical Geometry Workbench
KEYWORDS: 3D modeling - Numerical Geometry - Texturing - Lighting - CAD - Visualization
SCIENTIFIC DESCRIPTION: Graphite is an experimental 3D modeler, built on top of the Geogram programming library. It has data structures and efficient OpenGL visualization for pointsets, surfacic meshes (triangles and polygons), volumetric meshes (tetrahedra and hybrid meshes). It has state-of-the-art mesh repair, remeshing, reconstruction algorithms. It also has an interface to the Tetgen tetrahedral mesh generator (by Hang Si). This year, Graphite3 was released. It is a major rewrite, based on Geogram, with increased software quality standards (zero warnings on all platforms, systematic documentation of all classes / all functions / all parameters, dramatically improved performances). It embeds Geogram (and optionally Vorpaline) with an easy-to-use Graphic User Interface.
FUNCTIONAL DESCRIPTION: Graphite is a dedicated software platform in numerical geometry that enables, among other things, 3D modelling and texture baking.

- Participants: Bruno Lévy, David Lopez, Dobrina Boltcheva, Jeanne Pellerin, Nicolas Ray and Samuel Hornus
- Contact: Bruno Lévy
- URL: http://alice.loria.fr/software/graphite

6.2. GEOGRAM

GEOGRAM : A functions library for geometric programming
KEYWORD: 3D modeling
FUNCTIONAL DESCRIPTION: GEOGRAM is a programming library with a set of basic geometric algorithms, such as search data structures (AABB tree, Kd tree), geometric predicates, triangulations (Delaunay triangulation, Regular triangulation), intersection between a simplicial mesh and a Voronoi diagram (restricted Voronoi diagram). GEOGRAM also includes a code generator for predicates (PCK: Predicate Construction Kit) and an efficient implementation of expansion arithmetics in arbitrary precision. GEOGRAM is shipped with WARPDRIVE, the first program that computes semi-discrete optimal transport in 3D.

- Participant: Bruno Lévy
- Contact: Bruno Lévy
- URL: http://alice.loria.fr

6.3. OpenNL

Open Numerical Library
KEYWORDS: 3D modeling - Numerical algorithm
FUNCTIONAL DESCRIPTION: Open Numerical Library is a library for solving sparse linear systems, especially designed for the Computer Graphics community. The goal for OpenNL is to be as small as possible, while offering the subset of functionalities required by this application field. The Makefiles of OpenNL can generate a single .c + .h file, very easy to integrate in other projects. The distribution includes an implementation of the Least Squares Conformal Maps parameterization method.

RELEASE FUNCTIONAL DESCRIPTION: Latest version available as part of GEOGRAM:
∗ OpenMP parallel solver
∗ more compact data structures, X2 acceleration

∗ SuperLU weak coupling (dynamically loads SuperLU .so if available)

- Participants: Bruno Lévy, Nicolas Ray and Rhaleb Zayer
- Contact: Bruno Lévy
- URL: http://alice.loria.fr/index.php/software/4-library/23-opennl.html

6.4. IceSL

KEYWORD: Additive manufacturing
FUNCTIONAL DESCRIPTION: IceSL allows to model complex shapes through CSG boolean operations. Objects can be directly prepared and sent to a 3d printer for fabrication, without the need to compute an intermediate 3D mesh.

- Participants: Frédéric Claux, Jean Hergel, Jérémie Dumas, Jonas Martinez-Bayona, Samuel Hornus and Sylvain Lefebvre
- Contact: Sylvain Lefebvre
- URL: http://shapeforge.loria.fr/icesl/

6.5. LibSL

Simple Library For Graphics
KEYWORDS: 3D - Graphics
FUNCTIONAL DESCRIPTION: LibSL is a toolbox for rapid prototyping of computer graphics algorithms, under both OpenGL, DirectX 9 - 10, Windows and Linux.

- Participant: Sylvain Lefebvre
- Contact: Sylvain Lefebvre

6.6. 3DPrintScaffoldings

KEYWORDS: 3D - 3D modeling - Additive manufacturing
FUNCTIONAL DESCRIPTION: Support generation for additive manufacturing. Optimizes scaffolding made of vertical pillars and horizontal bars that are optimized to use minimal material, be easily removed and support the part at all stages of the fabrication process.

- Participants: Jean Hergel, Jérémie Dumas and Sylvain Lefebvre
- Partner: Université de Lorraine
- Contact: Sylvain Lefebvre
- URL: http://shapeforge.loria.fr/icesl/

6.7. VORPALINE

VORPALINE mesh generator
KEYWORDS: 3D modeling - Unstructured heterogeneous meshes
FUNCTIONAL DESCRIPTION: VORPALINE is a surfacic and volumetric mesh generator, for simplicial meshes (triangles and tetrahedra), for quad-dominant and hex-dominant meshes.

