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Université Joseph Fourier (Grenoble)

Activity Report 2013

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

Table of contents

Project-Team IMAGINE

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

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2. Overall Objectives

2.1. Scientific goals

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: while capture of real objects or motion restrict the range of possible content, using standard tools to design each 3D shape, animate them, and manually control camera trajectories is time consuming and entirely leaves the quality of results in the user's hand. Lastly, procedural generation methods, when applicable, save user's time but often come at the price of control.

The goal of *IMAGINE* is to develop a **new generation of models, algorithms and interactive environments for easily creating and conveying animated 3D scenes**.

Our insight is to revisit models for shapes, motion, stories and virtual cinematography 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.

- Therefore, our first scientific focus is the development of high-level models - namely, novel representations expressing a priori knowledge – providing the appropriate handles for conveying user intent while embedding procedural methods aimed at the fast generation of detailed content.
- Our second scientific focus is the combination of these models with intuitive control tools, towards interactive environments where users can create a new virtual scene, play with it, edit or refine it.

These models will be used within different environments for interactive content creation, dedicated to specific applications. More precisely, three main fields will be addressed:

1. **Shape design**: We aim to develop intuitive tools for designing and editing 3D shapes, from arbitrary ones to shapes that obey application-dependent constraints - such as, for instance, being developable for surfaces aimed at representing objects made of cloth or of paper.
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 will 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 will 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.

In addition to addressing specific needs of digital artists, this research will contribute 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.

2.2. Highlights of the Year

- One publication was accepted at SIGGRAPH 2013 [14], and two publications at SIGGRAPH Asia 2013 [5], [8].
- Prof. Michael Gleicher from University of Wisconsin is visiting our team during one year.
- France 3 made a video reportage about our team.
- An interview of Marie-Paule Cani was published in People of ACM.
- Marie-Paule Cani became vice chair of Eurographics.
- Computer Vision and Image Understanding 2013 Most cited paper award : *A survey of vision-based methods for action representation, segmentation and recognition*, by Daniel Weinland, Remi Ronfard and Edmond Boyer.

3. Research Program

3.1. A failure of standard modeling techniques?

Surprisingly, in our digital age, conceptual design of static shapes, motion and stories is almost never done on computers. Designers prefer to use traditional media even when a digital model is eventually created for setups such as industrial prototyping, and even when the elements to be designed are aimed at remaining purely virtual, such as in 3D films or games. In his keynote talk at SIGGRAPH Asia 2008, Rob Cook, vice president of technology at Pixar Animation Studios, stressed that even trained computer artists tend to avoid the use of 3D computerized tools whenever possible. They use first pen and paper, and then clay to design shapes; paper to script motion; and hand-sketched storyboards to structure narrative content and synchronise it with speech and music. Even lighting and dramatic styles are designed using 2D painting tools. The use of 3D graphics is avoided as much as possible at all of these stages, as if one could only reproduce already designed material with 3D modelling software, but not create directly with it. This disconnect can be thought of as the number one failure of digital 3D modelling methodologies. As Cook stressed: "*The 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*" (Cook 2008). The failure does not only affect computer artists but many users, from engineers and scientists willing to validate their ideas on virtual prototypes, to media, educators and the general public looking for simple tools to quickly personalize their favourite virtual environment.

Analyzing the reasons for this failure we observe that 3D modeling methodologies did not evolve much in the last 20 years. Standard software, such as Maya and 3dsMax, provide sophisticated interfaces to fully control all degrees of freedom and bind together an increasing number of shape and motion models. Mastering this software requires years of training to become skilled. Users have to choose the best suited representation for each individual element they need to create, and fully design a shape before being able to define its motion. In many cases, neither descriptive models, which lack high level constraints and leave the quality of results in user's hands, nor procedural ones, where realistic simulation comes at the price of control, are really convenient. A good example is modelling of garments for virtual characters. The designer may either sculpt the garment surface at rest, which provides direct control on the folds but requires lots of skill due to the lack of constraints (such as enforcing a cloth surface to be developable onto a plane), or they can tune the parameters of a physically-based model simulating cloth under gravity, which behaves as a black box and may never achieve the expected result. No mechanism is provided to roughly draft a shape, and help the user progressively improve and refine it.

Capture and reconstruction of real-world objects, using either 3D scanners or image-based methods, provides an appealing alternative for quickly creating 3D models and attracted a lot of attention from both Computer Graphics and Computer Vision research communities the last few years. Similarly, techniques for capture and reuse of real motion, enabling an easy generation of believable animation content, were widely investigated. These efforts are much welcome, since being able to embed existing objects and motion in virtual environments is extremely useful. However, it is not sufficient. One cannot scan every blade of grass, or even every expressive motion, to create a convincing virtual world. What if the content to be modelled does not exist yet, or will never exist? One of the key motivations for using digital modelling in the first place is as a tool for bringing to life new, imaginary content.

3.2. Long term vision: an "expressive virtual pen" for animated 3D content

Stepping back and taking a broader viewpoint, we observe that humans need a specialized medium or tool, such as pen and paper or a piece of clay, to convey shapes, and more generally animated scenes. Pen and paper, probably the most effective media to use, requires sketching from different viewpoints to fully represent a shape and requires a large set of drawings over time to communicate motion and stories.

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.

3.3. Methodology: "Control to the user, Knowledge to the system"

Thinking of future digital modeling technologies as an "expressive virtual pen", enabling to seamlessly design, refine and convey animated 3D content, is a good source of inspiration. It led us to the following methodology:

- As when they use a pen, users should not be restricted to the editing of preset shapes or motion, but should get a **full control over their design**. This control should ideally be as easy and intuitive as when sketching, which leads to the use of gestures – although not necessarily sketching gestures – rather than of standard interfaces with menus, buttons and sliders. Ideally, these control gestures should drive the choice of the underlying geometric model, deformation tool, and animation method in a predictable but transparent way, enabling users to concentrate on their design.
- Secondly, similarly to when they draw in real, users should only have to **suggest** the 3D nature of a shape, the presence of repetitive details, or the motion or deformations that are taking place: this will allow for faster input and enable coarse to fine design, with immediate visual feedback at every stage. The modeling system should thus act similarly to a human viewer, who can imagine a 3D shape in motion from very light input such as a raw sketch. Therefore, as much as possible **a priori knowledge** should be incorporated into the models and used for inferring the missing data, leading to the use of high-level representations enabling procedural generation of content. Note that such models will also help the user towards high-quality content, since they will be able to maintain

specific geometric or physical laws. Since this semi-automatic content generation should not spoil user's creativity and control, editing and refinement of the result should be allowed throughout the process.

- Lastly, creative design is indeed a matter of trial and error. We believe that creation more easily takes place when users can immediately see and play with a first version of what they have in mind, serving as support for refining their thoughts. Therefore, important features towards effective creation are to provide **real-time response** at every stage, as well as to help the user exploring the content they have created thanks to intelligent cameras and other cinematography tools.

To advance in these directions, we believe that models for shape, motion and cinematography need to be re-thought from a user centered perspective. We borrowed this concept from the Human Computer Interaction domain, but we are not referring here to **user-centred system design** (Norman 86). We rather propose to extend the concept, and develop user-centred graphical models: Ideally, a user-centred model should be designed to behave, under editing actions, the way a human user would have predicted. Editing actions may be for instance 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 used to transfer of some features from existing models to other ones. User-centred models need to incorporate knowledge in order to seamlessly generate the appropriate content from such actions. Knowledge may be for instance about developability to model paper or cloth; about constant volume to deform virtual clay or animate plausible organic shapes; about physical laws to control passive objects; or about film editing rules to generate semi-autonomous camera with planning abilities.

