INRIA

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

# *Project-Team ALCOVE*

# *Interacting with complex objects in collaborative virtual environments*

*Lille - Nord Europe*

THEME COG

Activity Report

2008

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# 2. Overall Objectives

## 2.1. Introduction

**Keywords:** *3D framework*, *3D interfaces*, *HCI*, *cooperative virtual world*, *interaction models*, *physical modeling*, *virtual reality*.

Our project aims at defining new methods and tools for cooperative frameworks. This work is at the edge of several research areas : physical modeling, virtual reality, and HCI.

- Animation and physically-based simulation is a very active research field. Recent advances, to which our research work contributes, now allow users to interact with physically-based models. Surgical simulation is one of the areas that benefits from this research.
- During the last decade, numerous research works have been carried out that aim at immersing users into virtual worlds. Besides technological aspects (VR devices, ..), these new tools require new kinds of interaction between the users and the environment, as classical WIMP interfaces are no longer suited. It is now clear that many applications do not require the user to be fully immersed into the environment, thus opening a new research area : finding the best compromise between immersion-based realism and new models that allow to navigate in and to interact with the virtual world.
- Graphical Human-Computer Interfaces are now a basic part of any computer. However, they are not well suited to current applications like communication and collaborative work. New research is beeing carried out in order to make them more user-friendly in cooperative environments (Collaborative Virtual Environment, Tangible User Interface).

Our project deals with these three research areas. In the animation and simulation field, we aim at defining virtual objects behaving like real ones. As far as Virtual Reality is concerned, we focus on providing the users with natural interaction with computer models. Last, we contribute to the HCI community by proposing and experimenting new interaction models and 3D interfaces between the users and the computer objects. Our team has been developing for several years a non-immersive 3D environment mimicking a meeting room. A group of users, each one using its own computer, can meet in a virtual office and work together. Such a concept involves new problems, like manipulating virtual objects inside a cooperative framework (how to model real objects ? how to interact with these models ?).

Our research currently focuses on fives subjects: one on physical models, one on Collaborative Virtual Environments and three around interactions : 3D HCI, tactile actuators, interaction between virtual objects in physical simulation. We focus on the medical field as main application area. We target tools (both numerical and hardware) for medical simulation, as well as for improval of patient rehabilitation .

## 2.2. Highlights of the year

- An interactive demonstration of cataract surgery simulation was presented to the public during two major events: "Salon Européen de la Recherche et de l'Innovation" and "Ville Européene des Sciences". It was featured in several media reports (TF1 national news June 7th, Euronews hi-tech report June 11th, TF1 national news November 14th).
- This year, two full papers from people of the team have been accepted for presentation in two major conferences: the Symposium of Computer Animation (SCA) where we presented a new method for handling collision between deformable bodies and MICCAI where our work on simulation of coil embolization has been presented

- This year has seen the publication of a paper in the major conference in the field of HCI: the 26th ACM Conference on Human Factors in Computing Systems . The work presented the effect of spring stiffness and control gain with an elastic rate control pointing device and was nominated for CHI2008 best paper award. In addition to that a paper was published in one of the major journal in the field of HCI: Human-Computer Interaction journal where the influence of control-display gain on user performance in pointing tasks was presented.
- Stephane Cotin successfully did in his habilitation thesis defence in front of a prestigious international commitee [11].

# 3. Scientific Foundations

## 3.1. 3D Human Computer Interface

**Keywords:** *3D desktop interaction*, *HCI*.

**Participants:** Géry Casiez, Christophe Chaillou, Samuel Degrande, Nicolas Martin, Qing Pan, Patricia Plénacoste, Johann Vandromme, Radu Vatavu, Quan Xu, Jean-Philippe Deblonde.

Since more than 20 years, the fundamental concepts of the computer's desktop environments remains largely the same : Windows, Icons, Mouse, Pointer (WIMP) are always the 2D metaphors used by humans to interact with applications. The 2D window remains the medium of interaction for all 2D and 3D applications. Current windowing systems tend to use the 3D capabilities of modern computer's video cards, but only to add some specific visual effects, such as transparency or shadows.

In our daily activities, we use simultaneously more and more applications, and we display more and more windows on the same screen. In the meantime, there is a growing number of domains requiring applications to work on 3D objects while displaying and working with 2D information. However, the 2D windowing environments are not well adapted to the display and the interaction with such a great amount of information. Some studies did show that the use of a 3D space to organize information can ease the user's activity for the organization of 2D windows. In the case of the concurrent interaction with 3D objects and 2D information, the WIMP highlights its limits and addresses the need for the development of new interaction techniques and input devices. Consequently, the computer-human interfaces must evolve, and we think that the far future computer's desktop systems will be specific 3D environments, seamlessly incorporating collaborative features.

At a low level, virtual tools or interaction metaphors are needed in collaborative virtual environment to let the user focus on her/his activity rather than on the manipulation of the physical devices. This should be done by matching the interaction technique with the physical properties of the input device. Useless interactions should be removed or replaced by high level virtual tools : those tools are used to transpose the user intentions, and in a collaborative framework, each public action is to be represented in the remote user's environments, to let them understand the ongoing global activity.

