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Université Joseph Fourier (Grenoble)

Activity Report 2012

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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Team IMAGINE

Keywords: Computer Graphics, Geometry Modeling, Computer Animation, Interaction, Ontology Matching, Interactive Graphics

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

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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

- CNRS Silver medal awarded to Marie-Paule Cani.
- We organized the International conference EXPRESSIVE 2012 (CAe, SBIM, NPAR) in Annecy in June 2012 and gathered 85 participants. The local and conference chair were respectively Jean-Claude Léon and Marie-Paule Cani (http://cae-sbim-npar-2012.inrialpes.fr/).
- Two publications were accepted at SIGGRAPH 2012: [1], [8], and one extra publication as a TOG paper [4].

3. Scientific Foundations

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. 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. Application Domains

4.1. 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)

5. Software

5.1. MyCorporisFabrica

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

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.

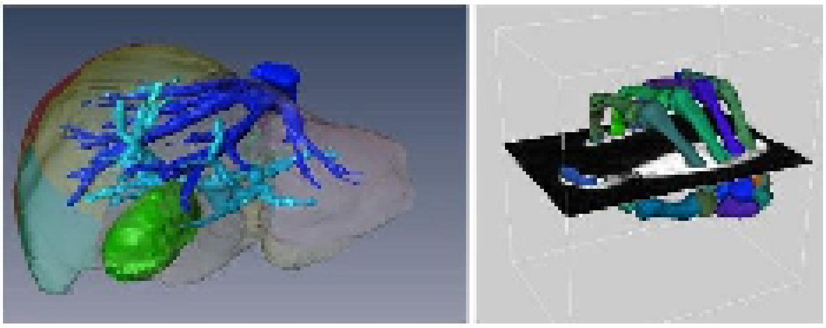

Figure 1. My Corporis Fabrica is an anatomical knowledge database developed in our team.

5.2. SOFA

Participants: Guillaume Bousquet, Ali Hamadi Dicko, François Faure, François Jourdes.

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.

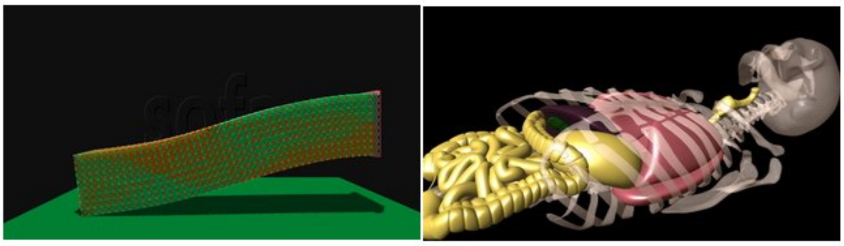

Figure 2. SOFA is an open source simulator for physically based modeling.

5.3. Convol

Participants: Marie-Paule Cani, Amaury Jung, Galel Koraa, Maxime Quiblier, Cédric Zanni.

Convol is a new C++ library we develop for easing our work on implicit surfaces – and more particularly on the sub-class of convolution surfaces. It enables us to make our latest research results soon available to the rest of the group and easily usable in our industrial partnerships. Convol incorporates all the necessary material for constructive implicit modeling: skeleton-based distance and convolution 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 skeleton or through sketch based modeling.

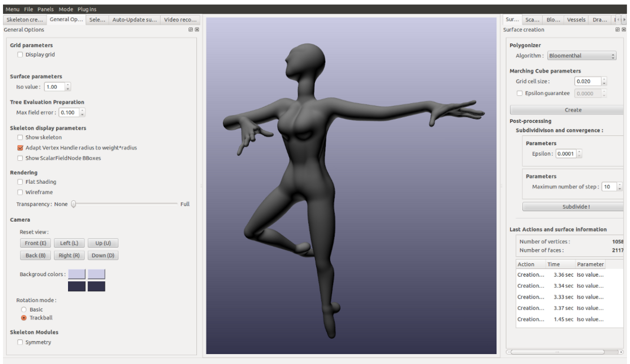

Figure 3. Example of implicit surface and the GUI proposed in the Convol software.

This development is funded by Inria as support to our research group.

6. New Results

6.1. 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 2012 for each axis.

6.2. High level model for shapes

Scientist in charge: Stefanie Hahmann

Other permanent researchers: Marie-Paule Cani, Jean-Claude Léon, Damien Rohmer.

6.2.1. Implicit surface modeling

Participants: Adrien Bernhardt, Marie-Paule Cani, Maxime Quiblier, 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 a researcher in formal computation, Evelyne Hubert, we improved and extended the analytical methods for computing closed form solutions for convolution surfaces [6].

Within Cédric Zanni's PhD we proposed a method based on anisotropic, surface Gabor noise, for generating procedural details on skeleton-based implicit surfaces, see Figure 4(left). The surfaces enhanced with details can still be smoothly blended, with a natural transition between the details they carry [19].

We also developed an extension to convolution surfaces, so-called scale-invariant integral surfaces, see Figure 4(right). Thanks to blending properties that are scale invariant these surfaces have three major advantages: the radius of the surface around a skeleton can be explicitly controlled, shapes generated in blending regions are self-similar regardless of the scale of the model, and thin shape components are not smoothed-out anymore when blended into larger ones. This work has been presented at AFIG2012 [23] and submitted for international publication.

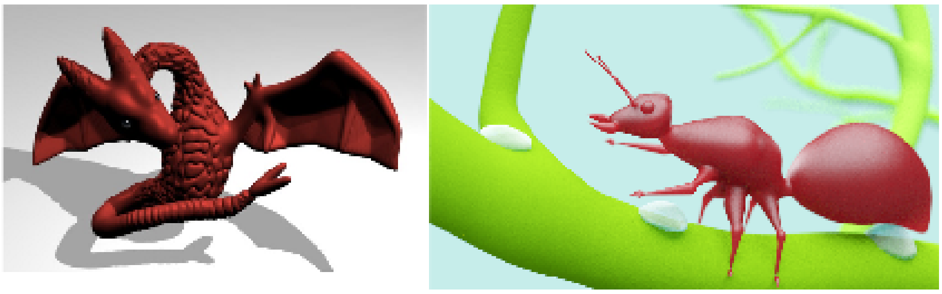

Figure 4. Left: Dragon model showing the variety of details that can be generated. Computation time was less than 2 minutes. Right: Shape obtained by the use of scale-invariant integral surfaces.

Lastly, in collaboration with Loic Barthe in Toulouse, we contributed to a new blending operator, gradient blending, which enables us to blend implicit shapes not only in function of the 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. A paper has been accepted for publication in ACM ToG [4].

6.2.2. Developable surfaces

Participants: Rémi Brouet, Marie-Paule Cani, Stefanie Hahmann, Damien Rohmer.

Figure 5. Design preserving garment transfer of a multi-layer outfit from a woman to a young girl. Middle: Automatically graded patterns shown to scale. Right: The zoomed-in source and target patterns for the back panel highlight the subtle changes in shape

A developable surface is a surface, which can be unfolded (developed) into a plane without stretching or tearing. Because of this property, developable surfaces lead to a variety of applications in manufacturing with materials that are not amenable to stretching (leather for shoes or hand bags, skins of aircrafts, sails). In computer graphics developable surfaces are very popular to model, simulate or animate clothes or folded papers in virtual environments.

In collaboration with Alla Sheffer (University of British Columbia, Canada visiting Inria) we developed a fully automatic method for design-preserving transfer of garments between characters with different body shapes. The method is able to generate design-preserving versions of existing garments for target characters whose proportions and body shape significantly differ from those of the source. The work has been presented at SIGGRAPH 2012 [1].