These user-centred models will be applied to the development of various interactive creative systems, not only for static shapes, but also for motion and stories. Although unusual, we believe that thinking about these different types of content in a similar way will enable us to improve our design principles thanks to cross fertilization between domains, and allow for more thorough experimentation and validation. The expertise we developed in our previous research team EVASION, namely the combination of layered models, adaptive degrees of freedom, and GPU computations for interactive modeling and animation, will be instrumental to ensure real-time performances. Rather than trying to create a general system that would solve everything, we plan to develop specific applications (serving as case studies), either brought by the available expertise in our research group or by external partners. This way, user expectations should be clearly defined and final users will be available for validation. Whatever the application, we expect the use of knowledge-based, user-centred models driven by intuitive control gesture to increase both the efficiency of content creation and the quality of results.

3.4. Application Domains

This 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 theatre 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 modelling within the reach of the general public, enabling educators, media and other practitioners to author their own 3D content.

In practice, fully developing a few specialized interactive systems will be instrumental for testing our models. The multi-disciplinary expertise and professional background of our team members will ease the set up of projects in the domains listed below. The diversity of users these domains bring, from digital experts to other professionals and novices, will be excellent for validating our general methodology. Our ongoing projects in these various application domains are listed in Section 6.

- Visual arts
  - Modeling and animation for 3D films and games (François Faure, Marie-Paule Cani,)
  - Virtual cinematography and tools for theatre directors (Rémi Ronfard)

- Engineering
  - Industrial design (Stéfanie Hahmann, Jean-Claude Léon)
  - Mechanical & civil engineering (Jean-Claude Léon, François Faure)
- Natural Sciences
  - Virtual functional anatomy (Olivier Palombi, François Faure)
  - Virtual plants (Marie-Paule Cani, François Faure)
- Education and Creative tools
  - Sketch-based teaching (Olivier Palombi, Marie-Paule Cani)
  - Creative environments for novice users (Marie-Paule Cani, Jean-Claude Léon)

3.5. Validation methodology

When developing digital creation tools, validation is a major challenge. Researchers working on ground-truth reconstruction can apply standard methodologies to validate their techniques, such as starting by testing the method on a representative series of toy models, for which the model to reconstruct is already known. In contrast, it is not obvious how to prove that a given tool for content creation brings a new contribution. Our strategy to tackle the problem is threefold:

- Most of our contributions will address the design of new models and algorithms for geometry and animation. Validating them will be done, as usual in Computer Graphics, by showing for instance that our method solves a problem never solved before, that the model is more general, or the computations more efficient, than using previous methods.
- Interaction for interactive content creation & editing will rely as much as possible on preliminary user studies telling us about user expectations, and on interaction paradigms and design principles already identified and validated by the HCI community. When necessary, we intend to develop as well new interaction paradigms and devices (such as the hand-navigator we are currently experimenting) and validate them through user studies. All this interaction design work will be done in collaboration with the HCI community. We already set up a long term partnership with the IIHM group from LIG in Grenoble, through the INTUACTIVE project at Grenoble INP (2011-2014) which involves co-advised students, and through the co-direction of the action "Authoring Augmented Reality" of the larger Labex PERSYVAL project (2012 – 2020).
- Lastly, working on specific applications in the domains we listed in Section 3 is essential for validation since it will give us some test beds for real-size applications. The expert users involved will be able to validate the use of our new design framework compared to their usual pipeline, both in terms of increased efficiency, and of satisfaction with new functionalities and final result. In addition to our work with scientific and industrial partners, we are establishing collaborations with the Ecole Nationale Supérieure des Arts Décoratifs (ENSAD Paris, Prof Pierre Hénon) and with the Ecole Nationale Supérieure Louis Lumière (Prof. Pascal Martin) for the evaluation of our ongoing work in shape and motion design, and on virtual cinematography.

4. Software and Platforms

4.1. MyCorporisFabrica

Participants: Ali-Hamadi Dicko, François Faure, Olivier Palombi.

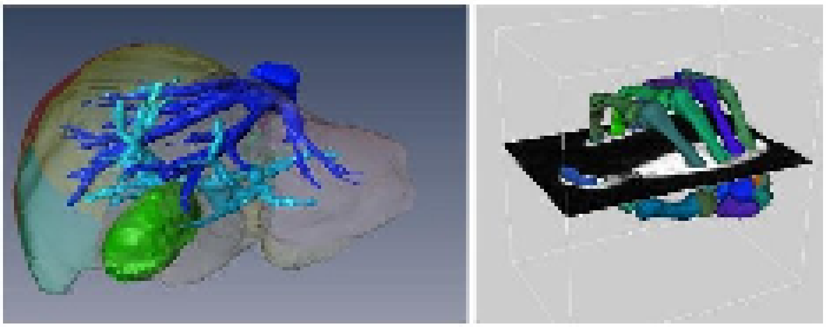

Figure 1. My Corporis Fabrica is an anatomical knowledge database developed in our team.

My Corporis Fabrica (MyCF) is an anatomical knowledge database (see fig. 1). During 2011, we have added new anatomical entities and improved some parts of FMA (Foundational Model of Anatomy). The FMA's license is now under Creative Commons licenses (CC-by : Licensees may copy, distribute, display and perform the work and make derivative works based on it only if they give the author or licensor the credits in the manner specified by these). The license of MyCF is not yet defined. Our new contribution this year, is the creation of a brand new ontology about human functions. Based on the International Classification of Functioning, Disability and Health, also known as ICF, we have organized human functions through a tree of 4330 items. A original journal paper must be submitted soon. MyCF browser is now available on line: http://www.mycorporisfabrica.org/. The MyCf's generic programming framework can be used for other domains. The link with semantic and 3D models matches research activities of IMAGINE towards interactive digital creation media. Anatomy can be seen as a study case.

4.2. SOFA

Participants: François Faure, Ali Hamadi Dicko, Armelle Bauer, Olivier Carré, Matthieu Nesme, Romain Testylier, Moreno Trlin.

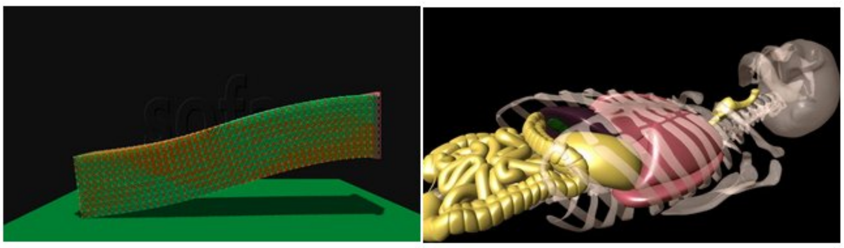

Figure 2. SOFA is an open source simulator for physically based modeling.

SOFA is a C++ library primarily targeted at medical simulation research. Based on an advanced software architecture, it allows to (1) create complex and evolving simulations by combining new algorithms with algorithms already included in SOFA; (2) modify most parameters of the simulation – deformable behavior, surface representation, solver, constraints, collision algorithm, etc. – by simply editing an XML file; (3) build

complex models from simpler ones using a scene-graph description; (4) efficiently simulate the dynamics of interacting objects using abstract equation solvers; and (5) reuse and easily compare a variety of available methods.
SOFA is gaining momentum. A start-up based on SOFA, InSimo, has been created in Strasbourg by Inria people, and one of our former engineers, François Jourdes, has been hired. A SOFA-specific workshop was co-located with conference Vriphys'13 in Lille, with 50 attendants and the participation of several companies including CAE (a Canadian world leader in simulation), Haption, BASF, InSimo and others.