At a higher level, the concept of "3D application" is defined. A 3D desktop should be able to allow the user to interact simultaneously with several 3D applications, like 2D windowing systems let users interact with several 2D applications at the same time. A 3D application is roughly a set of 3D objects and 3D tools. Handling several 3D applications thus means that the 3D desktop has to manage several sets of objects and tools, which are not necessarily spatially related. The 3D desktop must also provide specific tools to handle those 3D applications.

We are working on the software and the ergonomic parts needed to create such an environment.

## 3.2. New forms of Collaborative Virtual Environments

**Keywords:** *cooperative virtual environments*.

**Participants:** Christophe Chaillou, Samuel Degrande, Nicolas Martin, Patricia Plénacoste, Jeremy Ringard, Johann Vandromme, Haibo Wang, Damien Fournier.

Traditionally, virtual environments are used in teaching domains, to simulate physical phenomena or to represent objects taken from the natural environment, notably in such domains as medicine, nuclear industry (EDF), transport industry (SNCF, military or civil aviation). Their goal is to reproduce the environment and the objects as they are in reality, by integrating the natural properties of the objects, physical behaviors and environmental constraints. Our proposal is appreciably different. Indeed, we have chosen to consider co-operative activities of small groups of actors around virtual 2D or 3D objects. Our goal is to provide them with a virtual environment which uses classical computers and input devices, and which could be considered as an extension of their current working environment in the broad sense.
At first, we focus on user's activity centered environments. This implies that the CVE should be built around the activity, bringing to the user all the facilities she/he needs to organize her/his environment, simply manipulate objects without unneeded interactions, achieve her/his task as quickly as possible. This notion is in opposite to any other multi-users 3D virtual environments that we are aware of, those propositions being world-centered, trying to mimic the real world by placing a user 'inside' a common shared world without any possibility to adapt it to her/his personal needs or work's habits. The OpenMASK framework from SIAMES is in this category. We are now shifting our researches to group's activity centered environments, to enable group-to-group collaborations. Two situations are studied : co-localization, where all members of a group are situated in front of a common interaction device, and open collaborative spaces (or *war-rooms*), where the members of a group can use several distinct interaction devices inside a room.
Secondly we are interested in the software architecture. We aim at studying and providing an innovative software framework (from network communication channels, to 3D components), enabling to easily create complex collaborative applications, through the definition of dynamically adaptable interaction components. There are some researches on this topic in the Human-Computer Interface scientific community (in the In Situ project, for example), however they focus on 2D windowing interfaces, and the current findings are not easily transposable to 3D interfaces.
Our activity is at the intersection between the HCI community and the Web3D community.

## 3.3. Tactile actuator

**Keywords:** *normal and tangential strain*, *tactile device*.

**Participants:** Melissande Biet, Christophe Chaillou, Frédéric Giraud, Gaston Mboungui, Patricia Plénacoste, Betty Lemaire-Semail, Zheng Dai, Mohamad Abdolvahab, Romuald Vanbelleghem.

Since several years, research dealing with touch parameters in interaction situation plays an increasing role in the fields of robotics and haptics since fast development in sensors and actuators miniaturizations could allow studying and reproducing touch at small scale. So, one of the main interests in haptics applied to virtual reality is to find a general purpose desktop I/O device that could enhance virtual touch interactions by stimulating the finger pulp.
Today, tactile stimulators based on friction reduction are emerging technologies because they results in lightweight and small devices. They rely on a high frequency vibratory plate that can output smooth or braking sensation as a function of the amplitude of vibration. Moreover, by using a position sensor, an amplitude modulation of the vibration is achieved in the bandwidth of the mechanoreceptors, so as to excite alternatively shear forces on the surface of the substrate; stimulation is then synchronized on the fingertip's position. This modulation gives rise to simulation of various rippled surfaces which could be compared with some gratings. Moreover, in order to enlarge the number of types of tactile sensations it's possible to simulate, we colaborate with the IEMN laboratory (AIMAN) to study of a dense pin array based either on electromagnetic technology, or pulse air micro-valve technology.

But feeling has to correspond to the touch of real textures, no matter which technology is used, so we have to apply the "good" stimuli on the fingertip. To achieve such stimulation, we need a better biomechanical knowledge of touching process - and lateral touch more particularly. In this research field, the influence of the friction dynamics used to perceive still remains unclear. First, the action is not sufficiently characterized. Second, there is no existing description of vibratory sources at contact. And finally, frictional and tactile role of fingerprint ridges in roughness estimation is an open research question. Using appropriate modelings taking into account those characteristics, we look forward describing physical phenomena located at the contact point between a fingertip and an explored surface in order to deduce the lateral stress field induced by touch movement. At the end, stimuli variation will be found by inverting this modelling.
Further to touch interactions, force feedback is also needed to reach deeper immersion in virtual environment. Motors used in kinaesthetic devices are often electromagnetic ones, but piezo-electric Ultrasonic Motors are good challengers in these applications because they can be much smaller for the same output torque, or available for multi dof. However their control is not straightforward. This is why we are designing specific control schemes for those motors. Our goal is to build a 3-D haptic device with force feedback, actuated by three Piezo-electric motors. The first prototype should depict how much bulk size reduction can be expected.