Folded paper exhibits very characteristic shapes, due to the presence of sharp folds and to exact isometry with a given planar pattern. In the past we proposed a purely geometric solution to generate static folded paper geometry from a 2D pattern and a 3D placement of its contour curve. Current research focuss on the interactive manipulation of the folded surface without the strong requirement of starting by an initial contour curve, but using sparser positional constraints on the surface.

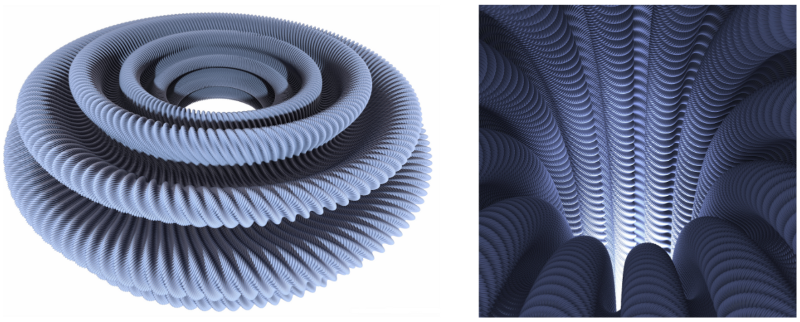

Figure 6. The first representation of a flat torus.

Damien Rohmer joined in 2012 the Hevea project: this is a project in collaboration between Vincent Borrelli (Institut Camille Jordan, Lyon), Boris Thibert (MGMI, LJK Grenoble) and Francis Lazarus (Gipsa Lab, Grenoble) focussed on the generation and visualisation of the flat torus. The flat torus is a mathematical smooth surface with the topology of a torus but having locally the metric of the plane. In other word, this is a developable torus. So far, no representation of such object had ever being made. In 2012, based on a convex integration algorithm generating coherent wrinkles on the torus called *corrugations*, we generated the first representation of such object that is both C^1 while being fractal as the number of wrinkles has to tend to infinity to converge toward true developability. The rendering made by Damien Rohmer has been used for the cover image of Proceedings of the National Academy of Sciences (PNAS) (http://www.pnas.org/content/109/19.cover-expansion).

6.2.3. Parametric surfaces

Participant: Stefanie Hahmann.

We are developing new smooth parametric surface models defined on irregular quad meshes. They are in fact a powerful alternative to singularly parameterized tensor product surfaces since they combine the advantages of both, the arbitrary topology of quad meshes and the smoothness of the tensor product patches.

In collaboration with G.-P. Bonneau (Maverick team) several parametric triangular surface models for arbitrary topologies have been published in the past (CAGD, IEEE TVCG and ACM ToG). A new tensor product spline surface model has been developed this year. It solves the problem of defining a G^1-continuous surface interpolating the vertices of an irregular quad mesh with low degree polynomial tensor product patches. It further aims to produce shapes of very high visual quality while reducing the number of control points. A comparison with existing methods and a journal paper are in preparation.

6.2.4. Fibrous structures

Participant: Damien Rohmer.

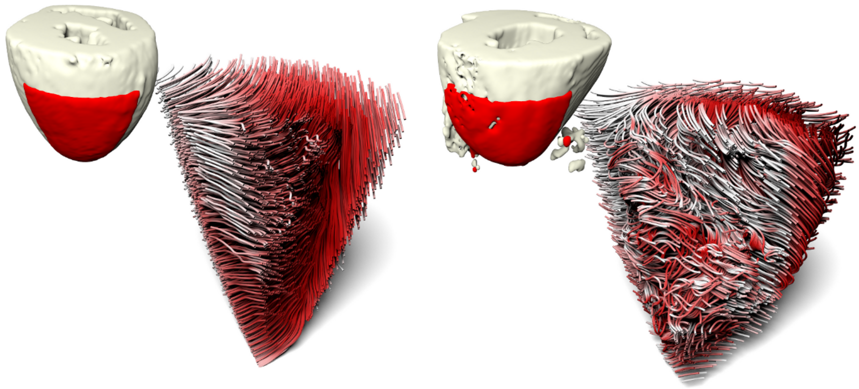

Figure 7. Visualization of fibrous structure in the heart for a normal case (left) and a defect heart (right).

Due to anisotropy, fibrous structures may exhibit complex deformation properties. These properties are of main interest to understand the behavior of some human organs such as the heart.

In collaboration with Grant Gullberg, Archontis Giannakidis from Lawrence Berkeley Laboratory, and Alexander Veress from University of Washington we developped a new visualization of heart defects based on the fibrous structure organization. Combining 3D visualization with the fiber structure analysis may help to detect heart defects such as cardiac Hypertrophy. This work as been published as a book chapter [29].

6.2.5. Virtual Prototypes

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

In the context of virtual prototyping (process of product development involving CAD/CAE software), a DMU (digital mock up) is the container of all the components of a 3D virtual product that be used during design and simulations.

Herein geometric interfaces, i.e. the imprint of a component onto each of its neighboring components, must be taken into account to generate simulation models. Indeed, a DMU does not contain these geometric interfaces. However, extensive use of CAD assemblies has led to increasingly complex DMUs with up to hundreds of thousands of components. The detection and generation of the geometric interfaces between all components with existing software is a very tedious task, which may require hours or days of user-interaction or is even not possible. As part of the ANR project ROMMA in collaboration with Georges-Pierre Bonneau and Francois Jourdes from the Maverick team, we developed a new method to rapidly detect and precisely describe the geometry of interfaces in highly complex assemblies [20].

Within the PhD of Flavien Boussuge, we take advantage of these interfaces to focus on the generation of mixed dimensional models from enriched DMUs for FE analysis of structural assemblies. The goal is to provide a methodology and operators for transforming geometries of complex assemblies so that they are directly usable for FE mesh generation. A first contribution to assembly model preparation for simulation has been presented at ECT12 [11]. Herein, a model preparation methodology has been proposed that addresses the shape transformation categories specific to assemblies. Current and future research includes the generation of construction graphs of volume models that contribute to idealization operators. These algorithms take the simulation objectives into account as part of the proposed methodology.

Another important issue connected to geometry transformation of assemblies and construction graphs of volume models relates to the global as well as partial symmetries of components and assemblies. Here, symmetry analysis is applied to B-Rep NURBS models and must be obtained within the tolerance of a geometric modeler, which differs rather significantly from approximate symmetries extracted from meshes. The symmetry analysis helps structuring the construction graphs of volume models to take into account repetitive locations of primitives. Also, symmetry properties combine with functional annotations of components to enhance their search and retrieval[16].

6.3. Models for real-time motion synthesis

Scientist in charge: François Faure

Other permanent researchers: Marie-Paule Cani, Damien Rohmer, Rémi Ronfard.

6.3.1. Interactive manipulation of folded paper surfaces

Participant: Damien Rohmer.

Although physically-based simulation has become very popular to model deformable surfaces such as cloth it is still not applicable to generate animations of creased paper. Due to the stiffness of this uncompressible material and to the complex changes of its mechanical behavior during creasing. As a result, this standard material in every-day life almost never appears in Computer Graphics applications such as movies or video games. Animating creased paper brings two main challenges: First, such surface needs to be deformed while preserving its length in every direction according to its original pattern. Secondly, sharp features, which are not commonly handled in numerical simulators, need to be generated on the surface.

With the master work of Ulysse Vimont, we developped a prototype (as seen in fig. 8) of a deformation tool enabling to interactively manipulate a virtual sheet of paper. The approach is a procedural approach based on some geometrical apriori knowledge of behavior of paper under deformation. We plan to extend this work in the next year with a new master student Camille Shreck.

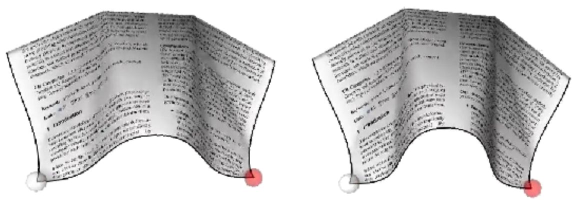

Figure 8. Example of interactive manipulation of a sheet of paper.