4.3. Expressive

Participants: Marie-Paule Cani, Amaury Jung, Mohamed-Galal Koraa, Maxime Quiblier, Cédric Zanni, Antoine Begault.

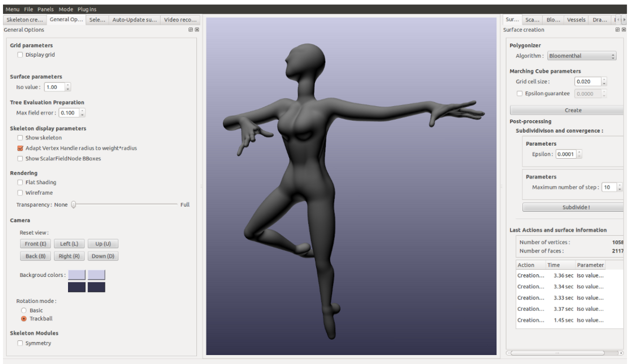

Figure 3. GUI and Example of implicit surface and modeled with the Expressive platform.

Expressive is a new C++ library developed to gather and share the models and algorithms developed within the ERC Expressive project. It enables us to make our latest research results on new creative tools; typically high level models together with intuitive, sketching or sculpting interfaces - soon available to the rest of the group and easily usable in our industrial partnerships. Its most developed part is Convol, a library dedicated implicit surfaces; and more particularly to the sub-classes of convolution surfaces and other integral surfaces along skeletons. Convol incorporates all the necessary material for constructive implicit modeling: skeleton-based convolution and SCALIS primitives, with closed form solution for the field values and gradient whenever possible; a variety of blending operators; and several methods for tessellating an implicit surface into a mesh, and for refining the later in highly curved regions. The creation of new geometry can be performed by direct manipulation of skeletal primitives or through sketch-based modeling.

5. New Results

5.1. Introduction

We are developing user-centred, knowledge-based models in three main domains: shape, motion and narrative design, leading us to three research axes. The fourth one is the combination of these models with intuitive interaction tools, in order to set up interactive creative environments dedicated to specific categories of content. The following sections describe our activities in 2013 for each axis.

5.2. High level model for shapes

- **Scientist in charge**: Stefanie Hahmann
- **Other permanent researchers**: Marie-Paule Cani, Jean-Claude Léon.

5.2.1. Implicit modeling

Participants: Antoine Bégault, Adrien Bernhardt, Marie-Paule Cani, Mohamed-Galal Koraa, Cédric Zanni.

Implicit surfaces are an appealing representation for free-form, volumetric shapes. In addition to being able to represent shapes of arbitrary topological genius, they have the ability to be constructed by successively blending different components, which eases interactive modeling.

In collaboration with Loic Barthe in Toulouse, we contributed to a new binary blending operator, called Gradient Blending [7], which enables us to blend implicit shapes not only in function of their field values but also of their gradients. This solves a number long standing problems in implicit modeling: we can generate bulge-free blending, ensure that the topological genius of the blended shape remains the one of the union of the input one, and avoid the blur of small details.

Figure 4. Example of surface generated using our SCALIS approach.

Within Cédric Zanni's PhD [2] we introduced closed-form solutions for convolution surfaces along helical skeletons and extended Gabor-noise texturing to enable the creation of repetitive geometric details along implicit surfaces. We also developed a novel extension to convolution surfaces, so-called SCALe-invariant Integral Surfaces (SCALIS) [15], see Figure 4. Thanks to their scale invariant blending properties, these surfaces have three main advantages: the radius of the surface around a skeleton can be explicitly controlled, shapes are self-similar regardless of the scale of the model, and thin components are not smoothed-out when blended into larger ones. This is done while preserving the main benefits of integral surfaces, namely n-ary blending with a simple plus, and shape preservation whatever the way the skeletons is spit into smaller primitives. We are currently extending this work to enable the topology of the implicit surface to always reflect the one of the skeleton

5.2.2. Analysis of CAD models

Participants: Francois Faure, Stefanie Hahmann, Jean-Claude Léon, Olivier Palombi, Flavien Boussuge, Ahmad Shahwan.

CAD models, as part of assemblies defining manufactured products, are often shaped in accordance with their physical counterpart. However, one can observe that the shape of some components, as modeled in CAD, may differ from that of their physical instance. In addition, assemblies representing products are most often reduced to a collection of CAD models representing each component and the designation of each component is neither a reliable information nor a faithful connection with one or more functions of a component. As a result, geometric interfaces between components are unknown and they cannot be reduced to contacts. Interferences may exist that are also relevant for several applications. Determining precisely, the geometric interfaces between components is a first requirement to enrich geometric models with functional information because a subset of functions derive from interfaces between components.

As an example, this is particularly useful for structural mechanics to be able to generate rapidly a Finite Element model of assemblies and it is especially critical when assemblies get very complex. [9] addresses the problem to generate automatically a class of geometric interfaces for very complex assemblies (see fig. 5). GPU-based algorithms have proved suitable to obtain reliable results on CAD models.

Using these geometric interfaces as well as the newly introduced concept of conventional interfaces, [6], [4] and [11], [12], [19] have proposed an approach using qualitative reasoning, ontology reasoning to connect CAD components, their geometric interfaces, to functions and functional designations of components: an intrinsic identifier of a component in an assembly that connects it to its function. As a result, it is shown how geometric models of components need to be restructured, which extends the concept of annotation presently reduced to a elementary link between geometric models and symbolic information.

At the level of assembly components, shape analysis [30] is particularly useful to generate dimensionally reduced models needed for structural mechanics. [3] shows that analyzing a B-Rep CAD model to derive a construction graph, i.e. a set of construction trees, can be a robust basis to generate dimensionally reduced models [18], [32].

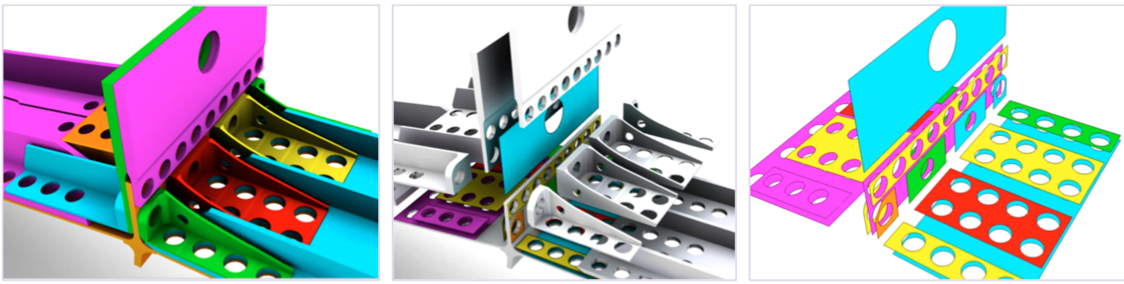

Figure 5. Computation of assembly interfaces in NURBS representation.

5.2.3. Knowledge-based shape transfert

Participants: Marie-Paule Cani, Ali Dicko, Francois Faure, Olivier Palombi.

Characters with precise internal anatomy are important in film and visual effects, as well as in medical applications. We have proposed the first semi-automatic method for creating anatomical structures, such as bones, muscles, viscera and fat tissues [5], as illustrated in 6. This is done by transferring a reference anatomical model from an input template to an arbitrary target character, only defined by its boundary representation (skin). The fat distribution of the target character needs to be specified. We can either infer this information from MRI data, or allow the users to express their creative intent through a new editing tool. The rest of our method runs automatically: it first transfers the bones to the target character, while maintaining their structure as much as possible. The bone layer, along with the target skin eroded using the fat thickness information, are then used to define a volume where we map the internal anatomy of the source model using harmonic (Laplacian) deformation. This way, we are able to quickly generate anatomical models for a large range of target characters, while maintaining anatomical constraints.

