



IN PARTNERSHIP WITH:
CNRS

**Institut polytechnique de
Grenoble**

Université de Grenoble Alpes

Activity Report 2018

Project-Team IMAGINE

Intuitive Modeling and Animation for
Interactive Graphics & Narrative Environments

IN COLLABORATION WITH: Laboratoire Jean Kuntzmann (LJK)

RESEARCH CENTER
Grenoble - Rhône-Alpes

THEME
Interaction and visualization

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Project-Team IMAGINE

Creation of the Team: 2012 January 01, updated into Project-Team: 2013 January 01

Keywords:

Computer Science and Digital Science:

- A5. - Interaction, multimedia and robotics
- A5.5. - Computer graphics
 - A5.5.1. - Geometrical modeling
 - A5.5.3. - Computational photography
 - A5.5.4. - Animation
- A5.6. - Virtual reality, augmented reality
- A5.7. - Audio modeling and processing
- A9.3. - Signal analysis

Other Research Topics and Application Domains:

- B2. - Health
 - B2.2. - Physiology and diseases
- B3. - Environment and planet
 - B3.3. - Geosciences
- B5. - Industry of the future
 - B5.2. - Design and manufacturing
 - B5.7. - 3D printing
- B9.1. - Education
 - B9.2.2. - Cinema, Television
 - B9.2.3. - Video games
 - B9.2.4. - Theater
- B9.6.6. - Archeology, History

1. Team, Visitors, External Collaborators

Research Scientists

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- Frédéric Devernay [Inria, Researcher, until Sep 2018]
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Post-Doctoral Fellow

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- Guillaume Cordonnier [Univ. Grenoble Alpes, until Sep 2018]

Pablo Coves [Univ Grenoble Alpes, until Mar 2018]
Amelie Fondevilla [Univ Grenoble Alpes]
Qianqian Fu [Univ Grenoble Alpes, from Nov 2018]
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Geoffrey Guingo [Institut polytechnique de Grenoble]
Youna Le Vaou [Cifre PSA]
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Sandra Nabil Mahrous Yacoub [Inria, until Nov 2018]

Technical staff

Maguelonne Beaud de Brive [Inria, until Nov 2018]
Rémi Colin de Verdière [Inria, from Oct 2018]
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Interns

Sami Chibane [Inria, from Feb 2018 until Jul 2018]
Rémi Colin de Verdière [Inria, from Feb 2018 until Jul 2018]
Maxime Isnel [Inria, from Jun 2018 until Sep 2018]
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Administrative Assistant

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Visiting Scientist

David Jourdan [Inria, from Jun 2018 until Jul 2018]

2. Overall Objectives

2.1. Context

With the fast increase of computational power and of memory space, increasingly complex and detailed 3D content is expected for virtual environments. Unfortunately, 3D modeling methodologies did not evolve as fast: most users still use standard CAD or 3D modeling software (such as Maya, 3DS or Blender) to design each 3D shape, to animate them and to manually control cameras for movie production. This is highly time consuming when large amounts of detailed content need to be produced. Moreover the quality of results is fully left in the user's hand, which restricts applicability to skilled professional artists. More intuitive software such as Z-Brush are restricted to shape design and still require a few months for being mastered by sculpture practitioners. Reducing user load can be done by capturing and re-using real objects or motions, at the price of restricting the range of possible content. Lastly, procedural generation methods can be used in specific cases to automatically get some detailed, plausible content. Although they save user's time, these procedural methods typically come at the price of control: indirect parameters need to be tuned during a series of trial and errors until the desired result is reached. Stressing that even skilled digital artists tend to prefer pen and paper than 3D computerized tools during the design stages of shapes, motion, and stories, Rob Cook, vice president of technology at Pixar animation studios notoriously stated (key-note talk, Siggraph Asia 2009): *new grand challenge in Computer Graphics is to make tools as transparent to the artists as special effects were made transparent to the general public*. This remains true ten years later.

Could digital modeling be turned into a tool, even more expressive and simpler to use than a pen, to quickly convey and refine shapes, motions and stories? This is the long term vision towards which we would like to advance.

2.2. Scientific goals

The goal of the IMAGINE project is to develop **a new generation of models, algorithms and interactive environments for the interactive creation of animated 3D content and its communication through virtual cinematography.**

Our insight is to revisit models for shapes, motion, and narration from a user-centred perspective, i.e. to give models an intuitive, predictable behaviour from the user's view-point. This will ease both semi-automatic generation of animated 3D content and fine tuning of the results. The three main fields will be addressed:

1. **Shape design:** We aim to develop intuitive tools for designing and editing 3D shapes and their assemblies, from arbitrary ones to shapes that obey application-dependent constraints - such as, for instance, developable surfaces representing cloth or paper, or shape assemblies used for CAD of mechanical prototypes.
2. **Motion synthesis:** Our goal is to ease the interactive generation and control of 3D motion and deformations, in particular by enabling intuitive, coarse to fine design of animations. The applications range from the simulation of passive objects to the control of virtual creatures.
3. **Narrative design:** The aim is to help users to express, refine and convey temporal narrations, from stories to educational or industrial scenarios. We develop both virtual direction tools such as interactive storyboarding frameworks, and high-level models for virtual cinematography, such as rule-based cameras able to automatically follow the ongoing action and automatic film editing techniques.

In addition to addressing specific needs of digital artists, this research contributes to the development of new expressive media for 3D content. The long term goal would be to enable any professional or scientist to model and interact with their object of study, to provide educators with ways to quickly express and convey their ideas, and to give the general public the ability to directly create animated 3D content.

3. Research Program

3.1. Methodology

As already stressed, thinking of future digital modeling technologies as an Expressive Virtual Pen enabling to seamlessly design, refine and convey animated 3D content, leads to revisit models for shapes, motions and stories from a user-centered perspective. More specifically, inspiring from the user-centered interfaces developed in the Human Computer Interaction domain, we introduced the new concept of user-centered graphical models. Ideally, such models should be designed to behave, under any user action, the way a human user would have predicted. In our case, user's actions may include creation gestures such as sketching to draft a shape or direct a motion, deformation gestures such as stretching a shape in space or a motion in time, or copy-paste gestures to transfer some of the features from existing models to other ones. User-centered graphical models need to incorporate knowledge in order to seamlessly generate the appropriate content from such actions. We are using the following methodology to advance towards these goals:

- Develop high-level models for shapes, motion and stories that embed the necessary knowledge to respond as expected to user actions. These models should provide the appropriate handles for conveying the user's intent while embedding procedural methods that seamlessly take care of the appropriate details and constraints.
- Combine these models with expressive design and control tools such as gesture-based control through sketching, sculpting, or acting, towards interactive environments where users can create a new virtual scene, play with it, edit or refine it, and semi-automatically convey it through a video.