6.3.2. Real-time skinning deformation with contacts

Participants: Marie-Paule Cani, Damien Rohmer.

Skinning deformation based on linear blending or dual quaternion approach is a very popular technique thanks to its fast computation. However, they do not capture the complex behavior of flesh bulging and contact between body parts.

In collaboration with Loic Barthe, Rodolphe Vaillant from IRIT Toulouse, and Gael Guennebaud from LaBRI Bordeaux, we developped a skinnning deformation handling both flesh bulges and collision avoidance.

An implicit surface is first fitted onto the original mesh surface. During the animation, the mesh is deformed using a standard skinning deformation while the implicit surface follows the rigid articulation of the bone. Finaly, the mesh is projected back toward the deformed implicit surface enabling to both compensate for mesh collapse and self collision. This work has been presented in AFIG [10] conference and won the *best article* award. It has also being accepted for publication in the REFIG Journal.

6.3.3. Particle-based simulation of concrete structures

Participants: Marie Durand, François Faure.

In collaboration with the LIG and L3S-R labs, we have published results on gpu-accelerated simulation of concrete fracturation due to impacts [2], leading to a speedup factor of about 15 compared to a CPU implementation. This led us to notice that collision detection was the major bottleneck. Consequently, we investigated and published a new incremental sorting method to more efficiently cluster the particles along a Z-curve, by improving the Packed Memory Array data structure for fast updates [15], as illustrated in Figure 9. We have proposed a new strategy to efficiently update the sorting, while maintaining a desired fill rate in each branch of the tree structure. Experiments show that our PMA can outperform a compact sorted array for up to 50% particle cell changes per time step.

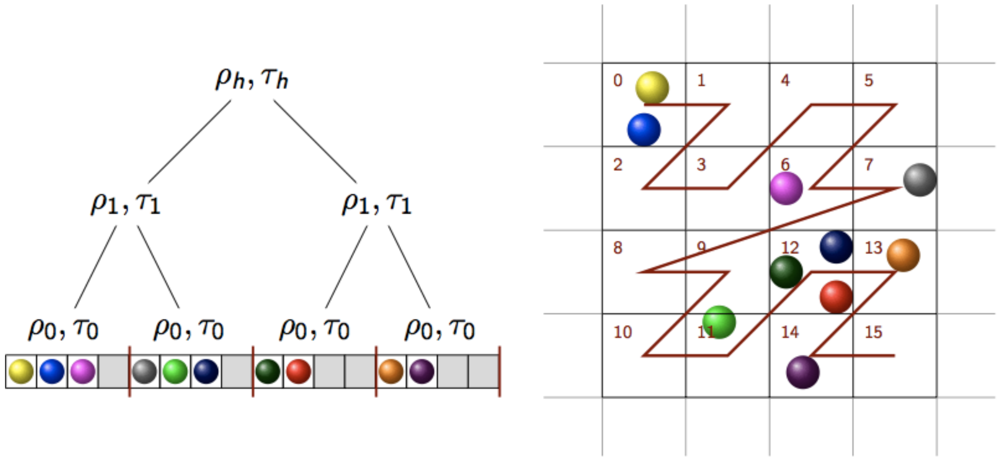

Figure 9. Z-sort using a Packed Memory Array structure. The gaps allow fast updates.

6.3.4. Collision detection and response

Participant: François Faure.

In collaboration with UBC, Vancouver, we have presented at SIGGRAPH 2012 a new method for image-based contact detection and modeling, with guaranteed precision on the intersection volume [8]. Unlike previous image-based methods, our method optimizes a nonuniform ray sampling resolution and allows precise control of the volume error. By cumulatively projecting all mesh edges into a generalized 2D texture, we construct a novel data structure, the Error Bound Polynomial Image (EBPI), which allows efficient computation of the maximum volume error as a function of ray density. Based on a precision criterion, EBPI pixels are subdivided or clustered. The rays are then cast in the projection direction according to the non-uniform resolution. The EBPI data, combined with ray-surface intersection points and normals, is also used to detect transient edges at surface intersections. This allows us to model intersection volumes at arbitrary resolution, while avoiding the geometric computation of mesh intersections. Moreover, the ray casting acceleration data structures can be reused for the generation of high quality images, as illustrated in Figure 10.

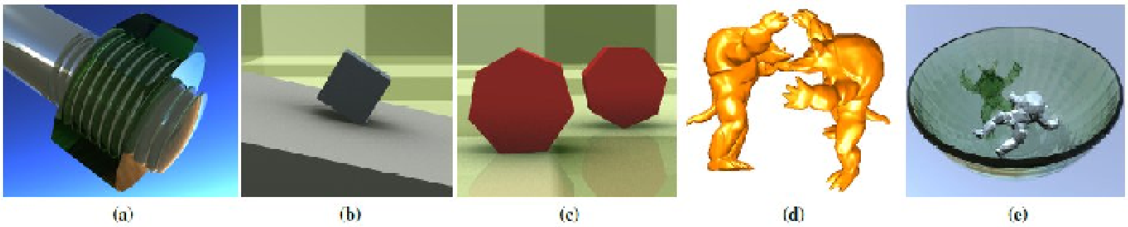

Figure 10. Examples of challenging contact scenarios handled by our method. (a) The movement of a tight fitting nut on a bolt can be simulated directly using the geometric models. (b) Very small geometric features on a flat surface can dramatically change the behavior of objects sliding on it. (c) "Ruina wheels." Two almost identical wheels have obviously different rolling behavior due to subtle features (one is slightly convex and another is slightly concave); our method can simulate this contact behavior realistically. (d) A simulation with 4:4 million triangles. (e) A snapshot of an interactive simulation with ray-traced rendering.

6.3.5. Action representation, segmentation and recognition

Participant: Remi Ronfard.

Following Daniel Weinland's PhD thesis, we published a survey of modern methods for representing, segmenting and recognizing full-body actions in video [32]. A taxonomy of methods is elaborated in that paper, where actions can be represented with local, structured or global features both in time and in space. The potential for future work in grammar-based action recognition is emphasized, with possible applications in corpus-based procedural modeling of actions.

6.3.6. Simulation software architecture

Participants: Ali-Hamadi Dicko, Guillaume Bousquet, Françcois Faure.

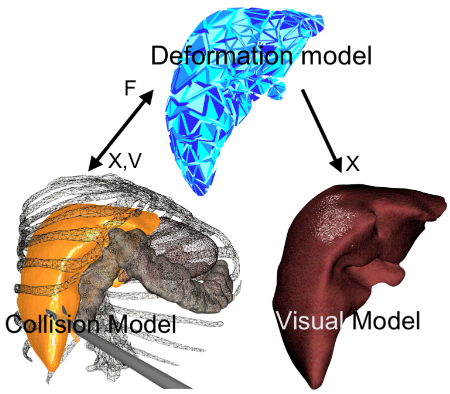

Figure 11. A simulated Liver. Three representations are used: one master model for the internal deformable mechanics, one for the collisions, and one for the visualization. Mappings (black arrows) are used to propagate positions (X) and velocities (V) from master to slaves, while forces (F) are propagated in the opposite direction

We continue the development of SOFA, the open source simulation library, which is becoming an international reference, and we have published a chapter on it in a Springer book [28]. SOFA facilitates collaborations between specialists from various domains, by decomposing complex simulators into components designed independently and organized in a scenegraph data structure. Each component encapsulates one of the aspects of a simulation, such as the degrees of freedom, the forces and constraints, the differential equations, the main loop algorithms, the linear solvers, the collision detection algorithms or the interaction devices. The simulated objects can be represented using several models, each of them optimized for a different task such as the computation of internal forces, collision detection, haptics or visual display, as illustrated in Figure 11. These models are synchronized during the simulation using a mapping mechanism. CPU and GPU implementations can be transparently combined to exploit the computational power of modern hardware architectures. Thanks to this flexible yet efficient architecture, SOFA can be used as a test-bed to compare models and algorithms, or as a basis for the development of complex, high-performance simulators

6.3.7. Real time fluid animation on GPU

Participant: Martin Guay.