Figure 6. A reference anatomy (left) is automatically transferred to arbitrary humanoid characters. This is achieved by combining interpolated skin correspondences with anatomical rules.

5.3. Models for motion and animation

- **Scientist in charge**: François Faure
- **Other permanent researchers**: Marie-Paule Cani, Damien Rohmer, Rémi Ronfard.

5.3.1. Physical models

Participants: Marie-Paule Cani, François Faure, Pierre-Luc Manteaux.

Frame-based deformable solids Our frame-based deformable model was published as a book chapter [31]. It combines the realism of physically based continuum mechanics models and the usability of frame-based skinning methods, allowing the interactive simulation of objects with heterogeneous material properties and complex geometries. The degrees of freedom are coordinate frames. In contrast with traditional skinning, frame positions are not scripted but move in reaction to internal body forces. The deformation gradient and its derivatives are computed at each sample point of a deformed object and used in the equations of Lagrangian mechanics to achieve physical realism. We introduce novel material-aware shape functions in place of the traditional radial basis functions used in meshless frameworks, allowing coarse deformation functions to efficiently resolve non-uniform stiffnesses. Complex models can thus be simulated at high frame rates using a small number of control nodes.

Adaptive particle simulation In collaboration with the NANO-D Inria Team, we have explored the use of Adaptively Restrained (AR) particles for graphics simulations [25]. Contrary to previous methods, Adaptively Restrained Particle Simulations (ARPS) do not adapt time or space sampling, but rather switch the positional degrees of freedom of particles on and off, while letting their momenta evolve. Therefore, inter-particles forces do not have to be updated at each time step, in contrast with traditional methods that spend a lot of time there. We first adapted ARPS to particle-based fluid simulations, as illustrated in 7 and proposed an efficient incremental algorithm to update forces and scalar fields. We then introduced a new implicit integration scheme enabling to use ARPS for cloth simulation as well. Our experiments showed that this new, simple strategy for adaptive simulations can provide significant speedups more easily than traditional adaptive models.

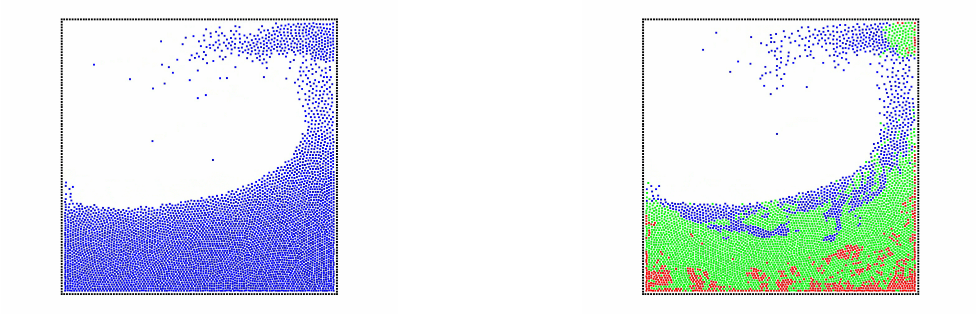

Figure 7. A dam break simulation with 5000 particles simulated with WCSPH (on the left) and with our adaptive method (on the right). On the right image, blue corresponds to full-dynamics particles, green to transition particles and red to restrained particles.

5.3.2. Skinning virtual characters

Participants: Marie-Paule Cani, Damien Rohmer.

Skinning is a widely used technique to deform articulated virtual characters. It can be computed fastly and therefore can deliver real-time feedback at the opposite of physically based simulation. Still standard skinning approaches cannot handle well large deformations and may require manual corrections.

In collaboration with Loic Barthe and Rodolphe Vaillant from University of Toulouse, and collaborators from Victoria University, Inria Bordeaux and University of Bath, we develop a new automatic correction for skinning deformation that has been published in SIGGRAPH [14]. Based on the volumetric implicit representation paradigm, it adjust the mesh vertices and improves the visual appearance of the deformed surface. Moreover, it seamlessly handle skin contact ensuring that no self collision can occurs as seen in fig. 8. Finally, the method can mimic muscular bulges controled by the implicit blending operators described in the work [7].

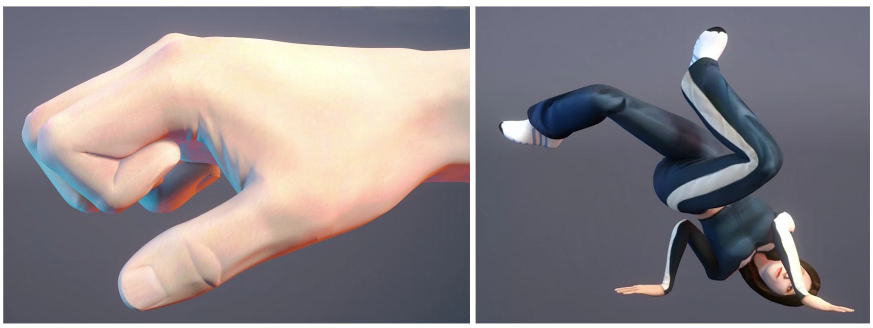

Figure 8. Example of large skinning deformation obtained in [14].

5.3.3. Animating crowds

Participants: Marie-Paule Cani, Quentin Galvane, Kevin Jordao, Kim Lim.

Crowd animation is an interesting case, since it can be either computed by developing artificial intelligence methods, by using physically-based simulation of some extended particle systems, or by applying a kinematic texturing methodology, made possible by the repetitive nature of crowd animations. We launched this new topic in the group in 2013, enabling us to explore the two last crowd animation methods:

Firstly, in collaboration with the University SAINTS, Malaysia, we extended particle-based crowd simulation to the case when 4 different populations, with different goals and behaviors, are interacting within the same environment [24]. This as illustrated by a cultural heritage application, with the reconstruction of past life in a harbor in Malaysia in the 19th century: see Figure 9.

Figure 9. Crowd simulation with 4 different populations from [24].

Secondly, within the ANR project CHROME with Inria Rennes, we adopted the crowd-patches technique, i.e. the idea of combining patches carrying pre-computed crowd trajectories, for quickly populating very large environments [23]. We are currently developing novel methods for enabling the interactive space-time editing of these animations (a paper will be published at the next Eurographics conference).

5.4. Knowledge-based models for narrative design

- **Scientist in charge**: Rémi Ronfard
- **Other permanent researchers**: Marie-Paule Cani, François Faure, Jean-Claude Léon, Olivier Palombi

5.4.1. Cinematographic virtual camera control

Participants: Marie-Paule Cani, Quentin Galvane, Vineet Gandhi, Chen Kim Lim, Rémi Ronfard.

Steering Behaviors for Autonomous Cameras [21] : We proposed a new method for automatically filming crowd simulations with autonomous cameras, using specialized camera steering behaviors and forces. Experimental results show that the method provides a good coverage of events in moderately complex crowds simulations, with consistently correct image composition and event visibility.

The prose storyboard language [26] : We presented a formal language for describing movies shot by shot, where each shot is described with a unique sentence. The language uses a simple syntax and limited vocabulary borrowed from working practices in traditional movie-making, and is intended to be readable both by machines and humans. The language is designed to serve as a high-level user interface for intelligent cinematography and editing systems.

5.4.2. Virtual actors

Participants: Adela Barbulescu, Rémi Ronfard.

Audio-Visual Speaker Conversion using Prosody Features [17] : We presented a new approach towards speaker identity conversion using speech signals and 3D facial expressions. Audio prosodic features are extracted from time alignment information for a better conversion of speaking styles. A subjective evaluation was performed to illustrate that the converted sequences are perceived as belonging to the target speakers. We are working to extend that approach to visual prosody features and to apply it to the situation where a director controls the expressions of a virtual actor, while maintaining its personality traits.