## 3.4. Physical models for real-time simulation

**Keywords:** *3D virtual environment*, *Physically-based simulation*, *adaptive models*, *computer graphics*, *computer vision*, *dynamic control*, *hysteresis*, *inverse modeling*, *inverse rendering*, *mechanical simulation*, *multi-models*, *multi-resolution*, *physical parameter identification*, *rendering*.

**Participants:** Jérémie Allard, Olivier Comas, Stéphane Cotin, Laurent Grisoni, Christian Duriez, Christophe Guébert, Juan-Pablo de la Plata Alcalde, Guillaume Saupin, Adrien Theetten.

The global activity of the project in real-time simulation is mostly targeted toward surgical simulators. The key activity of the team is to provide complex, integrated protocols of surgical operations, involving several models and surgical aspects. This activity seems complementary, in our opinion, to most of classical simulation research, where results mostly deal with very specific aspects, i.e. collision detection, haptic, or mechanical models. In particular, our activity relates to that of EVASION project (on general-purpose simulation) and ASCLEPIOS project (research on organ mechanical models). We consider to be at the state-of-the-art level for mechanical modeling of deformable 1D models. This 1D model is very useful to accurately reproduce the behavior the tools used during interventional radiology procedures ([26]). Our research work is more and more related with medical simulation. We aim at creating new technological tools for surgery that rely on simulation and help the physician before and during the procedures. The targeted applications include ophtalmology, interventional radiology, liver surgery and dental surgery.

## 3.5. Interaction between models

**Keywords:** *3D virtual environment*, *Interaction*, *collision*, *interaction with haptic devices*, *physically-based simulation*.

**Participants:** Jérémie Allard, Stéphane Cotin, Hadrien Courtecuisse, Jérémie Dequidt, Christian Duriez, Laurent Grisoni, Juan-Pablo de la Plata Alcalde, Guillaume Saupin.

We have been working on mechanical models, but also on the more global question to know how to mix together sophisticated mechanical system in the same simulation : although this question is, to our knowledge, barely studied by other research groups (we can note some early attempts though by Baraff, also SIAMES project), we consider this to be a key point for being able to provide complex surgical protocols in the near future. This aspect, among other, has allowed us to initiate, along with the CIMIT simulation group, the SOFA project, that is now international.

This work includes dealing with collision detection and collision response between deformable bodies ([28]). The model used for contact and friction may have a big impact on mechanical behavior of models. Contacts are often solved with simplified methods when real-time computation is required. However these simplified method could lead to incorrect behaviors. This is not acceptable in medical simulation. Thus, we propose an active research on models for contact and friction between deformable objects and on efficient solvers ([34], [27], [35]).

# 4. Application Domains

## 4.1. Interactive Simulation of Medical Procedures

**Keywords:** *health*, *planning*, *simulation*, *soft organ models*, *training*.

Medical simulation has been a very active research field for the past ten years. The ultimate goal is to provide medical students with realistic simulators that react like actual human patients.

One of the most challenging task in medical simulation is to realistically model soft organs and tissues, and their interaction with surgical instruments, requiring real-time solutions to complex problems such as physical modeling and collision detection.

We continue our contribution to the development of medical simulators. We have recently concentrated our effort on the design of a cataract surgery simulator in ophthalmology. The first step of the operation (namely capsulhorexis) has been modeled. We now have a realistic real-time behavior of the capsule and its interaction with the surgical instruments. The next step will be the realistic modeling of the lens. A first approach based on finite-element modeling has been investigated. It allows for an accurate simulation of the phacoemusification procedure (breaking of the lens).
We worked with Magritt project at INRIA on the realistic simulation of brain aneurysm embolization. In our ARC project, named "simple", we shared our knowledge about medical image processing for Magritt and physically based simulation for Alcove. We had some good results [26] which are milestones for proposing the simulation as a planning tool for this particular application in the near future.

We made a strong effort in the development of SOFA, our flexible open-framework dedicated to real-time simulations. This development is a joint-effort between Alcove, Asclepios (INRIA Sophia), Evasion (INRIA Grenoble) and the Sim group@CIMIT (Boston, USA). Our purpose is also to collaborate with other teams around the world involved in simulation.

## 4.2. Virtual Rehabilitation

**Keywords:** *Cerebral Vascular Accident*, *health*, *rehabilitation*, *simulation*, *stroke*.

We started this year some research on patient rehabilitation. This activity is supported by the ANR TecSan Reactive project, that will start in january 2008. This project is lead by the HOPALE fundation (medical institute, specialized in medical rehabilitation), and also involves the CEA, as well as Idees3com company.

Reactive addresses rehabilitation for patients that have suffered cerebrovascular accident (CVA). It aims at proposing new VR-based tools for rehabilitation, that would:

- improve patient involvement into her/his own rehabilitation, by proposing attractive training exercices;
- increase transfer of recovered skills, from exercices to real-life situations.

The proposed tools integrate tactile interfaces, including grabbing task analysis. We also plan to study how to evaluate some gesture quality: in the long term, this activity would open way to accurate exercice efficiency evaluation. Also, Human-Computer interfaces that integrate gesture analysis are hopefully reachable in a reasonnable range.