In collaboration with Manuel Vennier (Maverick, Inria), we developped a simple and fast method to animate fluids on the GPU. Inspired from the classical SPH method (Smooth Particles Hydrodynamics), we express a weekly compressible formulation for the fluid animation. Contrary to standard approaches, we fully developed the formulation on a grid, leading to an efficient GPU implementation. The method replace the implicit formulation of pressure by an explicit one based on density invariance. We therefore propose a method to simulate 3D Eulerian gaseous fluids in a single pass on the GPU. The results published in [22] are less accurate than a standard fluid simulation approach, but lead to real-time fluid-looking models (see fig. 12) which are practicable for video games or other interactive applications.

Figure 12. Example of fluid results obtained by our approach in [22].

6.4. Knowledge-based models for narrative design

Scientist in charge: Rémi Ronfard

Other permanent researchers: François Faure, Jean-Claude Léon, Olivier Palombi

6.4.1. Computational model of film editing

Participants: Remi Ronfard, Quentin Galvane.

Collaboration with the Mimetic team (Marc Christie) is continuing on this topic as part of the CINECITA (ANR jeune chercheur) and CHROME (ANR) projects.

We presented a survey of automatic video editing and new results from our ongoing collaboration at the first workshop on intelligent cinematography and editing (WICED) which took place during the Foundation of Digital Games (FDG) international conference [18], [14].

6.4.2. Stochastic Plex Grammars

Participant: Remi Ronfard.

During Quentin Doussot's master thesis, we experimented with stochastic plex grammars, which proved to be efficient for generating 3D scenes in the style of Keith Haring [17]. The model is able to generate static scenes by assembling colorful body parts into Keith Haring figures. The model is also able to simulate Markov chains of such figures by randomly changing attributes and composition of the scene.

6.4.3. Reframing theatre performances

Participants: Remi Ronfard, Vineet Gandhi.

In 2012, we made full-hd video recordings of rehearsals and performances at Celestins - Theatre de Lyon:

- A l'Ouest, directed by Nathalie Fillion. Coproduction - Théâtre du Rond-Point, Célestins, Théâtre de Lyon, Cie Théâtre du Baldaquin, AskUs , Le Gallia Théâtre-Saintes. Coproduction - Théâtre du Rond-Point, Célestins, Théâtre de Lyon, Cie Théâtre du Baldaquin, AskUs , Le Gallia Théâtre, Saintes.
- Lorenzaccio, directed by Claudia Stavisky, Théâtre de Saint Petersbourg.
- Mort d'un commis, directed by Claudia Stavisky, Célestins, Théâtre de Lyon.

As part of his PhD thesis, Vineet Gandhi developped novel algorithms for actor detection and naming. This has been tested on movies as well as theatre performances. Current work is focusing on automatically reframing those recordings into cinematically-valid shots focusing on one or more actors.

A related thread of work was started for semantic annotation of the recordings using the syntax and semantics of blocking notations, a symbolic notation used in North-American theatres [25].

6.4.4. Virtual theatre rehearsals

Participant: Remi Ronfard.

We are starting to investigate the possibility of rehearsing theatre plays with real and virtual actors, using extensions of interactive scores initially proposed for computer music. A position paper was presented to researchers in theatre studies during a seminar on the notation of theatre [24].

6.4.5. Extracting functional information from assembly models

Participants: Jean-Claude Léon, Ahmad Shahwan, Olivier Palombi.

Assembly models of products, as available from CAD software reduce to a set of independent geometric models of its components and a logical structure of the assembly described as a tree containing components' names. Such a model lacks of geometric connections between its components and the work performed at 6.5 contributes already to structure the geometric model of each component with its geometric interfaces. However, the assembly tree structure and components' names still have no connection with the geometric model of components and their names don't convey robust information because their are user chosen. Here, the purpose is to set tight connections between components' geometric models and their functions. Using dualities between geometric interfaces and interaction forces, it is possible to initialize qualitative mechanical values at each geometric interface, producing different possible configurations.

Then, the proposed approach builds upon relationships between function, behavior and shape to derive functional information from the geometry of component interfaces. Among these concepts, the concept of behavior is more difficult to set up and connect to the geometry of interfaces and functions. Indeed, states and design rules are introduced to express the behavior of components through a qualitative reasoning process [7]. This reasoning process, in turn, takes advantage of domain knowledge rules and facts, checking the validity of certain hypotheses that must hold true all along a specific state of the product's lifecycle, such as operational, stand-by or relaxed states. Eliminating configurations at geometric interfaces that contradict one or more of those hypotheses in their corresponding reference state reduces ambiguity, subsequently producing functional information in a bottom-up manner.

This bottom-up process starts with the generation of a Conventional Interfaces Graph (CIG) with components as nodes, and conventional interfaces (CI: the geometric interfaces) as arcs. A CI is initially defined by a geometric interaction that can be a contact or an interference between two components. CIs are then populated with Functional Interpretations (FI) according to their geometric properties, producing potentially many combinations. A first step of the reasoning process, the validation against reference states, reduces the number of FIs per CI. Then, a matching process takes place using inferences of an ontology reasoner to produce a functional designation of each component. The ontology is based on several taxonomies: conventional interfaces, functional interfaces and functional designations that are connected through the qualitative reasoning process. As a result, the geometric model of each component assigned with a functional designation becomes intrinsically structured with functional interfaces (see Figure 13). Structured models can be used to perform high level shape transformations like virtual prototypes. MyCorporisFabrica is a software framework we started to connect to. This activity is part of the ANR ROMMA project. It is a first contribution to simulation scenarios.

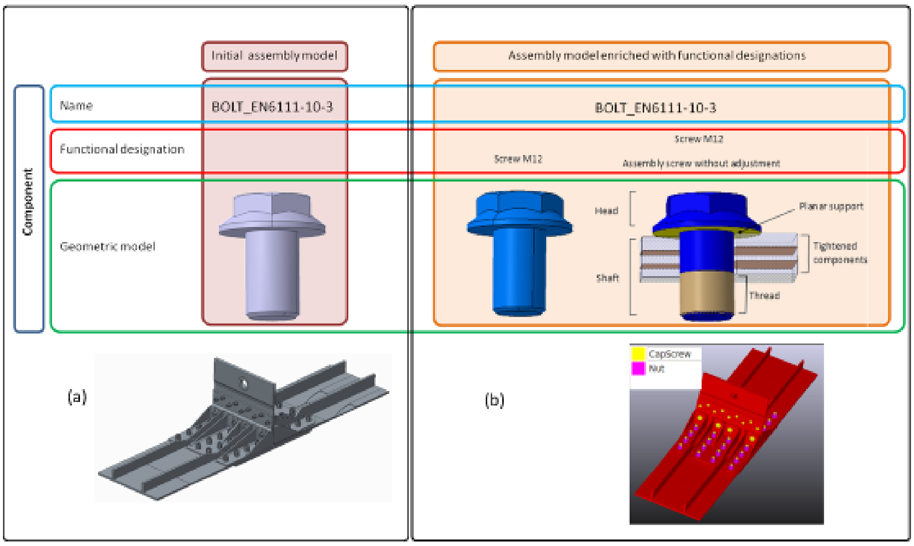

Figure 13. An example of assembly before (a) and after (b) the extraction of functional information. The upper part shows the influence of the extraction process on the structure of components' geometric models. The lower part illustrates the extraction process applied to a mechanical assembly.