5.4.3. Narrative analysis of video

Participants: Vineet Gandhi, Rémi Ronfard.

Naming and detecting actors in movies [22]: We proposed a generative model for localizing and naming actors in long video sequences. More specifically, the actor's head and shoulders are each represented as a constellation of optional color regions. Detection can proceed despite changes in view-point and partial occlusions. This work is being extended to the case of theatre actors during performances and rehearsals. It also opens the way to future work in automatic analysis of cinematographic and editing styles in real movie scenes. This was also presented as a poster at the International Conference on Computational Photography (ICCP).

Recording theatre rehearsals [29] : We presented a contribution to the International Federation for Theatre Research describing our ongoing collaboration with the Theatre des Celestins in Lyon, emphasising that high quality vídeo recordings make it possible to study the genetic evolution of a theatre performance, and make it an object of scientific study as well as an object of aesthetic appreciation.

5.5. Creating and interacting with virtual prototypes

- **Scientist in charge**: Jean-Claude Léon
- **Other permanent researchers**: Marie-Paule Cani, Olivier Palombi, Damien Rohmer, Rémi Ronfard.

5.5.1. Sketch-based modeling

Participants: Marie-Paule Cani, Martin Guay, Rémi Ronfard.

The Line of Action [8] : The line of action is a conceptual tool often used by cartoonists and illustrators to help make their figures more consistent and more dramatic. In this paper, we proposed a mathematical definition of the line of action (LOA), which allows us to automatically align a 3D virtual character to a user-specified LOA by solving an optimization problem. This woek is now being extended to the more challenging case of creating complete animations from storyboard-like hand-drawn sketches (see fig. 10).

Figure 10. The line of action defines the pose of the virtual character.

5.5.2. Sculpting methods

Participants: Marie-Paule Cani, Stefanie Hahmann, Damien Rohmer, Lucian Stanculescu.

Sculpting methods is a very powerful approach to design virtual models from an existing model. In the work of Lucian Stanculescu [13] we extend the standard sculpting paradigm of surfaces, to multi-dimensional nested structures. In this method, lower dimensional structures such as points and curves can be defined on the surface to defined a nested structure. Each part can follow a specific deformation behaviors. We therefore categorize the geometrical and topological behavior of the structure (such as rigidity or mutability) to develop a wider range of possible deformation. This method facilitate the persistence of sharp features that automatically split or merge with variable rigidity, even when the shape chages genus. This approach enable to deform a surface exhibiting typical behavior of both CAD model with sharp edges, and CG model with smooth surfaces as seen in fig. 11.

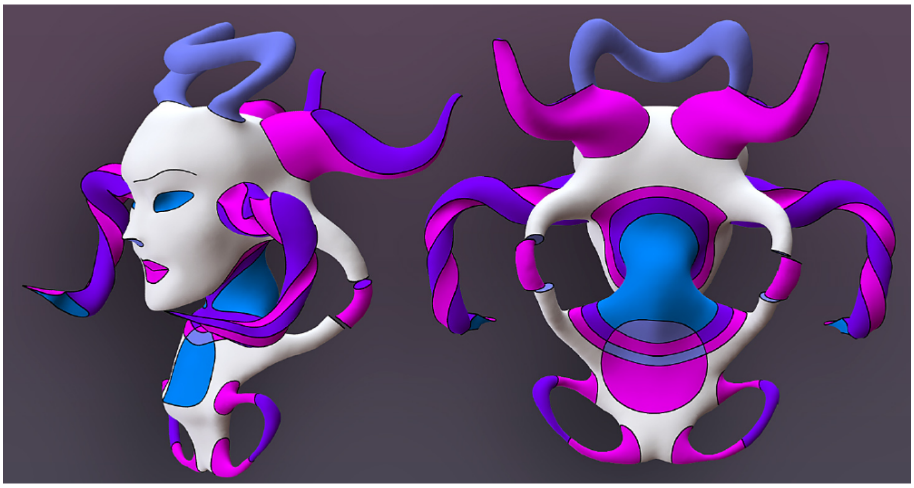

Figure 11. Deformed surface with nested structure from [13].

We also extends the sculpting approach to handle detailed surfaces. During sculpting deformation such as local stretching, the surface details should not extend as the global shape, but rather duplicates to ensure that the surface keeps his detailed appearance. We studied this question under two different approaches.

The first one, in collaboration with Max-Planck Institute focussed on the deformation of 1D-like parametric structure such as castle walls of centripede characters. The method enable to freely extend, compress, split and merges parts of the structures. The deformed structure is generated by an assembly of basic parts whose behaviors are encoded using a discrete shape grammar. During deformation, the system finds the most suitable collection of parts to assemble and ensure that the global shapes is coherent with the input rules. This work as been published in Eurographics 2014 [10].

The second approach consists in extending sculpting to continuous freeform deformation of a 2D surface with details. During the deformation gesture of stretching or compression, details on the surfaces should seamlessly appear or desappear continuously. In this work, we studied the simpler case of a planar surface with high field details and presented our result in GTMG [27]. We now work on the more general extention to this work as a collaboration with Max-Plack Institute and University of College London.

5.5.3. Interactive control of procedural models: terrains and waterfalls

Participants: Adrien Bernhardt, Marie-Paule Cani, Arnaud Emilien, Ulysse Vimont.

Procedural models, used for easily modeling large, natural environments, pose a specific challenge in terms of user control: how can these automatic methods, useful for quickly generating a huge number of self-similar details, be adapted to allow the coarse to fine level of control needed by the users?

This topic was first explored within Adrien Bernhard's PhD thesis [1], where we introduced a real-time terrain modeling tool using a fast GPU-based terrain solver with a lightweight CPU-based data structure. This tool was recently extended in collaboration with Cambridge University, to enable first-person sketch-based editing of terrains models.

Secondly, we have been working on interactive procedural modeling of plausible waterfalls, in collaboration with Montreal University. Offering interactive user control for this application is particularly challenging, since the shape taken by a fall heavily depends on the underlying terrain. Our solution, based on vectorial user-control, on a flow solver, and on procedural adaptation of the underlying terrain, enable users to quickly create plausible flowing water, while controlling which fall segments are in contact with the terrain (vs. in free fall), the topology of the network, and how much the flow should adapt to the current terrain, vs. the terrain to the user-designed trajectories (fig. 12). A paper is under review and a presentation has been made at the AFIG conference [16].

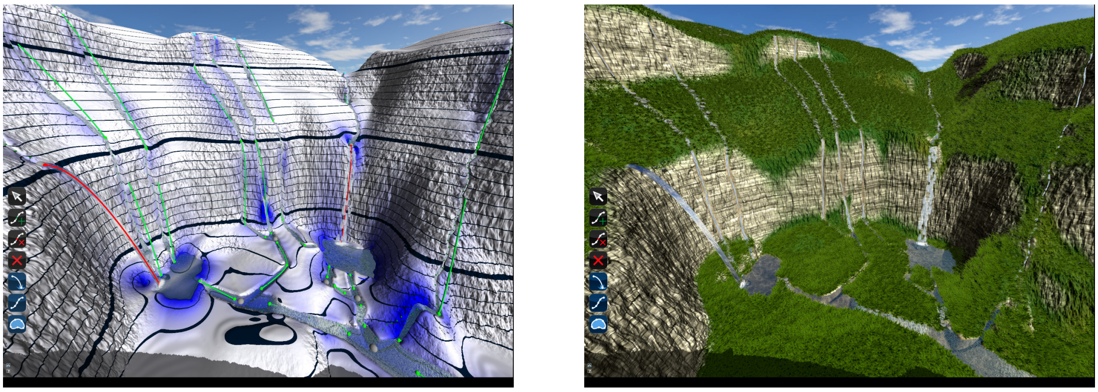

Figure 12. Waterfalls modeling using our approach developped in [16]

5.5.4. Interaction methods

Participants: Rémi Brouet, Marie-Paule Cani.