3.2. Validation

Validation is a major challenge when developing digital creation tools: there is no ideal result to compare with, in contrast with more standard problems such as reconstructing existing shapes or motions. Therefore, we had to think ahead about our validation strategy: new models for geometry or animation can be validated, as usually done in Computer Graphics, by showing that they solve a problem never tackled before or that they provide a more general or more efficient solution than previous methods. The interaction methods we are developing for content creation and editing rely as much as possible on existing interaction design principles already validated within the HCI community. We also occasionally develop new interaction tools, most often in collaboration with this community, and validate them through user studies. Lastly, we work with expert users from various application domains through our collaborations with professional artists, scientists from other domains, and industrial partners: these expert users validate the use of our new tools compared to their usual pipeline.

4. Application Domains

4.1. Visual arts

Our research can be applied to any situation where users need to create new, imaginary, 3D content. Our work should be instrumental, in the long term, for the visual arts, from the creation of 3D films and games to the development of new digital planning tools for theater or cinema directors. Our models can also be used in interactive prototyping environments for engineering. They can help promoting interactive digital design to scientists, as a tool to quickly express, test and refine models, as well as an efficient way for conveying them to other people. Lastly, we expect our new methodology to put digital modeling within the reach of the general public, enabling educators, media and other practitioners to author their own 3D content.

The diversity of users these domains bring, from digital experts to other professionals and novices, gives us excellent opportunities to validate our general methodology with different categories of users. Our ongoing projects in these various application domains are listed in Section 6.

- Sculpture.
- Modeling and animation for 3D films and games.
- Virtual cinematography and tools for theater directors.

4.2. Engineering

- Industrial design.
- Mechanical & civil engineering.

4.3. Natural sciences

- Geology.
- Virtual functional anatomy.

4.4. Education and creative tools

- Sketch-based teaching.
- Creative environments for novice users.
- Museography

5. Highlights of the Year

5.1. Highlights of the Year

This is a transition year where the team has been actively involved in starting new projects with new PhD students along new research directions, which will be further emphasized in the future team ANIMA, due to start after the termination of the IMAGINE team in July 2019.



Figure 1. Filming rehearsals of Jean-François Peyret's *La fabrique des monstres*, Théâtre de Vidy, Lausanne, January 2018.

We are now actively involved in the Performance Lab, a joint cross-disciplinary research program of IDEX Univ. Grenoble Alpes. In this new project started in January 2018 for three years, we will investigate "digital dramaturgies" mixing real-time computer graphics, augmented and virtual reality with live performances. We will also continue to develop our Kino Ai video capture, analysis and editing system.

As a follow-up to ADT ULTRAHD, we recorded three weeks of rehearsals from the play "La fabrique des monstres", a theatre adaptation of Mary Shelley's *Frankenstein* by Jean-François Peyret (Fig. 1). Our Kino Ai system was used to automatically generate six hours of cinematographic rushes from those recordings. Those rushes were edited by professional film editors into three short documentaries and published online (see [episode 1](#), [episode 2](#) and [episode 3](#) to watch the full movies).

5.1.1. Awards

In December 2018, PhD laureate Guillaume Cordonnier was awarded the prestigious ETH Zurich Postdoctoral Fellowship and will join the Computer Graphics Lab's simulation group in 2019.

5.1.2. Patents

As part of Youna Le Vaou's CIFRE PhD thesis with PSA, we filed a joint patent application:

Y La Vaou, S Masfrand, M Mika, S Hahmann, J-C Léon: Procédé de modification de la forme d'un objet virtuel tridimensionnel représenté dans un espace immersif et système immersif mettant en œuvre ledit procédé, December 2018.

This new result will also be submitted for publication at an international conference in 2019.

6. New Software and Platforms

6.1. MyCF

My Corporis Fabrica

KEYWORDS: 3D modeling - Simulation - Health - Ontologies - Anatomy - Patientspecific - Medical imaging

FUNCTIONAL DESCRIPTION: Knowledge-based 3D anatomical modeling using MyCF The MyCF software eases the creation of 3D anatomical models for visualization and mechanical simulation. As input, the user provides a list of anatomical entities or functions to simulate, using keywords or navigating in reference 3D model. As output, she gets a 3D model ready to visualize, or to simulate.

- Participants: Ali Hamadi Dicko, Federico Ulliana, François Faure and Olivier Palombi
- Partner: Université Joseph-Fourier
- Contact: Olivier Palombi

6.2. Kino AI

Artificial intelligence for cinematography

KEYWORDS: Video analysis - Post-production

FUNCTIONAL DESCRIPTION: Kino AI is an implementation of the method described in our patent "automatic generation of cinematographic rushes using video processing". Starting from a single ultra high definition (UltraHD) recording of a live performance, we track and recognize all actors present on stage and generate one or more rushes suitable for cinematographic editing of a movie.

- Partner: IIIT Hyderabad
- Contact: Rémi Ronfard
- Publications: [Multi-Clip Video Editing from a Single Viewpoint - Zooming On All Actors: Automatic Focus+Context Split Screen Video Generation](#)

6.3. Platforms

6.3.1. AANALYSIS

AANALYSIS is a platform developed from 2015 to 2018 as a module of the SALOME platform and as a plugin of SHAPER (a software under development by EDF, CEA and OpenCascade). It processes CAD assemblies to derive symmetry properties, similarities of solids and groups of solids, interface features between solids and is operational on industrial models. The plugin version implements a shape similarity selection feature. The module is connected with a knowledge database MyProductFabrica developed in our group in partnership with GraphiK Inria team. It enables the automatic generation/annotation of functional knowledge from 3D geometry using 350 concepts, 90 relations and more than 100 inferences.

6.3.2. RUMBA

RUMBA is a next-generation 3D animation software targeted to professional animation studios, developed jointly by Mercenaries Engineering, TEAMTO and IMAGINE. Development was funded in part by FUI projects COLLODI 1 and COLLODI 2. RUMBA has been used in production by TEAMTO since 2017. RUMBA will be made commercially available to other animation studio by Mercenaries Engineering in 2019. We are using RUMBA as a platform for developing new algorithms in sketch-based animation, based on our previous work during Martin Guay's PhD thesis. This includes many improvements to allow those methods to work in a professional workflow.

6.3.3. SKY ENGINE

Sky Engine is a realtime game engine developed by Maxime Garcia as part of his PhD thesis, which incorporates several shape modeling and animation tools developed within the team. It is hoped that it will supersede Expressive as a platform for future integration of research results of the team involving real-time, story-driven shape modeling, animation and cinematography.