6.4.6. Anatomical models

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

We continue the development and the exploitation of MyCF, our ontology-centered anatomical knowledge base, in collaboration with the Grenoble University Hospital, and the DEMAR team in Montpellier (Benjamin Gilles).

We have presented a novel pipeline for the construction of biomechanical simulations by combining generic anatomical knowledge with specific data [27], [21], as illustrated in Figure 14. Based on functional descriptors supplied by the user, the list of the involved anatomical entities (currently bones and muscles) is generated using formal knowledge stored in ontologies, as well as a physical model based on reference geometry and mechanical parameters. This simulation-ready model can then be registered to subject-specific geometry to perform customized simulations. The user can provide additional specific geometry, such as a simulation mesh, to assemble with the reference geometry. Subject-specific information can also be used to individualize each functional model. The model can then be visualized and animated. This pipeline dramatically eases the creation of biomechanical models.

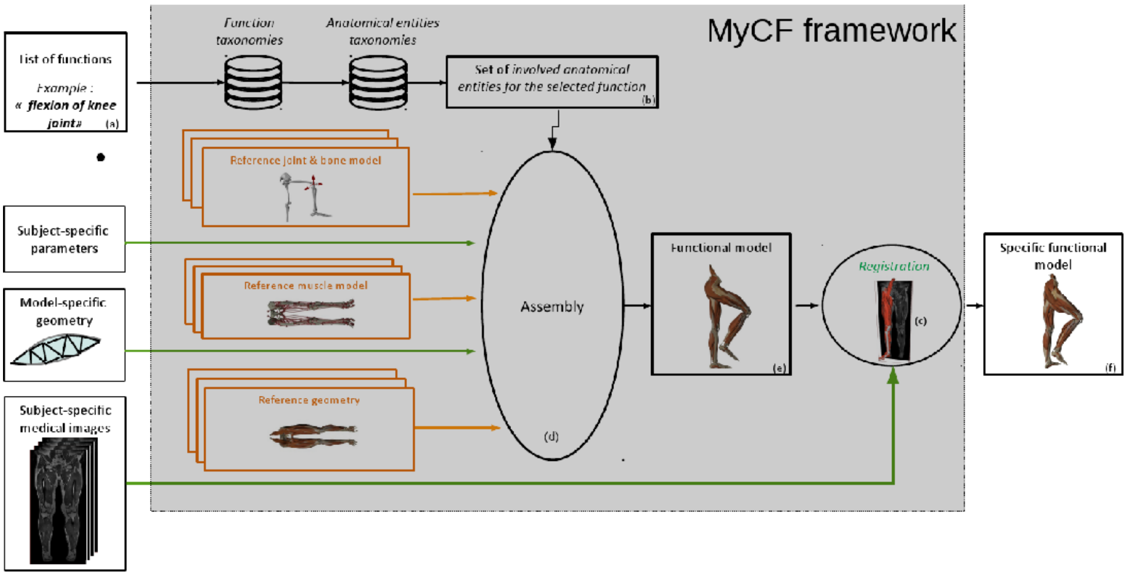

Figure 14. An overview of our modeling framework. On the left, the user input is a list of functions to simulate, optionally complemented with specific data. On the right, the output is a mechanical model ready for simulation. The modeling pipeline uses symbolic knowledge to select anatomical entities to assemble. The final model can be composed of a mix of reference and specific parameters and geometry.

6.4.7. Managing morphological and functional information of the human body

Participants: Olivier Palombi, Ali-Hamadi Dicko, François Faure, Jean-Claude Léon, Ahmad Shahwan.

My Corporis Fabrica (MyCF) is an anatomical knowledge database. During 2012, we have linked functional entities defined in MyCF to the involved anatomical structures. The scope has been limited to the musculoskeletal system. Based on this brain new formal description of the functional anatomy of limbs, we present a novel pipeline for the construction of biomechanical simulations by combining generic anatomical knowledge with specific data. This pipeline dramatically eases the creation of biomechanical models [27].

MyCF-Browser which is the GUI of MyCF has been completely reviewed and rewritten. The MyCf's style software architecture is REST (Representational State Transfer) that has emerged as a predominant Web service design model. The anatomical knowledge is now available through a WEB service. The next step is to write a full web MyCF-Browser. 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.

6.5. Creating and interacting with virtual prototypes

Scientist in charge: Jean-Claude Léon

Other permanent researchers: Marie-Paule Cani, Rémi Ronfard, Olivier Palombi

6.5.1. Space deformations

Participant: Stefanie Hahmann.

Free Form Deformation (FFD) is a well-established technique for deforming arbitrary object shapes in space. Although more recent deformation techniques have been introduced, amongst them skeleton-based deformation and cage based deformation, the simple and versatile nature of FFD is a strong advantage, and justifies its presence in nowadays leading commercial geometric modeling and animation software systems. Several authors have addressed the problem of volume preserving FFD. These previous approaches however make either use of expensive non-linear optimization techniques, or resort to first order approximation suitable only for small-scale deformations. Our approach was to take advantage from the multi-linear nature of the volume constraint in order to derive a simple, exact and explicit solution to the problem of volume preserving FFD. Two variants of the algorithm have been developed, without and with direct shape manipulation. Moreover, we showed that the linearity of our solution enables to implement it efficiently on GPU. This work has been done in collaboration with Gershon Elber from TECHNION, Hans Hagen from TU Kaiserslautern, Georges-Pierre Bonneau and Sébastien Barbier from Maverick Inria. It has been published in the journal The Visual Computer [5].

Figure 15. Comparison between standard FFD deformation (middle) and our method preserving the volume (right) from an initial rest shape (left).

Within Lucian Stanculescu PhD, we developped a mesh structure that dynamically adapts to the deformation defined by the user. Thanks to the quasi-uniform property of the mesh, it can be locally extended by any arbitrary deformation, and the mesh can also hanlde changes of topologies to be used as a virtual sculpting tool. This year we extend this work to handle local features such as sharp edges. In defining features (points or curves) over the surface we can interactively define meaningfull regions limiting the influence of the deformation tools, or to ease artistic decorration mapping such as textures or extra geometric layers. We aim to generate a new tool enabling to sculpt objects which blend between organic to CAD-style appearance.

6.5.2. Procedural modeling of terrains and cities

Participants: Adrien Bernhard, Marie-Paule Cani, Arnaud Emilien.

Within the PhD of Adrien Bernhard we introduced a real-time terrain modeling tool using a fast GPU-based terrain solver with a lightweight CPU-based data structure.

We then work on adding roads and settlements on this terrain within the PhD of Arnaud Emilien. We focused on the modeling of small, European villages that took benefit of terrain features to settle in safe, sunny or simply convenient places. We introduced a three step procedural method [3] for generating scattered settlements on arbitrary terrains, enabling villages and hamlets, with the associated roads, forests and fields to be built on arbitrary landscapes.

6.5.3. Hand Navigator

Participant: Jean-Claude Léon.

Figure 16. Fortified village at the top of a cliff, using a war-time growth scenario followed by farming style settlement.

The different deformation models we developed in the past few years open the problem of providing intuitive interaction tools for specifying the desired deformations in real-time. Therefore, work has focused on developing new devices to investigate interactions incorporating a rather large number of parameters. For the past three years, we focused on developing a peripheral device similar to a mouse, called the HandNavigator, enabling to control simultaneously ten or more degrees of freedom of a virtual hand. This device developed in collaboration with Jean-Rémy Chardonnet (Inst. Image, Arts et Métiers ParisTech) consists in a 3D mouse for the position and orientation of the hand in 3D space, enhanced with many sensors for moving and monitoring the virtual fingers. Thanks to a pre-industrialization project funded by the incubator GRAVIT, the first prototype, patented by Inria, has been extended with the incorporation of new sensors and new shapes to improve the device efficiency and evolve toward a passive haptic device (see Figure 17). An extension of the patent and a partnership with HAPTION company are new steps toward the industrialization of this device. The partnership with HAPTION focuses on grasping actions to use the Hand Navigator as a complement to their haptic feedback device. Publications took place after setting up the patent extension [12], [13]. The ongoing BQR INTUACTIVE funded by Grenoble-INP will lead to further scientific topics regarding interactions during grasping as well as with deformable bodies and a partnership is ongoing with GIPSA-Lab to study the muscular activity during interactions. A specific experiment has been set up to study the user's muscles activity.