We are currently exploring the use of multi-touch tables for the interactive design and editing of 3D scenes, in collaboration with the human-computer interaction group of LIG laboratory. The main challenge here is to find out how to use a 2D interaction media for editing 3D content, hence how to intuitively control the third dimension (depth, non-planar rotations, 3D deformations, etc).

Our first work consisted in an user study where we analyzed all possible hand interactions on table-tops and explored the ways users would intuitively try to manipulate 3D environments, either for changing the camera position or for moving objects around [20]. We extracted a general interaction pattern from this study. Our implementation enables both seamless navigation and docking in 3D scenes, without the need for any menu or button to change mode. We are currently extending this work to object editing scenarios, where shapes are to be bent of twisted in 3D using 2D interaction.

6. Bilateral Contracts and Grants with Industry

6.1. Bilateral Contracts and Grants with Industry

6.1.1. EADS - Idealization of components for structural mechanics (06/2011 - 06/2014)

Participants: Flavien Boussuge, Stefanie Hahmann, Jean-Claude Léon.

Cifre PhD in partnership with EADS IW to generate the shape of mechanical components through dimensional reduction operations as needed for mechanical simulations, e.g. transformations from volume bodies to shells or plates forming surface models, usually non-manifold ones. The topic addressed covers also the shape detail removal process that takes place during the successive phases where subsets of the initial shape are idealized. Mechanical criteria are taken into account that interact with the dimensional reductions and the detail removal processes. The goal is to define the transformation operators such that a large range of mechanical components can be processed as automatically and robustly as possible. Two major results have been obtained to generate construction graphs from CAD models and use a construction graph to generate a dimensionnally reduced model suited for Finite Element Analyses.

6.1.2. EDF - Generating construction graphs of solids for physical simulation purposes (09/2013 - 09/2016)

Participants: Jean-Claude Léon, Aarohi Johal.

Cifre PhD in partnership with EDF to generate a construction graph of a CAD solid model from its description as in a STEP file in collaboration with Georges-Pierre Bonneau (Maverick project).This is a most frequent requirement in an industrial context where construction trees are lost when transfering models between CAD and simulation software. It is also critical to describe variants of construction processes of a solid because different modifications or different applications require different construction processes whereas a CAD software could provide only the construction process used when initially generating a solid. This project builds upon the construction graph generation process set up for dimensional reduction of solids and on the symmetry analysis of solids that have been addressed in the past years.

6.1.3. HAPTIHAND technology transfer project (Inria-HAPTION-Arts et Métiers ParisTech) (10/2012-08/2014)

Participants: Maxime Borettaz, Thomas Dupeux, Jean-Claude Léon.

The objective is to transfer a device, named HandNavigator, that has been developed in collaboration with Arts et Métiers ParisTech/Institut Image, as add on to the 6D Virtuose haptic device developed by HAPTION. The purpose of the HandNavigator is to monitor the movement of a virtual hand at a relatively detailed scale (movements of fingers and phalanxes), in order to create precise interactions with virtual objects like object grasping. This includes monitoring the whole Virtuose 6D arm and the HandNavigator in a virtual environment, for typical applications of maintenance simulation and virtual assembly in industry. The project covers the creation of an API coupled to physical engine to generate and monitor a realistic and intuitive use of the entire device, the creation of physical prototypes incorporating multiple sensors for each user's finger. The physical prototypes have been developed using rapid prototyping technologies like the 3D printing device available from the Amiqual4Home project (ANR-11-EQPX-0002).

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. Scenoptique (12/2012 - 03/2014)

Participant: Rémi Ronfard.

In October 2011, we started a collaboration with Theatre des Celestins in Lyon on the topic of interactive editing of rehearsals. This research program is funded by the Region Rhone Alpes as part of their CIBLE project, with a budget for a doctoral thesis (Vineet Gandhi) and three large sensor video cameras. Theatre des Celestins is interested in novel tools for capturing, editing and browsing video recordings of their rehearsals, with applications in reviewing and simulating staging decisions. We are interested in building such tools as a direct application and test of our computational model of film editing, and also for building the world's first publicly available video resource on the creative process of theatre rehearsal. Using state-of-the-art video analysis methods, this corpus is expected to be useful in our future work on procedural animation of virtual actors and narrative design. The corpus is also expected to be shared with the LEAR team as a test bed for video-based action recognition.

7.1.2. Labex Persyval

Participants: Rémi Ronfard, Olivier Palombi, Armelle Bauer.

We received a doctoral grant from LABEX PERSYVAL, as part of the research program on authoring augmented reality (AAR) for PhD student Adela Barbelescu. Her thesis is entitled *directing virtual actors by imitation and mutual interaction - technological and cognitive challenges*. Her advisors are Rémi Ronfard and Gérard Bailly (GIPSA-LAB).

Additionally, this project funds the PhD thesis of Armelle Bauer which has started in October, co-advised by François Faure, Olivier Palombi, and Jocelyne Troccaz from TIMC-GMCAO. The goal is to tackle the scientific challenges of visualizing one's self anatomy in motion using Augmented Reality techniques.

7.1.3. TAPIOCA, Persyval Grant (11/2013 - 11/2015)

Participants: Damien Rohmer, Jean-Claude Léon, Marie-Paule Cani.

Tapioca (Tangibilité Physiologique Instrumentée: Outil mixte redimensionnable pour la conception d'artefact) is a *projet exploratoire* of the Persyval Grant. This project aim to study the use of resizable interactive interface to ease the generation of virtual models. This project is in collaboration with LIG, Gipsa-lab and GSCOP.

7.2. National Initiatives

7.2.1. ANR ROMMA (01/2010-12/2013)

Participants: François Faure, Jean-Claude Léon, Stefanie Hahmann.

The ANR project ROMMA has been accepted in 2009 and started in January 2010. The partners of this project are academic and industry experts in mechanical engineering, numerical simulation, geometric modeling and computer graphics. There are three academic members in the consortium: the LMT in Cachan, G-SCOP and LJK (EVASION and MGMI teams) in Grenoble. There are four industrial members: EADS, which coordinates the project, SAMTECH, DISTENE and ANTECIM. The aim of the project is to efficiently and robustly model very complex mechanical assemblies. We are working on the interactive computation of contacts between mechanical parts using GPU techniques. We will also investigate the Visualization of data with uncertainty, applied in the context of the project.

7.2.2. ANR SOHUSIM (10/2010-09/2014)

Participants: Ali Hamadi Dicko, François Faure.

Sohusim (Soft Human Simulation) is a ANR Project which started on October 1st 2010. It is done in collaboration between: EVASION (Inria), Fatronik France (TECNALIA), DEMAR (Inria), HPC PROJECT and the CHU de Montpellier.

This project deals with the problem of modeling and simulation of soft interactions between humans and objects. At the moment, there is no software capable of modeling the physical behavior of human soft tissues (muscles, fat, skin) in mechanical interaction with the environment. The existing software such as LifeMod or OpenSim, models muscles as links of variable length and applying a force to an articulated stiff skeleton. The management of soft tissues is not taken into account and does not constitute the main objective of this software.