## 4.3. Commercial Industries

During the year we participate to meetings of the PICOM "Pôle de compétitivité industries du commerce". We worked on a pre-project study, targeted toward virtual design of shops. We think that shop design, and also possibly virtual shops for client, could provide interesting test for advanced interaction techniques. We collaborate with Idées3com and 3Suisses International companies to define a new shopping concept using virtual reality : U-boutique. U-boutique is supported by Picom.

# 5. Software

## 5.1. Simulation Open Framework Architecture (SOFA)

**Participants:** Jérémie Allard [correspondant], Stéphane Cotin [correspondant], Jérémie Dequidt, Christian Duriez, Laurent Grisoni, Juan Pablo de la Plata Alcalde, Frédéric Roy.

This research outlines a plan to build a foundation for a potential interoperability standard for Medical Simulation. Theoretically, such a framework should be generic, platform-independent, public domain, open source, and extendible. ALCOVE has been working on this concept for the past few years and with the assistance of several INRIA projects (EVASION, ASCLEPIOS) and CIMIT simulation group at Boston. We have assembled a first prototype that we demonstrated at Medicine Meets Virtual Reality (MMVR). We wanted to extend and refine this prototype with the aim of publicly releasing it to the medical simulation research community. Essentially, SOFA (Simulation Open Framework Architecture) is a flexible core framework which will allow independently developed algorithms to interact together within a common simulation while minimizing the development time required for integration. The main objective of SOFA is to foster collaboration among research groups. Rather than a centralized toolkit for Medical Simulation, our approach focuses on the development of a core technology that will support the integration of modules using a plug-in system. It is our hope that SOFA will simplify the developmental time for simulators, reduce production costs, and provide a means to share components through a common interface.

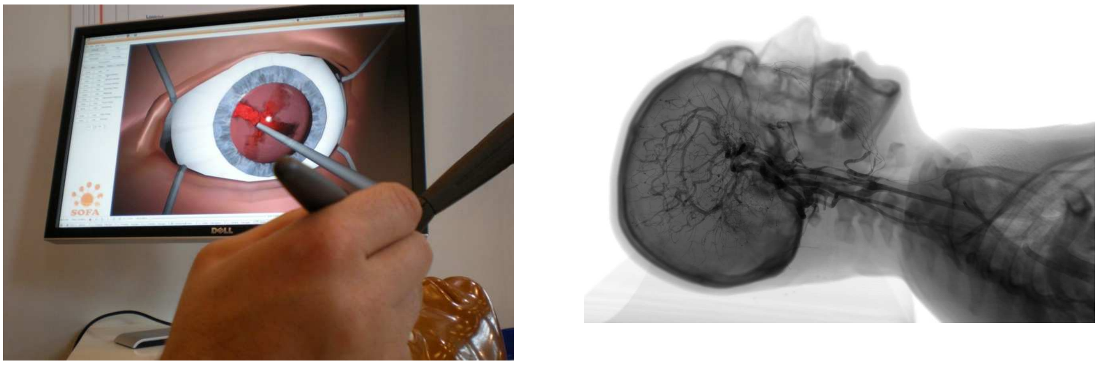

*Figure 1. Applications using SOFA: surgical procedure in ophthalmology and interventional radiology*

We had good result since SOFA is the most downloaded application of the INRIA's gforge with about 40.000 downloads.

**Framework Improvements**

Framework Improvements include (but is not limited to...)

- Cutting

The initial focus of the SOFA framework was on collision detection, deformation, collision response, and visual feedback since they are the current foci of the medical simulation research. Other simulation components such as cutting, physiology, haptics, multi-processing, etc can be required depending on the application requirements. Of these, cutting poses the greatest challenge since it changes the topology of all of an object's mapped representations such a visual, behavioral, collision and other possible future representations. As a result, a variety of cutting interface proposals were put forth so that this action could be simulated within SOFA framework before it matured too much.

- Multi-Processing

  Because of their complexity, realism demands and interactive requirements, medical simulators often constrain their computing and rendering capabilities. With decreasing hardware costs, multiple central processing units (CPUs) and more efficient graphics processing units (GPUs) are becoming more affordable. The SOFA framework has now the capability to take advantage of these multi-processing computing environments.

- Contact processing

  SOFA framework includes new algorithms for the collision response based on unilateral constraints and non-linear friction constraints based on Coulomb's law. The contact equations are solved using Gauss-Seidel iterative solver.

# 6. New Results

## 6.1. The effect of transfer function on user performance in pointing tasks with isotonic and eleastic devices

**Participant:** Géry Casiez.

We theoretically and empirically examine the impact of control-display gain (CD) on mouse pointing performance. Two techniques for modifying CD gain are considered: constant-gain (CG) where CD gain is uniformly adjusted by a constant multiplier, and pointer acceleration (PA) where CD gain is adjusted using a non-uniform function depending on movement characteristics. Both CG and PA are evaluated at various levels of relationship between mouse and cursor movement: from low levels which have a near one-to-one mapping, through to high levels that aggressively amplify mouse movement. We further derive a model predicting the modification in motor-space caused by pointer acceleration. Experiments are then conducted on a standard desktop display and on a very large high-resolution display, allowing us to measure performance in high index of difficulty tasks where the effect of clutching may be pronounced. The evaluation apparatus was designed to minimize device quantization effects, and also used accurate 3D motion tracking equipment to analyze users' limb movements.