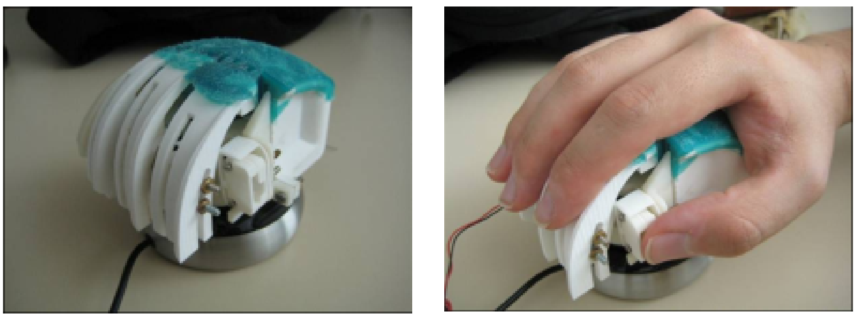

Figure 17. Current version of the HandNavigator prototype with three sensors per finger and a vibration damping structure.

7. Bilateral Contracts and Grants with Industry

7.1. Bilateral Contracts and Grants with Industry

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

Participants: Jean-Claude Léon, Stefanie Hahmann.

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. Some results from the homology computation topic may be used in the present context. An ongoing publication should address the description of the various stages of a component shape transformation in the context of assemblies.

7.1.2. HAPTIHAND technology transfer project (Inria-HAPTION-Arts et Métiers ParisTech) (10/2012-12/2013)

Participant: 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. 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, a research study about the optimal use of the device as well as a project management task.

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. BQR Intuactive 06/2011-12/2012

Participants: Rémi Brouet, Marie-Paule Cani, Jean-Claude Léon.

The Intuactive project is a collaboration between our research group, the conception group of G-scop lab, and the HCI group of LIG lab. The goial is to develop and compare 2D vs 3D interaction for selecting, placing and editing 3D shapes. The project is funded by Grenoble-INP and provides the grant for Rémi Brouet’s PhD.

8.1.2. BQR INP IDEAL (04/2009 - 03/2012)

Participant: Jean-Claude Léon.

3D models, coming for instance from engineering fields, are often ‘idealized’, or ‘simplified’ (topologically speaking), in order to be used for simulation. The goal of this project IDEAL, funded by Grenoble-INP, is to study these models, in particular the most general ones which are called ‘non-manifolds’ and which are not handled by current software. We collaborate in this project with the University of Genova in Italy (Leila De Floriani).

8.1.3. BQR INP "Modèles multirésolutions de fissures" (04/2009 - 09/2012)

Participants: Marie Durand, François Faure.

A project on the simulation of fracture propagation in concrete structures has started, funded by INP Grenoble. The puropose is to develop a mixed, dynamic model of structures, using finite elements everywhere excepted near crak fronts, where a discrete model is applied. This goes beyond the ANR Vulcain project because we want to dynamically switch between finite element and discrete models. Bui Huu Phoc has started a Ph.D. in October, co-tutored by Frederic Dufour and Vincent Richefeu, from the L3S-R CNRS laboratory, and François Faure from EVASION.

8.1.4. LIMA 2 "Loisirs et Images" (2007 - 2013)

Participants: Marie-Paule Cani, François Faure, Damien Rohmer.

LIMA 2 (Loisirs et Images) is a Rhône-Alpes project in the ISLE cluster (Informatique, Signal, Logiciel Embarqué) focussed on classification and computer graphics. This project founded the PhD for Lucian Stanculescu with Raphaelle Chaine (LIRIS) and Marie-Paule Cani. A research seminar is planed in January 2013 in Lyon. Thibaut Weise from EPFL will be invited as an international speaker.

8.1.5. 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.

8.1.6. PERSYVAL

Participant: Rémi Ronfard.

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).

8.2. National Initiatives

8.2.1. ANR RepDyn (01/2010-12/2012)

Participants: Marie Durand, François Faure.

We will participate to the ANR RepDyn project, starting at the beginning of 2010, in collaboration with CEA, EDF, Laboratoire de Mécanique des Structures Industrielles Durables (LaMSID), and ONERA. The purpose of this project is to enhance the performance of discrete elements and fluid computations, for the simulation of cracks in nuclear reactors or planes. Our task is to propose GPU implementations of particle models, as well as load balancing strategies in the context of multi-core, multi-GPU hardware. Marie Durand has started a PhD thesis on this task.

8.2.2. 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.

8.2.3. 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.

8.2.4. 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 [31], [30] to practical animation tools. This contract provides us with the funding of two engineers and one graphical artist during two years.

8.2.5. 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.

8.2.6. 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 *Investissements d'avenir* research program entitled *Technologies de numérisation et de valorisation des contenus culturels, scientifiques et éducatifs*.

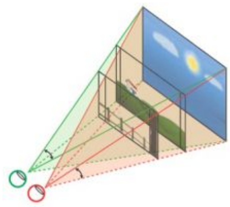

Figure 18. Illustration of the stereoscopic camera system.

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 PhD student Inigo Rodriguez who is working on learning-based camera control for stereoscopic 3D cinematography. His advisor is Rémi Ronfard.

8.2.7. 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).

8.2.8. 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.

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

Participant: Olivier Palombi.

8.3. European & International Initiatives

8.3.1. 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.

8.3.2. PhD grant from USM (University Sains Malaysia) (11/2011 - 10/2014)

Seou Ling NG: PhD supervisor: Stéfanie Hahmann: geometric modelling.

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

Chen Kim Lim: PhD supervisor: Marie-Paule Cani: croud modelling, animation.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Nicolas Szilas (University of Geneva): Interactive Storytelling: Models, Architecture and Approach (26/04/2012).
- Karan Singh (University of Toronto): Artist and Perception driven Interactive Graphics (10/05/2012).
- Alla Sheffer (University of British Columbia): Geometry in action (24/05/2012).
- Jarek Rossignac (Georgia Tech): The Beauty of a Motion: Mathematical Definition, Robust Implementation and Applications to Design and Animation (07/06/2012).
- Michael Gleicher (University of Wisconsin-Madison): From Art and Perception to Visualization, Video, and Virtual Reality (12/06/2012).
- Michael Wand (Max-Planck-Institut): Shape Analysis with Correspondences (06/07/2012).
- Ladislav Kavan (ETH Zurick): 3D Virtual Characters: Skinning, Clothing, and Weird Math (12/07/2012).
- Niloy J. Mitra (University of College London): Smart Geometry: In Search of Geometric Simplicity (25/10/2012).
- Mathieu Desbrun (California Institute of Technology): The Power of Duals: from Poisson to Blue Noise (20/12/2012).