A first axis of this project aims at the simple modeling and simulation of a passive human manipulated by a mecatronics device with for objective the study and the systems design of patient's manipulation with very low mobility (clinic bed). The second axis concentrates on the detailed modeling and the simulation of the interaction of an active lower limb with objects like orthesis, exoskeleton, clothes or shoes. The objective being there also to obtain a tool for design of devices in permanent contact with the human who allows determining the adequate ergonomics in terms of forms, location, materials, according to the aimed use.

Dicko Ali Hamadi is a Ph.D. student within EVASION team. His works turns around the problems in SOHUSIM project. He is co-tutored Olivier Palombi in IMAGINE. A part of this work was presented at Siggraph Asia [5].

7.2.3. ANR CORPUS SPECTABLE EN LIGNES (01/2013-01/2015)

Participant: Rémi Ronfard.

Spectacle En Ligne(s) amplifies our collaboration with the Theatre des Celetins in Lyon, which was started with the Scenoptique project in 2011. Scenoptique investigates novel techniques for recording ultra-high definition video, reframing them and editing them into interactive movies. Spectacle En Ligne(s), is targeted on the creation and diffusion of an original data set of integral vídeo recordings of theatre and opera rehearsals. The data set is naturally suited to researchers interested in the creation process and the genetic analysis of dramatic art and mise en scene. To support research in this area, we are extending the audio and visual analysis tools developed in the Scenoptique project.

7.2.4. FUI Dynam'it (01/2012 - 02/2014)

Participant: Francois Faure.

2-year contract with two industrial partners: TeamTo (production of animated series for television) and Artefacts Studio (video games). The goal is to adapt some technologies created in SOFA, and especially the frame-based deformable objects [34], [33] to practical animation tools. This contract provides us with the funding of two engineers and one graphical artist during two years.

7.2.5. FUI Collodi (October 2013 - October 2016)

Participants: Francois Faure, Romain Testylier.

This 3-year contract with two industrial partners: TeamTo and Mercenaries Engineering (software for production rendering), is a follow-up and a generalization of Dynamit. 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. It will include dynamics similarly to Dynamit, as well as innovative sketch-based kinematic animation techniques invented a Imagine by Martin Guay and Rémi Ronfard. This contract, started in October, funds 2 engineers for 3 years.

7.2.6. ANR CHROME (01/2012 - 08/2015)

Participant: Rémi Ronfard.

Chrome is a national project funded by the French Research Agency (ANR). The project is coordinated by Julien Pettré, member of MimeTIC. Partners are: Inria-Grenoble IMAGINE team (Remi Ronfard), Golaem SAS (Stephane Donikian), and Archivideo (Francois Gruson). The project has been launched in september 2012. The Chrome project develops new and original techniques to massively populate huge environments. The key idea is to base our approach on the crowd patch paradigm that enables populating environments from sets of pre-computed portions of crowd animation. These portions undergo specific conditions to be assembled into large scenes. The question of visual exploration of these complex scenes is also raised in the project. We develop original camera control techniques to explore the most relevant part of the animations without suffering occlusions due to the constantly moving content. A long-term goal of the project is to enable populating a large digital mockup of the whole France (Territoire 3D, provided by Archivideo). Dedicated efficient human animation techniques are required (Golaem). A strong originality of the project is to address the problem of crowded scene visualisation through the scope of virtual camera control, as task which is coordinated by Imagine team-member Rémi Ronfard.

Three phd students are funded by the project. Kevin Jordao is working on interactive design and animation of digital populations and crowds for very large environments. His advisors are Julien Pettré and Marie-Paule Cani. Quentin Galvanne is working on automatic creation of virtual animation in crowded environments. His advisors are Rémi Ronfard and March Christie (Mimetic team, Inria Bretagne). Julien Pettre. Chen-Kin Lim is working on crowd simulation and rendering of the behaviours of various populations using crowd patches. Her advisors are Rémi Ronfard and March Christie (Mimetic team, Inria Bretagne). Julien Pettre.

7.2.7. Action3DS (Caisse des dépôts) (10/2011 - 09/2014)

Participant: Rémi Ronfard.

Action3DS is a national project funded by Caisse des Dépots, as part of the *projet Investissements d'avenir ACTION3DS* research program entitled *Technologies de numérisation et de valorisation des contenus culturels, scientifiques et éducatifs*.

The project is coordinated by Thales Angénieux (Patrick Defay). Partners are Inria (Rémi Ronfard), Lutin Userlab (Chrles Tijus), LIP6 (Bernadette Bouchon-Meunier), GREYC (David Tschumperlé), École nationale supérieure Louis Lumière (Pascal Martin), Binocle (Yves Pupulin), E2V Semiconductors and Device-Alab.

The goal of the project is the developpement of a compact professional stereoscopic camera for 3D broadcast and associated software. Rémi Ronfard is leading a work-package on real-time stereoscopic previsualization, gaze-based camera control and stereoscopic image quality.

The project is funding our new postdoc researcher Christophe Lino who is working on learning-based camera control for stereoscopic 3D cinematography with Rémi Ronfard.

7.2.8. AEN MorphoGenetics (10/2012 - 09/2015)

Participant: François Faure.

3-year collaboration with Inria teams Virtual Plants and Demar, as well as INRA (Agricultural research) and the Physics department of ENS Lyon. The goal is to better understand the coupling of genes and mechanical constraints in the morphogenesis (creation of shape) of plants. Our contribution is to create mechanical models of vegetal cells based on microscopy images. This project funds the Ph.D. thesis of Richard Malgat, who started in October, co-advised by François Faure (IMAGINE) and Arezki Boudaoud (ENS Lyon).

7.2.9. PEPS SEMYO (10/2012 - 09/2014)

Participant: François Faure.

2-year collaboration with Inria team DEMAR (Montpellier) and Institut de Myologie (Paris) to simulate 3D models of pathological muscles, for which no standard model exist. The main idea is to use our mesh-less frame-based model to easily create mechanical models based on segmented MRI images.

7.2.10. MSTIC Adamo (03/2012 - 12/2013)

Participant: Olivier Palombi.

7.3. European & International Initiatives

7.3.1. ERC Grant Expressive (04/2012-03/2017)

Participants: Marie-Paule Cani, Stefanie Hahmann, Jean-Claude Léon.

To make expressive and creative design possible in virtual environments, the goal is to totally move away from conventional 3D techniques, where sophisticated interfaces are used to edit the degrees of freedom of pre-existing geometric or physical models: this paradigm has failed, since even trained digital artists still create on traditional media and only use the computer to reproduce already designed content. To allow creative design in virtual environments, from early draft to progressive refinement and finalization of an idea, both interaction tools and models for shape and motion need to be revisited from a user-centred perspective. The challenge is to develop reactive 3D shapes – a new paradigm for high-level, animated 3D content – that will take form, refine, move and deform based on user intent, expressed through intuitive interaction gestures inserted in a user-knowledge context. Anchored in Computer Graphics, this work reaches the frontier of other domains, from Geometry, Conceptual Design and Simulation to Human Computer Interaction.

7.3.2. PhD grant from USM (University Sains Malaysia) (08/2012 - 07/2015)

This grand from USM funds one PhD student: Chen Kim Lim who is supervised in IMAGINE my Marie-Paule Cani. The subject of the thesis is about crowd modeling and animation.