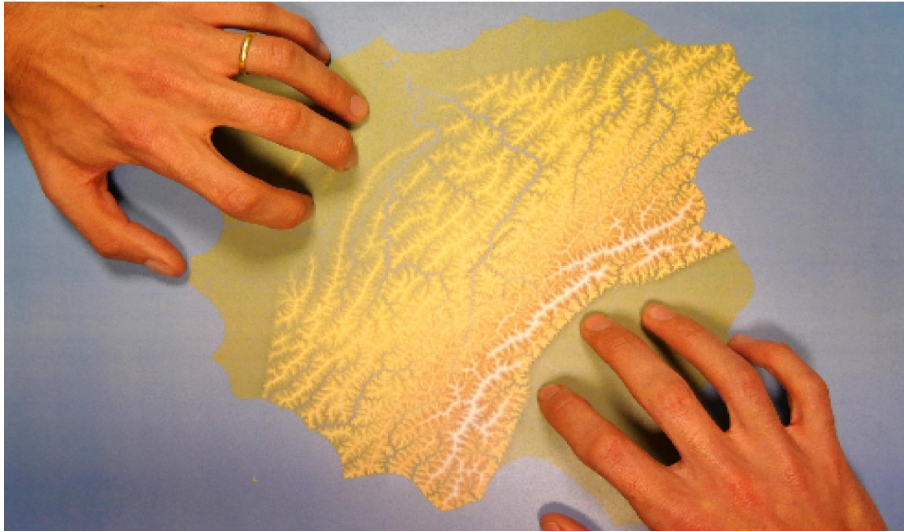


Figure 2. *Sculpting Mountains: Interactive Terrain Modeling Based on Subsurface Geology*

7. New Results

7.1. Sculpting Mountains: Interactive Terrain Modeling Based on Subsurface Geology

Most mountain ranges are formed by the compression and folding of colliding tectonic plates. Subduction of one plate causes large-scale asymmetry while their layered composition (or stratigraphy) explains the multi-scale folded strata observed on real terrains. As part of Guillaume Cordonnier's PhD thesis, we introduced a novel interactive modeling technique to generate visually plausible, large scale terrains that capture these phenomena (illustrated in Fig. 2). Our method draws on both geological knowledge for consistency and on sculpting systems for user interaction. The user is provided hands-on control on the shape and motion of tectonic plates, represented using a new geologically-inspired model for the Earth crust. The model captures their volume preserving and complex folding behaviors under collision, causing mountains to grow. It generates a volumetric uplift map representing the growth rate of subsurface layers. Erosion and uplift movement are jointly simulated to generate the terrain. The stratigraphy allows us to render folded strata on eroded cliffs. We validated the usability of our sculpting interface through a user study, and compare the visual consistency of the earth crust model with geological simulation results and real terrains.

7.2. Exploratory design of mechanical devices with motion constraints

Mechanical devices are ubiquitous in our daily lives, and the motion they are able to transmit is often a critical part of their function. While digital fabrication devices facilitate their realization, motion-driven mechanism design remains a challenging task. We take drawing machines as a case study in exploratory design. Devices such as the Spirograph can generate intricate patterns from an assembly of simple mechanical elements. Trying to control and customize these patterns, however, is particularly hard, especially when the number of parts increases. We propose a novel constrained exploration method that enables a user to easily explore feasible drawings by directly indicating pattern preferences at different levels of control. This is (illustrated in Fig. 3). The user starts by selecting a target pattern with the help of construction lines and rough sketching, and

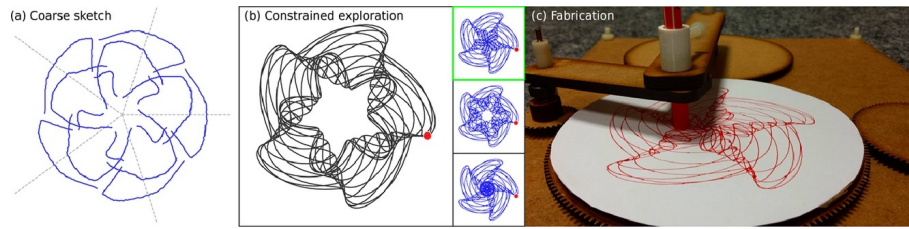


Figure 3. Exploratory design of mechanical devices with motion constraints. (a) The user first selects a mechanically feasible drawing by providing a rough sketch. (b) The user is then able to interactively explore local alternatives (b) by defining visual constraints directly on the pattern (here, the cusp position). (c) The resulting machine is automatically exported to laser cutter profiles for fabrication.

then fine-tunes it by prescribing geometric features of interest directly on the drawing. The designed pattern can then be directly realized with an easy-to-fabricate drawing machine. The key technical challenge is to facilitate the exploration of the high dimensional configuration space of such fabricable machines. To this end, we propose a novel method that dynamically reparameterizes the local configuration space and allows the user to move continuously between pattern variations, while preserving user-specified feature constraints. We tested our framework on several examples, conducted a user study, and fabricated a sample of the designed examples.

7.3. Automatic Generation of Geological Stories from a Single Sketch

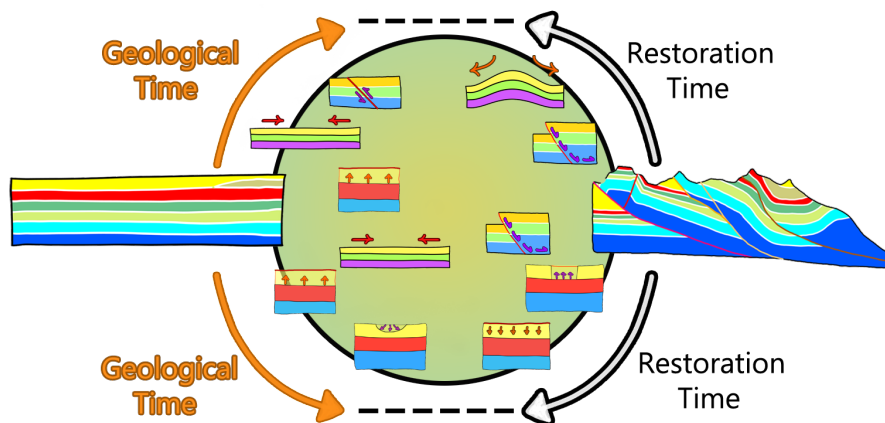


Figure 4. Automatic Generation of Geological Stories from a Single Sketch. From left to right, the original terrain from several million years ago undergoes events that will transform it to its current state. From right to left, the current terrain is restored and undergoes undo events that will transform it back to its original state.