On both displays, and in both gain techniques, we found that low levels of CD gain had a marked negative effect on performance, largely due to increased clutching and maximum limb speeds. High gain levels had relatively little impact on performance, with only a slight increase in time when selecting very small targets at high levels of constant gain. On the standard desktop display, pointer acceleration resulted in 3.3% faster pointing than constant gain, and up to 5.2% faster with small targets. This supported the theoretical prediction of motor-space modification, but fell short of the theoretical potential, possibly because PA caused an increase in target overshooting. Both techniques were accurately modeled by Fitts' law in all gain settings. From our results, we derive a usable range of CD gain settings between thresholds of speed and accuracy given the capabilities of a pointing device, display, and the expected range of target widths and distances.

This work has been carried out with Daniel Vogel and Ravin Balakrishnan from University of Toronto and Andy Cockburn from the University of Canterbury and the results were published in HCI Journal [16].

Isometric and elastic devices are most compatible with a rate control mapping. However, the effect of elastic stiffness has not been thoroughly investigated nor its interaction with control gain. In a controlled experiment, these factors are investigated along with user feedback regarding ease-of-use and fatigue. The results reveal a U-shaped profile of control gain vs. movement time, with different profiles for different stiffness levels. Using the optimum control gain for each stiffness level, performance across stiffness levels were similar. However, users preferred lower stiffness and lower control gain levels due to increased controller displacement. Based on these results, the general design for elastic rate control devices is given. (Fig. 2).

This work has been carried out with Daniel Vogel from University of Toronto and the results were published at CHI 2008 [24]. The paper was nominated for CHI 2008 best paper awards.

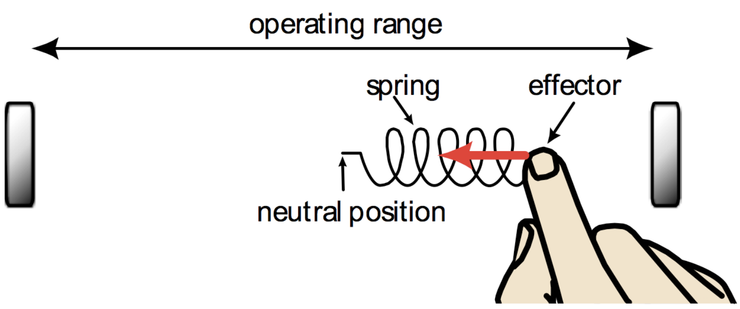


*Figure 2. Elastic device composed of a spring attached to an effector. The resistive force is proportional to the effector displacement which is limited by the operating range.*

## 6.2. Depth-of-Field Blur Effects in Virtual Environments

**Participant:** Géry Casiez.

In human vision, the depth of field (DoF) is the range of distances near the focus point where the eyes perceive the image as sharp. Objects behind and in front of the focus point are blurred. DoF and its associated blur effects are well-known classic depth cues in human vision. Virtual images that lack a DoF blur can sometimes look too perfect and therefore synthetic. System designers therefore added DoF blur effects early to computer graphics pipelines. Movies also use the classic blur effects of focal-distance changes to convey sensations or otherwise capture viewers attention. Real-time VR applications have not yet introduced visual blur effects. We now have the programming capabilities and the processing power to compute them in real time. However, we do not know how such effects will influence user performance and subjective experience.

The authors describe new techniques to improve blur rendering and report experimental results from a prototype video game implementation (Fig. 3).

This work has been carried out with Sébastien Hillaire, Anatole Lécuyer and Rémi Cozot from the INRIA Bunraku project at the University of Rennes I and the results were published in Computer Graphics and Applications journal[17].

Another part of the work describes the use of users focus point to improve some visual effects in virtual environments (VE). First, we describe how to retrieve users focus point in the 3D VE using an eye-tracking system. Then, we propose the adaptation of two rendering techniques which aim at improving users sensations during first-person navigation in VE using his/her focus point: (1) a camera motion which simulates eyes movement when walking, i.e., corresponding to vestibulo-ocular and vestibulocollic reflexes when the eyes compensate body and head movements in order to maintain gaze on a specific target, and (2) a Depth-of-Field (DoF) blur effect which simulates the fact that humans perceive sharp objects only within some range

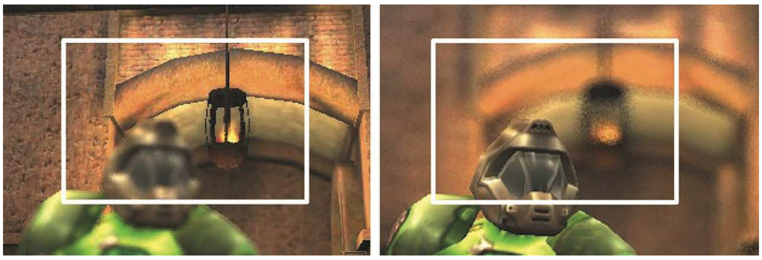

*Figure 3. The depth-of-field blur when using a rectangular autofocus zone (the white rectangle): (a) Without semantic weighting, the focus is on the background. (b) With semantic weighting, the focus is automatically set on the important character. (Quake III Arena screenshot, courtesy of IdSoftware)*

of distances around the focal distance. Second, we describe the results of an experiment conducted to study users subjective preferences concerning these visual effects during first-person navigation in VE. It showed that participants globally preferred the use of these effects when they are dynamically adapted to the focus point in the VE. Taken together, our results suggest that the use of visual effects exploiting users focus point could be used in several VR applications involving first- person navigation such as the visit of architectural site, training simulations, video games, etc.