7.3.3. Piper

The main objective of this European FP7 project is to develop new tools to position and personalize advanced human body models for injury prediction in car crashes. Our partners are automobile constructors and biomechanics research labs. Our main task is to provide tools for the interactive positioning of the models in the cockpits prior to the crash simulation, using our real-time simulation software SOFA. This 42-month contract funds one engineer in Imagine, and we plan to hire post-doc students next year.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Bedrich Benes: Inverse Procedural Modeling. University of Purdue (12/12/2013).
- Paul Kry: Preserving Topology and Elasticity for Embedded Deformable Models. University of Toronto (14/11/2013).
- James Gain: Better Interfaces to Procedural Modelling. University of Cape Town (31/11/2013).
- Joaquim Jorge: Adding More Than Two Dimensions to Tabletop Interfaces. Is Tony Stark home? Universidade de Lisboa (23/09/2013).
- Frédéric Cordier: Inferring 3D curves from sketches, Université de Haute Alsace (11/07/2013)
- Karan Singh: Pose centric animation: support for a primitive artform, Université de Toronto (04/07/2013)
- Julien Pettre: Velocity-based Models for Microscopic Crowd Simulation, Inria Rennes (20/06/2013)
- Ladislav Kavan: Elasticity-Inspired Deformers for Character Articulation University of Pennsylvania (06/06/2013)
- Yotam Gingold: Rescuing Computers from Hard Problems, George Mason University (30/05/2013)
- Eftychios Sifakis: Detailed Functional Simulation of Human Anatomy: Design Challenges, Performance Considerations and Emerging Applications, University of Winsconsin-Madison (23/05/2013)
- Marc Christie: Directors Lens: an intelligent assistant for virtual cinematography, IRISA/Inria Rennes (05/04/2013)
- Loic Barthe: Models for Intuitive Modeling, Université de Toulouse (IRIT) (07/03/2013).

8. Dissemination

8.1. Scientific Animation

8.1.1. Organization of conferences and editorial boards

- Marie-Paule Cani has been associate editor of ACM Transaction on Graphics since July 2013. She served on the programm committees of Shape Modeling International (SMI 2013), of Expressive'2013 (the ACM-EG symposium on Sketch-based Interfaces and Modeling - SBIM, Non-photorealistic Animation and Renderting - NPAR, and Computational Aestethics - CAe), and of the EG Symposium on Geometry Processing (SGP'2013).
- Stefanie Hahmann
  - General co-Chair with Konrad Polthier of the SIAM GD/SPM 2013 conference in Denver

  - Member of the IPC for Eurographics in Girona 2013 and for CAD/Graphics in Hongkong 2013
  - Member of Program committee for the International Conference on Shape Modeling and Applications in Bournemouth 2013 and Computer Graphics International (CGI) Hannover, 2013
- Rémi Ronfard was a Program Committee members for 6 international conferences
  - International Conference on Motion in Games (MIG).
  - International Conference on Interactive Storytelling (ICIDS).
  - ACM conference on Computational Aesthetics (CAE).
  - Workshop on Intelligent Cinematography and Editing (WICED).
  - Workshop on Intelligent Narrative Technologies (INT).
  - International Conference on 3D Imaging (IC3D).
- Jean-Claude Léon was Member of the scientific board of SBIM 2014.
- François Faure was chairing the Eurographics working group on *Animation and Simulation*.
- Damien Rohmer
  - Member of the Technical Brief & Posters committee for SIGGRAPH Asia 2013.
  - Member of the Short Paper committee for Eurographics 2014.

8.1.2. Management and administration of scientific organisations

- Marie-Paule Cani has been vice chair of the Eurographics association since January 2013. She has been chairing the steering committee of the Eurographics conference since May 2013. She is a member of the ACM Publication Board. She is also member of the steering committees of the SMI and Expressive international conferences.
  In France, Marie-Paule Cani is a member of the executive board of the GRD IG-RV (Informatique Graphique - Réalité Virtuelle) of CNRS, and an EC member of the french chapter of Eurographics.
- François Faure is a member of the Conseil du Laboratoire at LJK.
- Stefanie Hahmann
  - Member of the SMA Executive Committee (Shape Modeling Association)
  - President of GTMG (Groupe de Travail en Modélisation Géométrique) part of GDR IM and GDR IG.
  - International expert for the Italian Research and University Evaluation Agency (ANVUR)
  - Member of the Conseil du Laboratoire at LJK.
  - Responsible of Maths-Info department of the Grenoble doctoral school MSTII.
- Olivier Palombi is a member of the scientific board of ECCAMI (Excellence center for computer assisted medical interventions).
- Rémi Ronfard is the Director of the Geometry and Image Department, Laboratoire Jean Kuntzman, Université de Grenoble.

8.1.3. Public dissemination

- Damien Rohmer is involved in the Hévéa project working on the mathematical model of the flat torus. This flat torus has been highlighted in various medias during the year 2013 (fig. 13).
  - The flat torus and its vizualisation has been published in several diffusion journal
    - Pour la Science, n. 425, mars 2013. *Les fractales lisses, un nouvel objet mathématique*
    - La Recherche, n. 471, janvier 2013. The flat torus is cited as the 5th most important discovery of 2012.

    * Science & Vie, decembre 2012. *Le tore plat n'a plus de secrets.*
    * Cover of the magazine *CNRS Rhone-Auvergne*
    * Images des Maths, decembre 2012, *Rothorn un tore plat!*
    * Images des Maths, decembre 2012, *Gnash! un tore plat!*
  - 14 posters were created for the *Fête de la science* in Lyon to explains the model of he flat torus in October 2013.
  - From October to December 2013, the flat torus was highlighted in the art exhibition *Formes élémentaires* in Gyuancourt.
  - In 2014, a large image of the flat torus is exposed in the subway of Paris at the Montparnasse station.
- Rémi Ronfard gave an invited talk at the International Federation for Theatre Research where he presented his ongoings projects Scenoptique and Spectaclenligne(s) for recording, analyzing and editing theatre performances and rehearsals.
  He co-chaired a national meeting on the analysis and understanding of emotions, as part of the working group on "action and gesture", CNRS GDR ISIS, and the ARC6 region network, in Lyon in October 2013.
  Remi Ronfard organized an INTECH workshop on the convergence between digital cinéma and interactive games, which attracted 100 participants from research and industry to Inria Rhone Alpes (http://www.inria.fr/centre/grenoble/actualites/cinema-et-jeu-video-la-convergence-passe-par-inria).

Figure 13. Various diffusions foccusing on the flat torus project.

8.2. Teaching - Supervision

8.2.1. Responsabilities of academic programs

- Marie-Paule Cani is responsible for two courses at Ensimag/Grenoble-INP: 3D Graphics (a course that attracts about 80 master 1 students per year) and IRL (Introduction à la recherche en laboratoire), a course enabling engineering students to work on a personal project in a reseach lab during one semester, to get an idea of what academic research is.
- Stefanie Hahmann is co-responsible of the MMIS (Images and Applied Maths) department at University ENSIMAG/Grenoble INP.
- Olivier Palombi is responsible of the French Campus numérique of anatomy.
  Olivier Palombi is responsible and national leader of the project SIDES (http://side-sante.org/). All the French medical schools (43) have planed to use the same e-learning framework (SIDES) to manage evaluations (examen) and to create a large shared database of questions.

- François Faure was responsible of the GVR-(Graphics, Vision and Robotic) programm in the MOSIG Master.
- Damien Rohmer is coordinator of the Math-Info-Image program in the school CPE Lyon.
- Rémi Ronfard served as president of the jury for Master 2 students at the University of Grenoble, Mathématiques et Informatique, option Graphique, Vision et Robotique (GVR).

Note that MOSIG is joint master program between University Joseph Fourier (UJF) and Institut Polytechnique de Grenoble (INPG) taught in English since it hosts a number of internal students. If belongs to the doctoral school MSTII.

8.2.2. Educational activities

Most of the members of our team are Professor or Assistant Professor in University where the common teaching load is about 200h per year. Rémi Ronfard who is only researcher usually perform some teaching in delegation.

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