Describing the history of a terrain from a vertical geological cross-section is an important problem in geology, called geological restoration. Designing the sequential evolution of the geometry is usually done manually, involving many trials and errors. In this work, we recast this problem as a storyboarding problem, where the different stages in the restoration are automatically generated as storyboard panels and displayed as

geological stories. Our system allows geologists to interactively explore multiple scenarios by selecting plausible geological event sequences and backward simulating them at interactive rate, causing the terrain layers to be progressively un-deposited, un-eroded, un-compacted, unfolded and un-faulted. Storyboard sketches are generated along the way. When a restoration is complete, the storyboard panels can be used for automatically generating a forward animation of the terrain history, enabling quick visualization and validation of hypotheses. As a proof-of-concept, we describe how our system was used by geologists to restore and animate cross-sections in real examples at various spatial and temporal scales and with different levels of complexity, including the Chartreuse region in the French Alps.

7.4. 3D Shape Decomposition and Sub-parts Classification

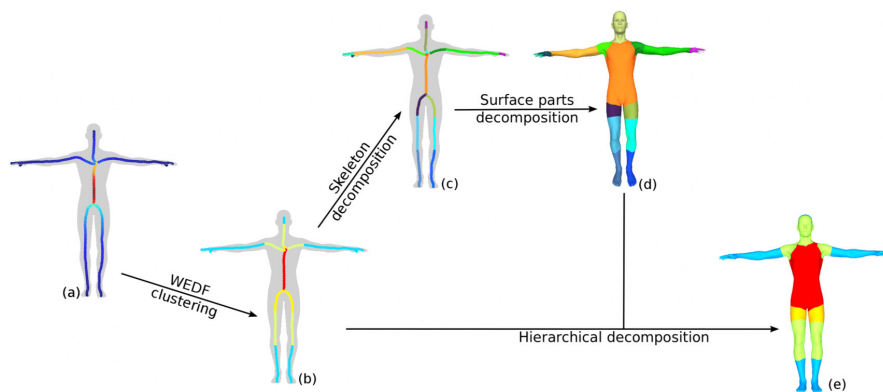


Figure 5. 3D Shape Decomposition and Sub-parts Classification. Starting from a 3D shape and its curve skeleton, we compute a new measure called WEDF on the curve skeleton (a) and, by clustering WEDF values, we decompose the skeleton into hierarchical parts (b). To each connected part on the skeleton –shown with a different color (c)– a connected region of the surface mesh is assigned (d). Then, a saliency value according to the hierarchy is assigned to each corresponding surface part (e) –parts of same importance get a similar color.

This paper (illustrated in Fig. 5) introduces a measure of significance on a curve skeleton of a 3D piecewise linear shape mesh, allowing the computation of both the shape's parts and their saliency. We begin by reformulating three existing pruning measures into a non-linear PCA along the skeleton. From this PCA, we then derive a volume-based saliency measure, the 3D WEDF, that determines the relative importance to the global shape of the shape part associated to a point of the skeleton. First, we provide robust algorithms for computing the 3D WEDF on a curve skeleton, independent on the number of skeleton branches. Then, we cluster the WEDF values to partition the curve skeleton, and coherently map the decomposition to the associated surface mesh. Thus, we develop an unsupervised hierarchical decomposition of the mesh faces into visually meaningful shape regions that are ordered according to their degree of perceptual saliency. The shape analysis tools introduced in this paper are important for many applications including shape comparison, editing, and compression.

7.5. Interactive Generation of Time-evolving, Snow-Covered Landscapes with Avalanches

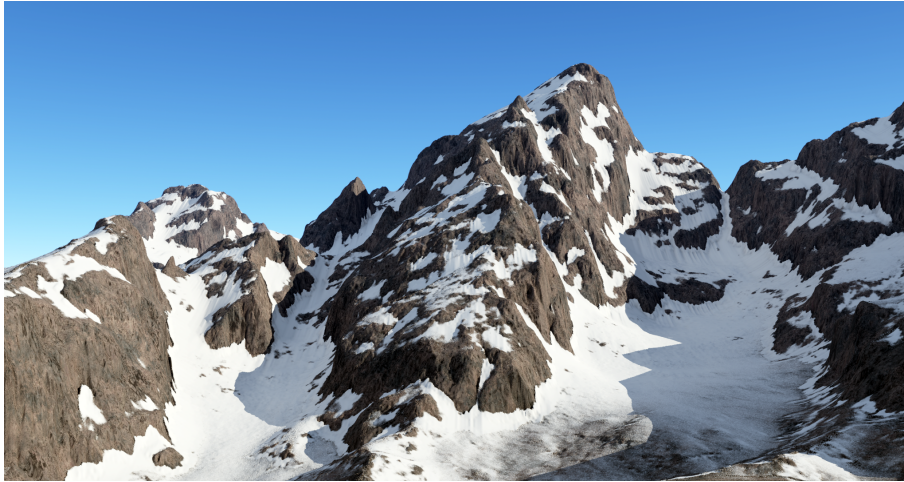


Figure 6. Interactive Generation of Time-evolving, Snow-Covered Landscapes with Avalanches

As part of Guillaume Cordonnier's PhD thesis, we also introduced a novel method for interactive generation of visually consistent, snow-covered landscapes, which provides control of their dynamic evolution over time. Our main contribution (illustrated in Fig. 6) was the real-time phenomenological simulation of avalanches and other user-guided events, such as tracks left by Nordic skiing, which can be applied to interactively sculpt the landscape. The terrain is modeled as a height field with additional layers for stable, compacted, unstable, and powdery snow, which behave in combination as a semi-viscous fluid. We incorporate the impact of several phenomena, including sunlight, temperature, prevailing wind direction, and skiing activities. The snow evolution includes snow-melt and snowdrift, which affect stability of the snow mass and the probability of avalanches. A user can shape landscapes and their evolution either with a variety of interactive brushes, or by prescribing events along a winter season time-line. Our optimized GPU-implementation allows interactive updates of snow type and depth across a large (10×10 km) terrain, including real-time avalanches, making this suitable for visual assets in computer games. We evaluated our method through perceptual comparison against existing methods and real snow-depth data.

8. Bilateral Contracts and Grants with Industry

8.1. Bilateral Contracts with Industry

We have an ongoing contract with EDF R & D Saclay (Raphael Marc) on "Shape analysis of mechanical assemblies and their components". This has funded the work of Harold Vilmar until August 2018. The project has been renewed for 2019 and is funding the development of the AANALYSIS software (Jean-Claude Léon).