This work has been carried out with Sébastien Hillaire, Anatole Lécuyer and Rémi Cozot from the INRIA Bunraku project at the University of Rennes I and the results were published at VR 2008 [31].

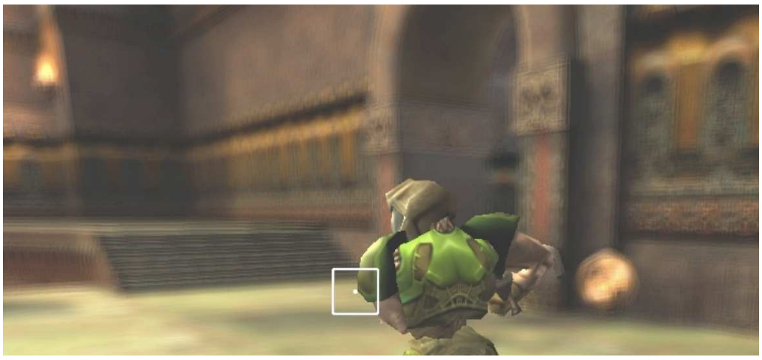

*Figure 4. QuakeIII video game with Depth-of-Field blur effect implemented. The white square corresponds to the auto-focus zone that follows the user focus point measured by eye-tracking.*

## 6.3. A New Human Representation Mixing Video and Avatar

**Participants:** Haibo Wang, Christophe Chaillou, Jeremie Ringard, Li Ding.

Creating a realistic face avatar is still a challenging problem. In the paper, we propose a new video-based technique for synthesizing such an online avatar that is capable of replicating facial expressions under natural head movements. Our approach is to track 3D head pose, simultaneously extract video face textures from monocular video sequences and then map them onto a static head model. In contrast to most of the current facial animation solutions, our approach can avoid the procedures to track high dimensional facial features, warp face textures and deform face model. In addition, the method allows independent control of head pose and facial textures that are separated from videos. The demonstrations of our method in real video scenarios validate its efficiency.

'Gestures' play important part during conversation. In our project, we extract gestures from 2D video stream and try to show the gesture in the Virtual Environment(VE). Hence, image processing, pattern recognition and model establishing technics are used. Firstly, we segment human body out of background clutter, especially some key feature (eg. head and hands spatial relationship, contour of upper body). Secondly, model 'gesture' according to prior knowledge and motion captured data. Consequently, we will find out what the gesture means and finally render the virtual human in the VE.

These works are collaborated with Professor Chunhong PAN at the laboratory of LIAMA in Beijing and the results were published in the ECAG'08 Workshop[38] and the ICIPCVPR'08 conference[39].

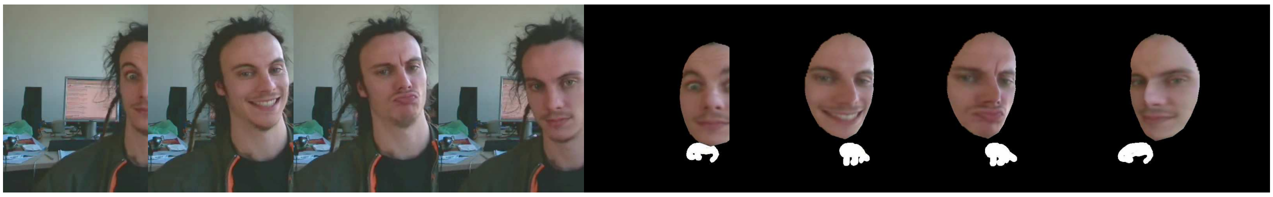

*Figure 5. Video-driven face avatar. The first row shows images captured from a video webcam; the second row shows the synthetic face avatar while the white hand points to the tracked head pose.*

## 6.4. Software-hardware interaction platform for colocated collaboration

**Participants:** Jeremy Ringard, Samuel Degrande, Stephane Louis-dit-picard, Christophe Chaillou.

For several years, researchers have performed many studies on collaborative work. The research has mainly been focused on developing tools that allow geographically distant users to work together on a common project, through a virtual environment. However, these collaborative virtual environments (CVE) are not well adapted for users located in the same geographic point. Consequently, companies have adopted teamwork for this kind of configuration, through the use of war rooms. War rooms are spaces into which individuals are brought together and are physically present to work on a common project. The application of this environment can be used for brainstorming, emergency response management, or any kind of task that requires good reactivity or instant feedback between collaborators.
In this study [40], we propose a new software-hardware platform for collocated collaboration, that can be considered a computer-supported war room. This platform consists of a physical workspace equipped with various computer hardware that will allow team members to interact freely upon shared 3-D objects. Our proposition is to take advantage of this hardware diversity by providing, on each terminal of the room, the most suitable tools and interactions for each kind of subtask. We have already developed a prototype for the desired platform of a collaborative room (Fig. 6). This software is based on a structure, which could be easily assimilated into a Model-View-Controller paradigm. we have set up a distribution of the MVC components through the network. As a result, for each semantic object in the virtual environment, there is only one instance of the model. This distribution in the room is fully independent from the material means, and can be modified dynamicaly giving rise to several collaboration scenarios.