9. Dissemination

9.1. Scientific Animation

9.1.1. Organization of conferences and editorial boards

- Marie-Paule Cani

  - General co-chair with Beryl Plimmer of the Expressive 2012 conference, co-sponsored by ACM SIGGRAPH and Eurographics, which grouped three international even in Annecy, in June 2012: Sketch-Based Interfaces and Modeling (SBIM), Non-protorealistic Animation & Rendering (NPAR) and Coputational Aesthetics (CAe).
  - Editorial boards of Computer Graphics Forum and of Graphical Models.
  - Steering committees of Shape Modelling International (SMI) and of SBIM.
- Stefanie Hahmann
  - SPM 2012 paper chair
  - Journal CAD Vol. 45 No.2 (Elsevier), Special Issue of SPM 2012, co-editor
  - Journal Graphical Models Vol. 74 No. 6 (Elsevier), Special Issue on Geometric Modling, co-editor
- Jean-Claude Léon
  - Local chair of EXPRESSIVE 2012 conference
- Rémi Ronfard
  - Member of the program committees for the international conferences on Computational Aesthetics (CAE), Interactive Digital Storytelling (ICIDS) and Motion in Games (MIG).
  - Organization of the 3rd international workshop on 3D Cinematography in Providence, USA, during the CVPR conference, with an audience of 100 participants. The 3D Cinematography series of workshops is devoted to all areas of computer vision contributing to the generation of 3D content from live action video, including structure from motion, binocular and trinocular stereo, multi-view stereo, geometric modeling, 3D signal processing, plenoptic modeling and light field cameras.

9.1.2. Management and administration of scientific organisations

- Marie-Paule Cani
  - Co-chair with Laurence Nigay of the axis "Authoring Augmented Reality" of the Laxeb Persyval.
  - Member of the executive board of the GDR Informatique Graphique (IG), a french virtual lab sponsored by CNRS.
  - Elected member of the executive committee of EG-France, the french chapter of eurographics.
  - Elected to the executive committee of Eurographics, where she will serve as second vice president from January 2013.
  - Member of the ACM Publication board (monthly audi-confs plus two in person meetings a year, to handle new publications, changes of editors in chiefs and the publication strategy of the ACM.
- François Faure
  - Member of the Conseil du Laboratoire at LJK.
- Stefanie Hahmann
  - President of GTMG (Groupe de Travail en Modelisation Géometrique) part of GDR IM and GDR IG.
  - Member of the Conseil du Laboratoire at LJK.
  - Vice chair of SIAM activity group Geometric Design.
  - Responsible of Maths-Info Department of the Grenoble doctoral school MSTII.
- Olivier Palombi

  - Member of the scientific board of ECCAMI (Excellence center for computer assisted medical interventions).
- Rémi Ronfard
  - Responsible of the *Géométrie and Images* department at LJK.
  - Member of the Conseil du Laboratoire at LJK.
  - Coordinator of a *thematic action* of the national GDR ISIS, on face, gesture, action and behavior (Visage, geste, action et comportement), together with Catehrine Achard and Patrick Horain (Télécom Paris Tech).

9.1.3. Public dissemination

- Marie-Paule Cani gave two key-note talks in Febuary 2012,"Towards expressive modelling of animated virtual worlds", respectively within the key-note speech of the LIG laboratory (Laboratoire d'informatique de Grenoble) and in the Polaris colloquium "From real to virtual" sponsored by Inria Lille.
- In March 2012, Marie-Paule Cani gave the talk "Are women afraid of computer science" at the European Research Center of Xerox, at the occasion of the "woman day".
- In May, Marie-Paule Cani gave courses on modeling and animation of virtual worlds, respectively within the cursus for high-school professors in computer sciences set up by Inria, and within a symposium for "classes préparatoire" professors organized by Ensimag/Grenoble INP.
- In November 2012, Marie-Paule Cani gave a course on "high-level models for intuitive modelling and animation" to the french PhD students in Computer Graphics, within the doctoral school day in Calais co-organized by the GDR IG (Informatique Graphique) and by the french Computer Graphics association (AFIG).
- Olivier Palombi gave a talk in *journée des sciences de l'université de Gène* in Italia.
- The images of the flat torus rendered by Damien Rohmer (see chap. 6.2.2) have been published in several magazines: NewScientist, Magazine Science, Universcience, Wired, IO9, The Aperiodical, Images des mathématiques.

9.2. Teaching - Supervision

9.2.1. Responsabilities of academic programs

- Responsible of the French Campus numérique of anatomy, Olivier Palombi.
- 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. Olivier Palombi
- Marie-Paule Cani and then François Faure were responsible of the GVR-(Graphics, Vision and Robotic) programm in the MOSIG Master.

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.

9.2.2. Educational activities

- Marie-Paule Cani, 200 hours a year, Professor ENSIMAG/Grenoble INP.
- Stefanie Hahmann, 200 hours a year, Professor ENSIMAG/Grenoble INP, M2R MIA.
- Jean Claude Léon, 96 hours a year, Professor ENSE3/Grenoble INP.
- Olivier Palombi, 200 hours a year, Professor UJF, medicine.
- Damien Rohmer, 200 hours a year, Assistant Professor CPE Lyon.
- Rémi Ronfard, 18 hours, M2 Pro, UJF.

10. Bibliography

Publications of the year

Articles in International Peer-Reviewed Journals

[1] R. BROUET, A. SHEFFER, L. BOISSIEUX, M.-P. CANI. *Design Preserving Garment Transfer*, in "ACM Transactions on Graphics, Proceedings of ACM SIGGRAPH", August 2012 [*DOI :* 10.1145/2185520.2185532], http://hal.inria.fr/hal-00695903.

[2] M. DURAND, P. MARIN, F. FAURE, B. RAFFIN. *DEM-based simulation of concrete structures on GPU*, in "European Journal of Environmental and Civil Engineering", August 2012, p. 1-13 [*DOI :* 10.1080/19648189.2012.716590], http://hal.inria.fr/hal-00733674.

[3] A. EMILIEN, A. BERNHARDT, A. PEYTAVIE, M.-P. CANI, E. GALIN. *Procedural Generation of Villages on Arbitrary Terrains*, in "The Visual Computer", April 2012, Special Issue - CGI 2012 [*DOI :* 10.1007/s00371-012-0699-7], http://hal.inria.fr/hal-00694525.

[4] O. GOURMEL, L. BARTHE, M.-P. CANI, B. WYVILL, A. BERNHARDT, M. PAULIN, H. GRASBERGER. *A Gradient-Based Implicit Blend*, in "ACM Transactions on Graphics", 2012, http://hal.inria.fr/hal-00753246.

[5] S. HAHMANN, G.-P. BONNEAU, S. BARBIER, G. ELBER, H. HAGEN. *Volume Preserving FFD for Programmable Graphics Hardware*, in "Visual Computer", February 2012, vol. 28, n^{o} 3, p. 231-245 [*DOI :* 10.1007/s00371-011-0608-5], http://hal.inria.fr/hal-00599442.

[6] E. HUBERT, M.-P. CANI. *Convolution Surfaces based on Polygonal Curve Skeletons.*, in "Journal of Symbolic Computation", June 2012, vol. 47, n^{o} 6, p. 680-699 [*DOI :* 10.1016/J.JSC.2011.12.026], http://hal.inria.fr/inria-00429358.

[7] A. SHAHWAN, J.-C. LÉON, G. FOUCAULT, M. TRLIN, O. PALOMBI. *Qualitative behavioral reasoning from components' interfaces to components' functions for DMU adaption to FE analyses*, in "CAD", 2013, vol. 45, p. 383–394, http://hal.inria.fr/hal-00726149.

[8] B. WANG, F. FAURE, D. K. PAI. *Adaptive Image-based Intersection Volume*, in "ACM Transactions on Graphics, Proceedings of ACM SIGGRAPH", August 2012, http://hal.inria.fr/hal-00699908.

[9] C. WEBER, S. HAHMANN, H. HAGEN, G.-P. BONNEAU. *Sharp feature preserving MLS surface reconstruction based on local feature line approximations*, in "Graphical Models", November 2012, vol. 74, n^{o} 6, p. 335-345, Special Issue of selected papers from the 8th Dagstuhl seminar on Geometric Modeling [*DOI :* 10.1016/J.GMOD.2012.04.012], http://hal.inria.fr/hal-00695492.