8.2. Bilateral Grants with Industry

We have an ongoing CIFRE PhD contract with PSA on the topic of aesthetic shape modeling in immersive virtual reality environments, which is funding the PhD of Youna Le Vaou.

9. Partnerships and Cooperations

9.1. Regional Initiatives

9.1.1. Performance Lab (January 2018 - June 2021)

Participants: Rémi Ronfard, Qianqian Fu, Mélina Skouras, Maxime Garcia, Pierre Casati, Vaishnavi Ameya Murukutla, Rémi Colin de Verdière.

Performance Lab is a cross-disciplinary project (CDP) by IDEX Univ. Grenoble Alpes, started in January 2018, which is funding the Phd thesis of Qianqian Fu.

Conceived as an international platform, the Performance Lab brings together a community of researchers who are exploring contemporary issues that link embodiment, society and technology. The ambition of the project is to renew the ways in which research is conceived and practiced at Univ. Grenoble Alpes by developing new methods inspired by Anglo-Saxon notions of Performance as Research (PAR), research creation, practice-led and based research.

As part of the Performance Lab, tIMAGINE is actively involved in the research group on "digital dramaturgies" co-led by Remi Ronfard and Julie Valero.

9.2. National Initiatives

9.2.1. InriaHub ADT Kino Ai (October 2018-September 2020)

Participants: Rémi Ronfard, Rémi Colin de Verdière, Qianqian Fu.

This two-year contract is a follow up to the one-year InriaHub ULTRAHD project which was successfully completed in December 2017. Kino Ai is a joint research project of the IMAGINE team at Inria Grenoble Alpes, and the Performance Lab at Univ. Grenoble Alpes. Following our previous work in "multiclip video editing" and "Split Screen Video Generation", we are working to provide a user-friendly environment for editing and watching ultra-high definition movies online, with an emphasis on recordings of live performances.

The code from Vineet Gandhi's PhD thesis was entirely re-designed for supporting ultra high definition video. The software was extensively tested in 2017 on a large dataset of 4K video recordings of theatre rehearsals, in collaboration with the Litt&Arts team at Univ. Grenoble Alpes, theatre director Jean-Francois Peyret in Paris, Theatre de l'Hexagone in Meylan and Theatre de Vidy in Lausanne. The goal of the Kino AI ADT is to allow the Kino Ai python code to run in a web server, and to provide a redesigned user interface (in javascript) running on a web client. The user interface will be designed, tested and evaluated with the Litt&Arts team at Univ. Grenoble Alpes, as part of CDP project Performance Lab.

9.2.2. FUI LIVE360 TV(December 2015 - December 2018)

Participants: Frédéric Devernay, Sandra Nabil Mahrous Yacoub.

L'objectif de ce projet collaboratif est de développer une solution bout-en-bout pour la création « live », la diffusion et la restitution d'audio/vidéo 360° multi-écrans, et ce avec une qualité répondant aux exigences du marché « broadcast ».

Ce projet est né sous l'impulsion d'un consortium formé de PME (Arkamys, ATEME, Aviwest et Kolor) et de laboratoires (Inria et Télécom ParisTech). Il bénéficie du programme FUI19, le Fonds Unique Interministériel. This 3-year contract with industrial partners Arkamys, ATEME, Aviwest et Kolor (now GoPRO) was dedicated to creating an end-to-end solution for recording and broadcasting immersive multi-screen 360 degree audio/video movies with a professional quality.

The project has funded the PhD thesis of Sandra Nabil. It was completed in November 2018, with the Phd defense of Sandra Nabil and the closing FUI project meeting.

9.2.3. *FUI Collodi 2 (December 2016 - April 2019)*

Participants: Rémi Ronfard, Maguelonne Beaud de Brive, Julien Daval.

This 2-year contract with two industrial partners: TeamTo and Mercenaries Engineering (software for production rendering), is a follow-up and a generalization of Dynam'it and Collodi 1. The goal is to propose an integrated software for the animation and final rendering of high-quality movies, as an alternative to the ever-ageing Maya. The project is funding 2 engineers for 2 years.

The project was extended for four additional months from January to April 2019 to allow extended expert evaluation of our sketch-based animation toolkit.

9.2.4. *FUI 3D-Oncochip (October 2018 - September 2021)*

Participants: Jean-Claude Léon, Musaab Khalid Osman Mohammed.

3D-Oncochip project is a collaboration with Microlight 3D, with the objective of fabricating nanoscale 3D microtumors, which are human biological models of real tumors. This 3-year contract is funding the postdoc position of Musaab Khalid Osman Mohammed.

9.2.5. *ANR E-ROMA (November 2017 - October 2020)*

Participants: Rémi Ronfard, Stefanie Hahmann, Pierre Casati.

The eRoma project aims at revisiting the digitization and virtual restoration of archaeological and fine arts artefacts by taking advantage of the sites from which they were retrieved and the eras they belong to. To do so, e-Roma will develop a new virtual representation both versatile and unified enough to be used for both restoration and animation of digitized artworks. Traditional cardboard models with a fixed and rigid representation will therefore be replaced by interactive dynamic virtual prototypes, to help restore statues and illustrate changes over time.

This 3-year contract is a joint project with GeoMod team at LIRIS and the musée gallo-romain in Lyon. The contract started in November 2017 and is funding the PhD thesis of Pierre Casati.

9.2.6. *ANR FOLD-DYN (November 2017 - October 2020)*

Participant: Thomas Buffet.

The FOLDDyn project (Field-Oriented Layered Dynamics animating 3D characters) proposes the study of new theoretical approaches for the effective generation of virtual characters deformations, when they are animated. These deformations are twofolds: character skin deformations (skinning) and garment simulations. We propose to explore the possibilities offered by a novel theoretical way of addressing character deformations: the implicit skinning. This method jointly uses meshes (the standard representation for 3D animations) and volumetric scalar functions (an unusual representation in this community).

This 3-year contract is a joint project with the University of Toulouse. The contract started in November 2017 and is funding the PhD thesis of Thomas Buffet.

9.2.7. *ANR ANATOMY2020 (November 2017 - October 2020)*

Participants: Olivier Palombi, Rémi Ronfard, Vaishnavi Ameva Murukutla.

Anatomy2020 aims at developing an innovative educational platform to facilitate learning of functional anatomy. This platform will integrate recent advances in computer graphics, human-computer interaction together with recent insights in educational and cognitive sciences to design and test optimal scenarios for anatomy learning. The approach is based on evidences that body movements could improve learning of different knowledge by “augmenting” or “enriching” traces in long-term memory. This “embodied” perspective is particularly relevant for learning of functional anatomy as the knowledge to acquire could be specifically related to the learner’s body in motion.