## 6.5. An Interactive System Based on Semantic Graphs

**Participants:** Johann Vandromme, Samuel Degrande, Patricia Plénacoste, Christophe Chaillou.

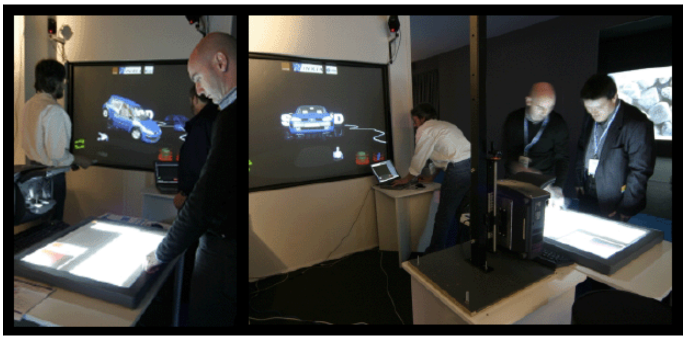

*Figure 6. The collaborative platform prototype, presented at LAVAL VIRTUAL 2008*

In WIMP systems, application functionalities are represented by buttons grouped in menus, sub-menus and tool boxes. Given the increasing number of these functionalities, graphical interfaces grow in complexity. Some rules and habits exist to design menus and interfaces but they are limited to common operations such as Open File, Save File, Print... For specific tools, interaction modalities and their location in the interface may vary from an application to another (e.g layer manipulation in 2D image editing software). The second element that induces such complexity is the lack of interoperability between applications.
We propose to simplify interfaces by structuring the whole desktop using a semantic multi-graph structure. This structure is a set of trees that group the objects (documents or components ) having common semantic properties. In our system, tools can modify the components attributes as well as semantic-graphs structures. The whole system is structured this way, so documents become components of the whole system. Thus the same tools can be used to manage documents or parts of documents.
To illustrate our method, we have developed a demonstration desktop based on semantic graphs. Several generic tools are proposed that can act on different semantic aspects (importance, publication, geometry...) using direct manipulation.

## 6.6. Real-Time Acquisition of Human Gestures for Interacting with Virtual Reality

We address in this thesis [14] the problem of gesture recognition with specific focus on providing a flexible model for movement trajectories as well as for estimating the variation in execution that is inherently present when performing gestures. Gestures are captured in a computer vision scenario which approaches somewhat the specifics of interactive surfaces. We propose a flexible model for gesture commands based on a spline representation which is enhanced with elastic properties in a direct analogy with the theory of elasticity from classical physics. The model is further used for achieving gesture recognition in the context of supervised learning. In order to address the problem of variability in execution, we propose a model that measures objectively and quantitatively the local tendencies that users introduce in their executions. We make use of this model in order to address a problem that is considered hard by the community: automatic segmentation of continuous motion trajectories and scale invariant identification of gesture commands. We equally show the usefulness of our model for performing ergonomic analysis on gesture dictionaries.

## 6.7. Improving tactile simulation on a friction reduction based tactile device

**Participants:** Frédéric Giraud, Betty Semail, Michel Amberg, Romuald Vanbelleghem.

We investigate the use of friction based tactile displays for the simulation of finely textured surfaces, as such displays offer a promising way for the development of tactile devices. In order to improve their design, we first proposed a modeling of the friction reduction. This modeling, which is based on "squeeze film theory" was applied on the specific case of a fingertip touching a vibrating plate [15]. In this modeling, epidermal ridges are taken into account and friction reduction can then be deduced according to the vibratory amplitude and normal pressure with which user pushes on the plate. These results help to give final device's dimensions and lead to the realization of a prototype [29].

In [22], it has been possible to measure resolution of the textures rendered with such devices and their matching to real textures. To achieve that, we need to measure fingertip's position. The sensor used for these experiments allowed only 1 degree of freedom, so, only textured surfaces along one direction could be simulated. We then conclude that participants recognize simulated gratings with same Weber fraction as for real ones.

In order to simulate 2d gratings, we need 2d sensors. We then designed a finger localization system which measures finger's position along two directions. We first proposed a sensor based on a camera and a motion capture program. This set up was presented during the demo session of Haptic Symposium 2008 in Reno, and could run all the three days. However, because frame rate was too slow (60 frames per seconds), this sensor could not succeed in simulating very fine 2d textures.

An other design of a 2d sensor was proposed then. It relies on a linear CCD sensor, mirrors and light sources. When a fingertip touch the tactile stimulator, its shadow is measured and interpreted by a DSP. At the end a resolution of $100\mu m$ is achieved with a refreshing rate of $200Hz$. In (Fig. 7) we presented the new design of the sensor, and the results.