- Participant: Bruno Lévy
- Contact: Bruno Lévy
- URL: http://alice.loria.fr/index.php/erc-vorpaline.html

7. New Results

7.1. Hex-dominant meshing: Mind the gap!

Participants: Nicolas Ray, Dmitry Sokolov, Maxence Reberol, Franck Ledoux, Bruno Lévy.

We proposed a robust pipeline that can generate hex-dominant meshes from any global parameterization of a tetrahedral mesh (Figure 1). We focus on robustness in order to be able to benchmark different parameterizations on a large database. Our main contribution is a new method that integrates the hexahedra (extracted from the parameterization) into the original object. The main difficulty is to produce the boundary of the result, composed of both faces of hexahedra and tetrahedra. Obviously, this surface must be a good approximation of the original object but, more importantly, it must be possible to remesh the volume bounded by this surface minus the extracted hexahedra (called void). We enforce these properties by carefully tracking and eliminating all possibilities of failure at each step of our pipeline.

We tested our method on a large collection of objects (200+) with different settings. In most cases, we obtained results of very good quality as compared to the state-of-the-art solutions.

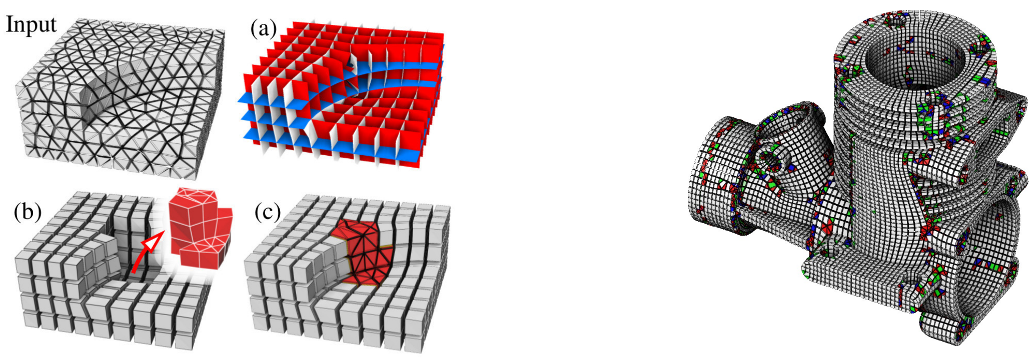

*Figure 1. Our hexahedral-dominant meshing procedure: Start from an input tetrahedral mesh. Compute a global parameterization **(a)**. Extract hexahedra by contouring the isovalues of the parameterization. Isolate the boundary of the void (in red), i.e., the volume with a degenerate / singular parameterization **(b)** (also called "gap" or "cavity"), shown in red. Remesh the void and stitch it into the hexahedral mesh **(c)**.*

7.2. Meshless Voronoi on the GPU

Participants: Nicolas Ray, Dmitry Sokolov, Sylvain Lefebvre, Bruno Lévy.

We proposed a GPU algorithm that computes a 3D Voronoi diagram (Figure 2). Our algorithm is tailored for applications that solely make use of the geometry of the Voronoi cells, such as Lloyd's relaxation used in meshing, or some numerical schemes used in fluid simulations and astrophysics. Since these applications only require the geometry of the Voronoi cells, they do not need the combinatorial mesh data structure computed by the classical algorithms (Bowyer-Watson). Thus, by exploiting the specific spatial distribution of the point-sets used in this type of applications, our algorithm computes each cell independently, in parallel, based on its nearest neighbors. In addition, we show how to compute integrals over the Voronoi cells by decomposing them on the fly into tetrahedra, without needing to compute any combinatorial information. The advantages of our algorithm is that it is fast, very simple to implement, has constant memory usage per thread and does not need any synchronization primitive. These specificities make it particularly efficient on the GPU: it gains one order of magnitude as compared to the fastest state-of-the-art multicore CPU implementations. To ease the reproducibility of our results, the full documented source code is included in the supplemental material.

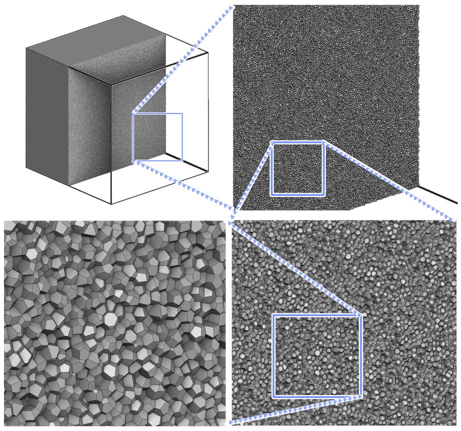

Figure 2. The 3D Voronoi diagram of 10 million points computed on the GPU in 800 ms (NVidia V100). We do not compute the tetrahedra, but in terms of equivalent computation speed, this corresponds to 84 million Delaunay tetrahedra per second.