This 3-year contract is a joint project with TIMC (Computer-Assisted Medical Intervention team), Anatoscope, Gipsa-Lab (speech and cognition dept.), LIBM and LIG (Engineering Human-Computer Interaction team). The contract started in November 2017 and is funding the PhD thesis of Ameva Murukutla.

10. Dissemination

10.1. Promoting Scientific Activities

Remi Ronfard is a member of the selection committee for Inria-MCC (Ministry of Culture and Communication) activities.

Stefanie Hahmann is a member of the Comité d'Etudes Doctorales (CED) at Inria Grenoble.

10.1.1. Scientific Events Organisation

10.1.1.1. General Chair, Scientific Chair

Stefanie Hahmann was Program Chair of Conference Shape Modeling International (SMI18) held in Lisbon 2018.

10.1.1.2. Member of the Organizing Committees

Rémi Ronfard is a member of the steering committee for the Eurographics workshop on intelligence cinematography and editing (WICED).

Rémi Ronfard was a co-organizer of the international workshop Attention machine ! Pratiques artistiques et recyclages médiatiques at Univ. Grenoble Alpes in February 2018.

Stefanie Hahmann served in the International Program Committee for the Symposium on Solid and Physical Modeling (SPM18), Bilbao 2018

Jean-Claude Léon was a member of the program committee for the SPM 2018 conference.

10.1.2. Scientific Events Selection

10.1.2.1. Chair of Conference Program Committees

Mélina Skouras was the Poster Chair for ACM/Eurographics Symposium on Computer Animation 2018.

10.1.2.2. Member of the Conference Program Committees

Rémi Ronfard was a member of the Program Committees for Expressive 2018, International Conference on Interactive Storytelling (ICIDS) 2018, and Eurographics workshop on intelligence cinematography and editing (WICED) 2018.

Mélina Skouras was a member of the Program Committees for Eurographics 2018, Advances in Architectural Geometry 2018, Shape Modeling International 2018, and ACM/Eurographics Symposium on Computer Animation 2018.

10.1.2.3. Reviewer

Remi Ronfard was an external reviewer for Siggraph 2018 and Siggraph Asia 2018.

Jean-Claude Léon was a reviewer for the CAD 2018 conference.

10.1.3. Journal

10.1.3.1. Member of the Editorial Boards

Stefanie Hahmann is an Associate Editor of CAG (Computers and Graphics, Elsevier) and CAD (Computer Aided Design, Elsevier). She also was a guest Editor of the journal Computers and Graphics Vol. 74 (Elsevier): Special Issue on Shape Modeling International 2018,

Jean-Claude Léon is a member of the editorial board of the CAD journal.

10.1.3.2. Reviewer - Reviewing Activities

Rémi Ronfard was a reviewer for Siggraph 2018, Siggraph Asia 2018 and ACM transactions on Graphics (TOG).

Mélina Skouras was a reviewer for Siggraph Asia 2018 and ACM Transactions on Graphics.

Stefanie Hahmann was a reviewer for the journals CAD, Computers and Graphics,

10.1.4. Invited Talks

Mélina Skouras gave invited guest talks at Bellairs Workshop on Computer Animation, Fields Workshop on Robust Geometric Algorithms for Computational Fabrication, and Dagstuhl Seminar on Computational Aspects of Fabrication.

Remi Ronfard Remi Ronfard gave an invited talk on "Authoring and directing animated story worlds" at the national meeting of the GTAS (Groupe de Travail sur l'Animation et la Simulation) organized by GdR IG-RV (Informatique Géométrique et Graphique, Réalité Virtuelle et Visualisation) in Paris, July 2018.

10.1.5. Leadership within the Scientific Community

Stefanie Hahmann serves as a member of the Advisory Board (2014-2018) for the European Marie-Curie Training Network ARCADES.

Remi Ronfard and Julie Valéro (Litt & Arts, Univ. Grenoble Alpes) started a research group on Digital Dramaturgies as part of the Performance Lab, IDEX Univ. Grenoble Alpes (2018-2021). This research group is actively investigating (i) how contemporary dramaturgies represent digital worlds on stage; (ii) how contemporary dramaturgies use digital tools for writing and staging performances combining real actors with virtual actors and scenographies; and (iii) how contemporary dramaturgies can be digitally captured, indexed and analyzed for a better comprehension of the creative processes at work during pre-production and rehearsals. The research group is composed of researchers of Univ. Grenoble Alpes from multiple disciplines, i.e. literature, theatre, choreography, film studies, social sciences, geography, computer science and applied mathematics.

10.1.6. Scientific Expertise

Remi Ronfard was a member of the scientific committee of IMAGINOVE in 2018.

Remi Ronfard was a member of the scientific committee for EXPERIMENTA 2018.

10.1.7. Research Administration

Stefanie Hahmann is the head of the French working group "GTMG" (Groupe de travail en Modélisation Géométrique) part of the CNRS GDR IM and GDR IGRV.

10.2. Teaching - Supervision - Juries

10.2.1. Teaching

Licence : Stefanie Hahmann, Numerical Methods, Ensimag - Grenoble INP, 240 students, 3rd year Bachelor level, 42h,

Master : Stefanie Hahmann, Geometric Modeling, Ensimag - Grenoble INP, 60 students, Master 1st year, 47h.

Master : Stefanie Hahmann, Surface Modeling, Ensimag - Grenoble INP, 30 students, Master 2nd year, 51h.

Master : Rémi Ronfard, Advanced Computer Graphics, 18 HETD, M2, Univ. Grenoble Alpes, France

Master : Rémi Ronfard, Game Engine Programming, 18 HETD, M2, Univ. Montpellier, France

Licence : Mélina Skouras, Surface modeling, 14.5 HETD, Ensimag, Grenoble, France

Doctorate : Rémi Ronfard, Spatial Media, 90 HETD, ENSAD, Paris Sciences et Lettres (PSL), France

Stefanie Hahmann is co-responsible of the department MMIS (Images and Applied Maths) at Grenoble INP with 120 students. Stefanie Hahmann was also president of the jury for over 30 Masters (PFE) thesis defences in 2018.

Jean-Claude Léon is in charge of the module Mechanical Systems at Grenoble-INP ENSE3 (300 students, 64h, coordination of three courses).

Olivier Palombi is responsible for the French **Campus numérique** of anatomy. He is responsible and national leader of the project SIDES. All the French medical schools (43) have planned to use the same e-learning framework (SIDES) to manage evaluations and to create a large shared database of questions.