Articles in National Peer-Reviewed Journals

[10] R. VAILLANT, L. BARTHE, G. GUENNEBAUD, M.-P. CANI, D. ROHMER, B. WYVILL. *Déformation de la peau d'un personnage avec prise en compte des contacts*, in "REFIG - Revue Electronique Francophone d'Informatique Graphique", 2013, n^{o} 2, Best Paper Award AFIG/EGFR.

International Conferences with Proceedings

[11] F. BOUSSUGE, J.-C. LÉON, S. HAHMANN, L. FINE. *An analysis of DMU transformation requirements for structural assembly simulations*, in "The Eighth International Conference on Engineering Computational Technology", Dubronik, Croatia, Civil Comp Press, September 2012, http://hal.inria.fr/hal-00765407.

[12] J.-R. CHARDONNET, J.-C. LÉON. *Designing Interaction in Virtual Worlds through a Passive Haptic Peripheral*, in "21st IEEE International Symposium and Robot and Human Interactive Communication", Paris, France, 2012, http://hal.inria.fr/hal-00726152.

[13] J.-R. CHARDONNET, J.-C. LÉON. *Monitoring a Realistic Virtual Hand using a Passive Haptic Device to Interact with Virtual Worlds*, in "Joint Virtual Reality Conference of ICAT - EGVE - EuroVR", Madrid, Spain, 2012, http://hal.inria.fr/hal-00726171.

[14] M. CHRISTIE, C. LINO, R. RONFARD. *Film Editing for Third Person Games and Machinima*, in "Workshop on Intelligent Cinematography and Editing", Raleigh, United States, A. JHALA, R. M. YOUNG (editors), ACM, May 2012, http://hal.inria.fr/hal-00694455.

[15] M. DURAND, B. RAFFIN, F. FAURE. *A Packed Memory Array to Keep Moving Particles Sorted*, in "VRIPHYS - Ninth Workshop on Virtual Reality Interactions and Physical Simulations", Darmstadt, Germany, J. BENDER, A. KUIJPER, D. W. FELLNER, E. GUÉRIN (editors), The Eurographics Association, December 2012, p. 69-77, http://hal.inria.fr/hal-00762593.

[16] K. LI, A. SHAHWAN, M. TRLIN, G. FOUCAULT, J.-C. LÉON. *Automated contextual annotation of B-Rep CAD mechanical components deriving technoligy and symmetry information to support partial retrieval*, in "Conférence int. Eurographics 3DOR", Cagliari, Italy, May 2012, http://hal.inria.fr/hal-00726162.

[17] R. RONFARD, Q. DOUSSOT. *Generating 3D Scenes in the style of Keith Haring*, in "Generative Arts", Lucca, Italy, December 2012, http://hal.inria.fr/hal-00767471.

[18] R. RONFARD. *A Review of Film Editing Techniques for Digital Games*, in "Workshop on Intelligent Cinematography and Editing", Raleigh, United States, A. JHALA, R. M. YOUNG (editors), ACM, May 2012, http://hal.inria.fr/hal-00694444.

[19] C. ZANNI, P. BARES, A. LAGAE, M. QUIBLIER, M.-P. CANI. *Geometric Details on Skeleton-based Implicit Surfaces*, in "Eurographics 2012", Cagliari, Italy, May 2012, short paper, http://hal.inria.fr/hal-00694504.

National Conferences with Proceeding

[20] G.-P. BONNEAU, F. JOURDES, S. HAHMANN, F. FAURE, G. FOUCAULT, M. TRLIN, A. SHAHWAN, J.-C. LÉON, F. BOUSSUGE, L. FINE. *Interface, représentations fonctionnelles et transformations d'assemblages complexes pour la simulation des structures*, in "Congrès NAFEMS", Paris, France, June 2012, http://hal.inria.fr/hal-00726150.

[21] A. DICKO, V. FAVIER, F. FARNY, B. GILLES, F. FAURE. *Ontologie de la physiologie du corps humain pour la modélisation et la simulation du système musculosquelettique*, in "AFIG", Calais, France, November 2012.

[22] M. GUAY, M. VENNIER. *Méthodes simples pour l'animation de fluides en temps réel sur GPU*, in "AFIG", Calais, France, November 2012, http://hal.inria.fr/hal-00768017.

[23] C. ZANNI, A. BERNHARDT, M.-P. CANI. *Surfaces Implicites Homothétiques*, in "AFIG - 25èmes Journées de l'Association Française d'Informatique Graphique", Calais, France, November 2012, http://hal.inria.fr/hal-00766335.

Conferences without Proceedings

[24] G. GAGNERÉ, R. RONFARD, M. DESAINTE-CATHERINE. *La simulation du travail théâtral et sa notation informatique*, in "Notation du travail théâtral, du manuscript au numérique", 2012.

[25] R. RONFARD. *Notation et reconnaissance des actions scéniques par ordinateur*, in "Notation du travail théâtral, du manuscript au numérique", 2012.

Scientific Books (or Scientific Book chapters)

[26] M. BUCKI, O. PALOMBI, M. BAILET, Y. PAYAN. *Doppler Ultrasound Driven Biomechanical Model of the Brain for Intraoperative Brain-Shift Compensation: A Proof of Concept in Clinical Conditions*, in "Soft Tissue Biomechanical Modeling for Computer Assisted Surgery", Y. PAYAN (editor), Springer-Verlag, 2012, p. 135-165 [*DOI :* 10.1007/8415_2012_119], http://hal.inria.fr/hal-00706803.

[27] A. H. DICKO, B. GILLES, F. FAURE, O. PALOMBI. *From Generic to Specic Musculoskeletal Simulations using an Ontology-based Modeling Pipeline*, in "INTELLIGENT COMPUTER GRAPHICS 2012", D. PLEMENOS, G. MIAOULIS (editors), Springer, May 2012, http://hal.inria.fr/hal-00701190.

[28] F. FAURE, C. DURIEZ, H. DELINGETTE, J. ALLARD, B. GILLES, S. MARCHESSEAU, H. TALBOT, H. COURTECUISSE, G. BOUSQUET, I. PETERLIK, S. COTIN. *SOFA: A Multi-Model Framework for Interactive Physical Simulation*, in "Soft Tissue Biomechanical Modeling for Computer Assisted Surgery", Y. PAYAN (editor), Springer, June 2012 [*DOI :* 10.1007/8415_2012_125], http://hal.inria.fr/hal-00681539.

[29] A. GIANNAKIDIS, D. ROHMER, A. I. VERESS, G. T. GULLBERG. *Diffusion Tensor Magnetic Resonance Imaging-Derived Myocardial Fiber Disarray in Hypertensive Left Ventricular Hypertrophy: Visualization, Quantification and the Effect on Mechanical Function*, in "Cardiac Mapping, 4th Edition", M. SHENASA, G. HINDRICKS, M. BORGGREFE, G. BREITHARDT, M. E. JOSEPHSON (editors), Wiley, 2012, http://hal.inria.fr/hal-00765985.

References in notes

[30] F. FAURE, B. GILLES, G. BOUSQUET, D. K. PAI. *Sparse Meshless Models of Complex Deformable Solids*, in "ACM Transactions on Graphics", 2011, http://hal.inria.fr/inria-00589204.

[31] B. GILLES, G. BOUSQUET, F. FAURE, D. PAI. *Frame-based Elastic Models*, in "ACM Transactions on Graphics", April 2011, vol. 30, n^{o} 2 [*DOI :* 10.1145/1944846.1944855], http://hal.inria.fr/inria-00589199.

[32] D. WEINLAND, R. RONFARD, E. BOYER. *A survey of vision-based methods for action representation, segmentation and recognition*, in "Computer Vision and Image Understanding", February 2011, vol. 115, n^{o} 2, p. 224-241 [*DOI :* 10.1016/J.CVIU.2010.10.002], http://hal.inria.fr/hal-00640088.