7.3. Computational Optimal Transport

Participants: Bruno Lévy, Erica Schwindt.

We continued working on Optimal Transportation and its applications in fluid simulation and astrophysics [21], [20]. We developed an efficient and robust algorithm to compute Laguerre diagrams and intersections with tetrahedralized domains, that is, the geometric structure involved in a specific form of optimal transport that we are interested in. In addition, we developed an efficient parallel algorithm to compute Laguerre diagrams, with the possibility of handling periodic boundaries (3-torus), that is to say that the domain is a unit cube with opposite faces that are identified (if one leaves the domain from the left, it enters the domain from the right, etc..., like in the PacMan game). Such a topology is interesting for some simulations in astrophysics, or in material science, that consider a huge domain with homogeneous behavior and replace it with a tiny fraction and periodic boundary conditions (equivalent to a periodic material). We made the algorithms available in the geogram programming library (http://alice.loria.fr/software/geogram/doc/html/index.html). In cooperation with Roya Mohayaee (Institut d'Astrophysique de Paris) and Jean-Michel Alimi (Observatoire de Paris), we started applying the method to some inverse problems in astrophysics (Early Universe Reconstruction), that is reconstructing the past history of the universe from a 3D map of the galaxy clusters. Under some simplifying assumptions, the problem is precisely an instance of semi-discrete optimal transport that our algorithm solves efficiently. Our algorithm does the computation on a desktop PC within hours for several tenths of million points. With Quentin Merigot and Hugo Leclerc (U. Paris Sud), we are designing a new algorithm with the aim of scaling up to billions points (as requested by our astrophysicist colleagues).

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. EXPLORAGRAM

Inria exploratory project EXPLORAGRAM (in cooperation with MOKAPLAN): We explored new algorithms for computational optimal transport. The project allowed us to hire a post-doc for 18 months (Erica Schwindt).

She worked on the semi-discrete algorithm, and its application to the simulation of fluid-structure interactions. The project allowed to strengthen the cooperation with MOKAPLAN. It also allowed us to start exploring new cooperations, with Institut d'Astrophysique de Paris, on early universe reconstruction. The results were published in [7].

8.1.2. ANR MAGA (2016-2020)

We participate in the ANR MAGA (ANR-16-CE40-0014) on the Monge Ampere equation and computational geometry. In this ANR project, we cooperate with Quentin Merigot and other researchers of the MOKAPLAN Inria team on new computational methods for optimal transport.

8.1.3. ANR ROOT (2016-2020)

We participate in the Young Researcher ANR ROOT (ANR-16-CE23-0009) on Optimal Transport for computer graphics, with Nicolas Bonneel (CNRS Lyon) as Principal Investigator. In the context of this project, we develop a new symmetric algorithm for semi-discrete optimal transport that optimizes for both the location of the samples and their Lagrange multipliers. An ENS training period will start in Jan. 2018 (Agathe Herrou), hosted in Nancy.

8.2. International Research Visitors

8.2.1. Visits of International Scientists

Oleksandr Bondarenko (KPI, Ukraine) visited the team from 19 October 2018 to 30 October 2018. The goal of the visit was to work on pendulum stabilization.

8.2.2. Visits to International Teams

8.2.2.1. Sabbatical programme

Dmitry Sokolov visited Kuban State University (Russia) from 1 August 2018 to 31 August 2018 for his CNRS sabbatical programme. As a result, two papers are being prepared for Mechantronics 2019 submission.

9. Dissemination

9.1. Promoting Scientific Activities

9.1.1. Scientific Events Organisation

9.1.1.1. Members of Organizing Committees

The team contributed to the "Journées Jeunes Chercheurs 2018", organized by the GdR Informatique Mathématique.

9.1.2. Scientific Events Selection

9.1.2.1. Chair of Conference Program Committees

Bruno Lévy was program co-chair of Computer Graphics International 2018

9.1.2.2. Member of the Conference Program Committees

Bruno Lévy was IPC member of Eurographics 2018, SGP 2018, GMP 2018

9.1.2.3. Reviewer

Members of the team were reviewers for Eurographics, SIGGRAPH, SIGGRAPH Asia, Computer Aided Design, ISVC, Pacific Graphics, and SPM.