10.2.2. Supervision

PhD : Romain Brégier, Détection et estimation de pose d'instances d'objet rigide pour la manipulation robotisée, Univ. Grenoble Alpes, June 11, 2018, supervised by James Crowley and Frédéric Devernay

PhD : Even Entem, Interprétation et modélisation 3D automatique à partir de dessins au trait de formes organiques, Univ. Grenoble Alpes, October 26, 2018, supervised by Marie-Paule Cani and Loic Barthes

PhD : Sandra Nabil, Evaluation de la qualité de vidéos panoramiques synthétisées, Univ. Grenoble Alpes, November 27, 2018, supervised by James Crowley and Frédéric Devernay

PhD : Guillaume Cordonnier, Modèles à couches pour simuler l'évolution de paysages à grande échelle, Univ. Grenoble Alpes, December 6, 2018, supervised by Marie-Paule Cani and Eric Galin

PhD in progress : Maxime Garcia, Animation transfer: character animation by playing and acting, since October 2016, supervised by Rémi Ronfard

PhD in progress : Youna Le Vaou, Virtual Sculpture: shape creation and modification through immersive CAVE-like systems, since March 2017, supervised by Jean-Claude Léon and Stefanie Hahmann. Funded by CIFRE contract with PSA

PhD in progress : Amélie Fondevilla, Modélisation et animation de surfaces développables, since September 2016, supervised by Stefanie Hahmann and Damien Rohmer

PhD in progress : Ameya Murukutla, Storyboarding augmented reality anatomy lessons, since October 2017, supervised by Rémi Ronfard and Olivier Palombi

PhD in progress : Pierre Casati, Modeling and animation of antique statues, since October 2017, supervised by Rémi Ronfard and Stéphanie Hahmann

PhD in progress : Qianqian Fu, Computational video editing of live performances, since November 2018, supervised by Rémi Ronfard and Benjamin Lecouteux (GETALP, LIG).

PhD in progress : Thomas Buffet, Efficient multi-layered cloth animation using implicit surfaces, since December 2017, supervised by Marie-Paule Cani and Damien Rohmer.

PhD in progress : Robin Roussel, Function-aware design for objects to be fabricated, since October 2015, supervised by Niloy Mitra, Marie-Paule Cani and Jean-Claude Léon.

PhD in progress : Geoffrey Guingo, Synthesis of animated textures, since October 2015, supervised by Marie-Paule Cani, Jean-Michel Dischler and Basile Sauvage.

PhD in progress : Nachwa Aboubakr, Observation and modeling of human activities, since October 2016, supervised by James Crowley and Rémi Ronfard.

PhD in progress: David Jourdan, Support optimization for tensile membrane structures, since October 2018, supervised by Adrien Bousseau and Mélina Skouras.

PhD in progress: Mickaël Ly, Inverse elastic shell design with contact and friction with applications to garment design, since October 2017, supervised by Florence Descoubes and Mélina Skouras.

Master's thesis : David Jourdan, Optimization of support structures for tensile architecture, June 2018, supervised by Adrien Bousseau and Mélina Skouras.

Master's thesis : Rémi Colin de Verdière, Multi-target inverse kinematics for real-time character animation, June 2018, supervised by Rémi Ronfard.

Master's thesis : Sami Chibane, What makes motion beautiful?, June 2018, supervised by Rémi Ronfard.

10.2.3. Juries

Rémi Ronfard was the president of the jury for Sandra Nabil's Phd Thesis.

Rémi Ronfard was part of the selection committee for recruiting an assistant professor at Univ. Montpellier in May 2018.

Stefanie Hahmann was member of the HDR committee of Julie Digne at Univ. Lyon 1 and a reviewer of the HDR Thesis of Alexandra Bac at Univ. Aix-Marseille. She also was a reviewer of 2 PhD thesis, Univ. Claude Bernard Lyon 1 (Mathieu Giroux) and Univ. Nice (Jean-Dominique Favreau) in 2018.

Stefanie Hahmann also participated in 2018 in 2 committees for recruiting assistant professors, one at UGA, Grenoble, the other at Univ. Aix-Marseille.

10.3. Popularization

Rémi Ronfard and Julie Valéro organized a panel at Experimenta on "Virtual reality storytelling between cinema and theatre", with invited guests Christelle Derré, (collectif Or Norme), Philippe Fuchs (MINES ParisTech), Pauline Bouchet (Univ. Grenoble Alpes), Pierre-Emmanuel Le Goff (France TV) and Annick Jakobowicz (France TV).

Rémi Ronfard presented new results of the COLLODI2 project to Computer Animation professionals at MIFA in June 2018, Next-generation computer animation with RUMBA, International Animation Film Festival Annecy.

Marie-Paule Cani and Rémi Ronfard were featured in a special report on Intelligence artificielle et création artistique, Science et Avenir, aout 2018.

Rémi Ronfard and Julie Valéro published online three new video documentaries shot using our KINO AI virtual cinematography system during rehearsals of the stage adaptation of Mary Shelley's Frankenstein, written and directed by Jean-Francois Peyret.

Rémi Ronfard and Julie Valéro wrote a blog entry, L'informatique rentre en scène, Blog Binaire, Le Monde, 4 décembre 2018.

11. Bibliography

Publications of the year

Doctoral Dissertations and Habilitation Theses

- [1] R. BRÉGIER. *Detection and pose estimation of instances of a rigid object for robotic bin-picking*, Univ. Grenoble Alpes, June 2018, <https://hal.inria.fr/tel-01977050>
- [2] G. CORDONNIER. *Layered Models for Large Scale Time-Evolving Landscapes*, Université Grenoble Alpes (France), December 2018, <https://tel.archives-ouvertes.fr/tel-01971947>
- [3] E. ENTEM. *Automatic interpretation and 3D modeling from line drawings of organic shapes*, UNIVERSITÉ GRENoble ALPES, October 2018, <https://tel.archives-ouvertes.fr/tel-01977694>
- [4] S. NABIL. *Evaluation de la qualité des vidéos panoramiques assemblées*, Université Grenoble Alpes, November 2018, <https://hal.archives-ouvertes.fr/tel-01979682>

Articles in International Peer-Reviewed Journals

- [5] E. BARTZOS, V. BORRELLI, R. DENIS, F. LAZARUS, D. ROHMER, B. THIBERT. *An Explicit Isometric Reduction of the Unit Sphere into an Arbitrarily Small Ball*, in "Foundations of Computational Mathematics", August 2018, vol. 18, n^o 4, pp. 1015–1042 [DOI : 10.1007/s10208-017-9360-1], <https://hal.inria.fr/hal-01647062>

- [6] T. BLANC-BEYNE, G. MORIN, K. LEONARD, S. HAHMANN, A. CARLIER. *A Saliency Measure for 3D Shape Decomposition and Sub-parts Classification*, in "Graphical Models", September 2018, vol. 99, pp. 22-30 [DOI : 10.1016/J.GMOD.2018.07.003], <https://hal.inria.fr/hal-01840016>
- [7] R. BRÉGIER, F. DEVERNAY, L. LEYRIT, J. CROWLEY. *Defining the Pose of any 3D Rigid Object and an Associated Distance*, in "International Journal of Computer Vision", June 2018, vol. 126, n^o 6, pp. 571–596, <https://arxiv.org/abs/1612.04631> [DOI : 10.1007/s11263-017-1052-4], <https://hal.inria.fr/hal-01415027>
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- [9] G. CORDONNIER, P. ECORMIER, E. GALIN, J. GAIN, B. BENES, M.-P. CANI. *Interactive Generation of Time-evolving, Snow-Covered Landscapes with Avalanches*, in "Computer Graphics Forum", May 2018, vol. 37, n^o 2, pp. 497-509 [DOI : 10.1111/CGF.13379], <https://hal.inria.fr/hal-01736971>
- [10] M. GRARD, R. BRÉGIER, F. SELLA, E. DELLANDRÉA, L. CHEN. *Object segmentation in depth maps with one user click and a synthetically trained fully convolutional network*, in "Springer Proceedings in Advanced Robotics", 2019, vol. 7, pp. 207-221, <https://arxiv.org/abs/1801.01281> - This is a pre-print of an article published in Human Friendly Robotics, 10th International Workshop, Springer Proceedings in Advanced Robotics, vol 7. The final authenticated version is available online [DOI : 10.1007/978-3-319-89327-3_16], <https://hal.archives-ouvertes.fr/hal-01674511>
- [11] M. LY, R. CASATI, F. BERTAILS-DESCOUBES, M. SKOURAS, L. BOISSIEUX. *Inverse Elastic Shell Design with Contact and Friction*, in "ACM Transactions on Graphics", November 2018, vol. 37, n^o 6, pp. 1-16 [DOI : 10.1145/3272127.3275036], <https://hal.inria.fr/hal-01883655>
- [12] G. NIETO, F. DEVERNAY, J. L. CROWLEY. *Rendu basé image avec contraintes sur les gradients*, in "Traitement du Signal", 2018, pp. 1-26 [DOI : 10.3166/HSP.X.1-26], <https://hal.archives-ouvertes.fr/hal-01900200>
- [13] R. ROUSSEL, M.-P. CANI, J.-C. LÉON, N. MITRA. *Exploratory design of mechanical devices with motion constraints*, in "Computers and Graphics", August 2018, vol. 74, pp. 244-256 [DOI : 10.1016/J.CAG.2018.05.023], <https://hal.archives-ouvertes.fr/hal-01828500>

Invited Conferences

- [14] S. NABIL, R. BALZARINI, F. DEVERNAY, J. L. CROWLEY. *Designing objective quality metrics for panoramic videos based on human perception*, in "IMVIP 2018 - Irish Machine Vision and Image Processing Conference", Belfast, United Kingdom, August 2018, pp. 1-4, <https://hal.inria.fr/hal-01849043>

International Conferences with Proceedings

- [15] N. ABOUBAKR, R. RONFARD, J. L. CROWLEY. *Recognition and Localization of Food in Cooking Videos*, in "Joint Workshop on Multimedia for Cooking and Eating Activities and Multimedia Assisted Dietary Management (CEA-MADiMa 2018)", Stockholm, Sweden, CEA/MADiMa '18 Proceedings of the Joint Workshop on Multimedia for Cooking and Eating Activities and Multimedia Assisted Dietary Management, ACM, July 2018, pp. 21-24, In conjunction with the 27th International Joint Conference on Artificial Intelligence [DOI : 10.1145/3230519.3230590], <https://hal.archives-ouvertes.fr/hal-01815512>

- [16] E. ENTEM, A. D. PARAKKAT, M.-P. CANI, L. BARTHE. *Structuring and layering contour drawings of organic shapes*, in "Expressive 2018 - Joint Symposium on Computational Aesthetics and Sketch-Based Interfaces and Modeling and Non-Photorealistic Animation and Rendering", Victoria, Canada, ACM Press, August 2018, vol. 18, pp. 1-14 [DOI : 10.1145/3229147.3229155], <https://hal.inria.fr/hal-01853410>
- [17] M. GARCIA, M.-P. CANI, R. RONFARD, C. GOUT, C. PERRENOUD. *Automatic Generation of Geological Stories from a Single Sketch*, in "Expressive '18 - The Joint Symposium on Computational Aesthetics and Sketch Based Interfaces and Modeling and Non-Photorealistic Animation and Rendering", Victoria, Canada, ACM, August 2018, pp. 17-19 [DOI : 10.1145/3229147.3229161], <https://hal.inria.fr/hal-01817923>
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- [19] T. STANKO, N. SAGUIN-SPRYNSKI, L. JOUANET, S. HAHMANN, G.-P. BONNEAU. *Morphorider: a new way for Structural Monitoring via the shape acquisition with a mobile device equipped with an inertial node of sensors*, in "EWSHM 2018 - 9th European Workshop on Structural Health Monitoring", Manchester, United Kingdom, July 2018, pp. 1-11, <https://hal.inria.fr/hal-01962789>

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- [20] A. GOMES, S. HAHMANN, E. KALOGERAKIS (editors). *Proceedings of Shape Modeling International (SMI) 2018 - Special Issue of Computers & Graphics Vol. 74. Jun 2018, Lisbon, Portugal, Elsevier, pp.33-243, 2018, Elsevier, France, May 2018* [DOI : 10.1016/j.cag.2018.05.022], <https://hal.archives-ouvertes.fr/hal-01840061>

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- [21] C. BARILLOT, I. FIJALKOW, I. QUEINNEC, F. THEOLEYRE, H. TOUZET, M. BEAUDOUIN-LAFON, M.-P. CANI, F. CHAUMETTE, G. CONREUR, V. CORTIER, C. GAVOILLE, G. -. GOGNIAT, J. GOSSA, A. HERZIG, J. KRIVINE, P. LAMARRE, F. LAMNABHI-LAGARRIGUE, A.-C. LETOURNEL, L. SEINTURIER, I. TELLIER, S. TORRES, C. TRUCHET, A. TSOUKIAS, M. VERLEYSEN. *Prospective Report of the scientific council of the Information Sciences and their interactions Institute of CNRS*, CNRS, December 2018, pp. 1-87, <https://hal.archives-ouvertes.fr/hal-01956087>

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