9.1.3. Journal

9.1.3.1. Member of Editorial Boards

- B. Lévy is a member of the editorial board of ACM Transactions on Graphics.
- B. Lévy is a member of the editorial board of Graphical Models (Elsevier)
- B. Lévy is a member of the editorial board of Computer Graphics and Applications

9.1.3.2. Reviewer - Reviewing Activities

Members of the team were reviewers for Computer Aided Design (CAD), Discrete Applied Mathematics (Elsevier), Transactions on Visualization and Computer Graphics (IEEE), and Computers & Graphics (Elsevier).

9.1.4. Invited Talks

Bruno Lévy gave an invited course at Symposium of Geometry Processing 2018 on Numerical Optimal Transport.

9.1.5. Popularization

Dmitry Sokolov participated in the Bett Show, one of the largest gatherings of the education community, and gave STEM popularization talk in front of a general public.

9.2. Teaching - Supervision - Juries

9.2.1. Teaching

Master : Bruno Lévy, Numerical Geometry, 12h, M2, ENSG

Licence : Dobrina Boltcheva, Infographie 3D, 30h, 3A, IUT Saint-Dié-des-Vosges

Licence : Dobrina Boltcheva, Advanced Object Oriented Programming & UML, 60h, 2A, IUT Saint-Dié-des-Vosges

Licence : Dobrina Boltcheva, Advanced algorithmics, 50h, 2A, IUT Saint-Dié-des-Vosges

Licence : Dobrina Boltcheva, Image Processing, 30h, 2A, IUT Saint-Dié-des-Vosges

Licence : Dobrina Boltcheva, UML Modeling, 20h, 1A, IUT Saint-Dié-des-Vosges

Licence : Dmitry Sokolov, C++, 40h, 2A, University of Lorraine

Licence : Dmitry Sokolov, Programming, 30h, 1A, University of Lorraine

Licence : Dmitry Sokolov, Logic, 30h, 3A, University of Lorraine

Master : Dmitry Sokolov, Logic, 22h, M1, University of Lorraine

Master : Dmitry Sokolov, 3D printing, 12h, M2, University of Lorraine

Master : Dmitry Sokolov, Numerical modeling, 12h, M2, University of Lorraine

10. Bibliography

Major publications by the team in recent years

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[2] J. Martínez, J. Dumas, S. Lefebvre, L.-Y. Wei. *Structure and Appearance Optimization for Controllable Shape Design*, in "ACM Trans. Graph.", October 2015, vol. 34, n° 6, pp. 229:1–229:11, http://doi.acm.org/10.1145/2816795.2818101

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[4] D. SOKOLOV, N. RAY, L. UNTEREINER, B. LÉVY. *Hexahedral-Dominant Meshing*, in "ACM Transactions on Graphics", 2016, vol. 35, n^o 5, pp. 1 - 23 [*DOI :* 10.1145/2930662], https://hal.inria.fr/hal-01397846

Publications of the year

Doctoral Dissertations and Habilitation Theses

[5] M. REBEROL. *Hex-dominant meshes : generation, simulation and evaluation*, Université de Lorraine, March 2018, https://tel.archives-ouvertes.fr/tel-01771056

Articles in International Peer-Reviewed Journals

[6] C. DAI, C. C. WANG, C. WU, S. LEFEBVRE, G. FANG, Y.-J. LIU. *Support-free volume printing by multi-axis motion*, in "ACM Transactions on Graphics", July 2018, vol. 37, n^o 4, pp. 1 - 14 [*DOI :* 10.1145/3197517.3201342], https://hal.inria.fr/hal-01887571

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[10] I. RYADCHIKOV, S. SECHENEV, M. DROBOTENKO, A. SVIDLOV, P. VOLKODAV, R. VISHNYKOV, D. SOKOLOV, E. NIKULCHEV. *Stabilization system of a bipedal non-anthropomorphic robot AnyWalker*, in "Journal of Engineering Science and Technology Review", August 2018, https://hal.inria.fr/hal-01927623

International Conferences with Proceedings

[11] N. RAY, D. SOKOLOV, M. REBEROL, F. LEDOUX, B. LÉVY. *Hex-dominant meshing: mind the gap!*, in "SPM 2018 - International Conference on Solid and Physical Modeling", Bilbao, Spain, June 2018, https://hal.inria.fr/hal-01927557

[12] I. RYADCHIKOV, D. SOKOLOV, A. BIRYUK, S. SECHENEV, A. SVIDLOV, P. VOLKODAV, Y. MAMELIN, K. POPKO, E. NIKULCHEV. *Stabilization of a hopper with three reaction wheels*, in "ISR 2018 - 50th International Symposium on Robotics", Munich, Germany, June 2018, https://hal.inria.fr/hal-01927624

Other Publications

[13] S. LEFEBVRE, L.-Y. WEI, C. BARNES. *Informational Texture Synthesis*, March 2018, working paper or preprint, https://hal.inria.fr/hal-01706539

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