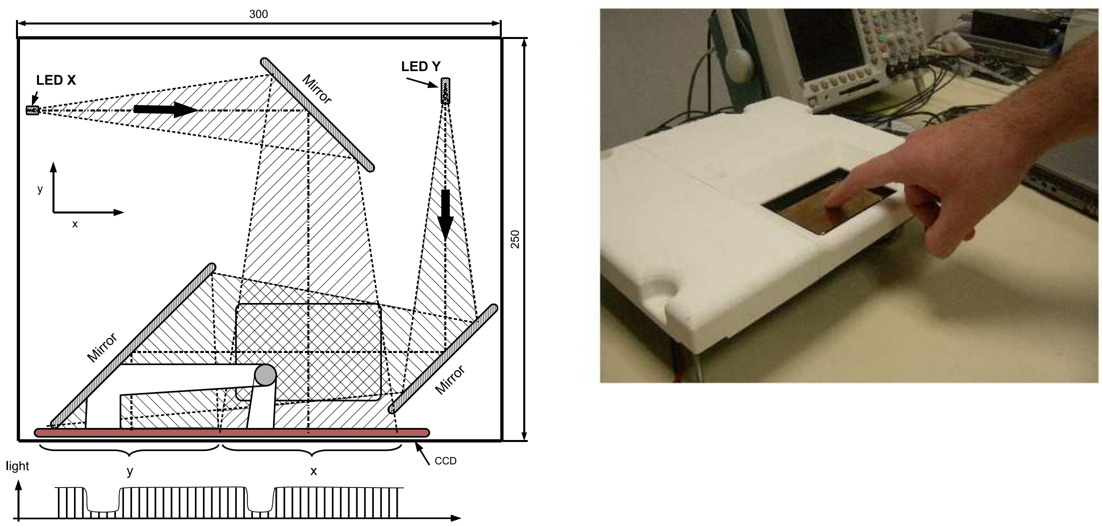


*Figure 7. New sensor's design for finger localization .*

## 6.8. Using Piezo-electric actuators in force-feedback devices

**Participants:** Frédéric Giraud, Betty Semail, Gaston MB´oungui, Zheng Dai.

Travelling wave Ultrasonic Motors (TWUM) can be used instead of classical DC Motors in Haptic Devices. In fact, because they output large torque at low rotational speed, they can be directly mounted on effector's axle, allowing size and weight reduction. However, their energy conversion process are very different compared to

DC motors. Torque on TWUM is not a straightforward function of input voltage or current. An accurate torque control at very low rotational speed is thus an issue for using TWUM in such applications. To achieve that, we first try to find out modeling of the energy conversion to deduce, by inversion, good control laws.

One the one hand, control of vibrating stator is required for stable application at every load conditions. In [36], an hybrid control mixing a phase and a frequency control was applied on a precise positioning of a TWUM. This is is a first step toward admittance control of an haptic interface actuated by a piezo-electric motor. Moreover, because torque produced by the traveling wave found its origin from the contact mechanisms at stator/rotor interfaces, an accurate modeling of the contact is needed and was established in [30]. In this modeling, Petri Nets are used to take into account stick-sleep effect which occurs at low rotational speed and high torque. This new modelling may lead to new control schemes.

Finally, we also try to find new actuators for force-feedback applications. In [23], we proposed a prototype of a force-feedback mouse. This device is made up with a copper plate on which piezo-electric transducers are bonded (Fig. 8). This plate lays on a mouse pad. When the tranducers are powered up, they create a vibration. The effect of the vibration is to decrease friction between the plate and the mouse pad. Consequently, by turning on and of the transducers, or by energizing more or less them, we can make the illusion that the mouse pad is a programmable grooved surface. First results have shown that a friction reduction of $50\%$ can be obtained with a vibration level of $1\mu m$ at $30kHz$.

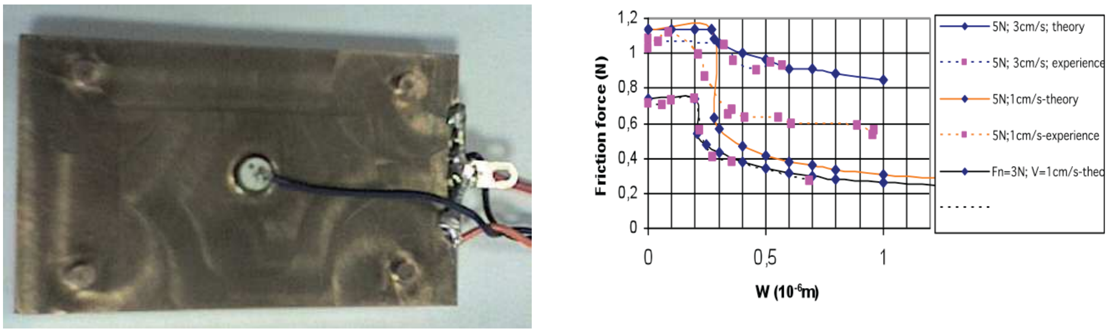


*Figure 8. Force feedback 2-D device.*

## 6.9. Refining the 3D surface of blood vessels from a reduced set of 2D DSA images

**Participant:** Jérémie Dequidt.

Numerical simulations, such as blood flow or coil deployment in an intra-cranial aneurism, are very sensitive to the boundary conditions given by the surface of the vessel walls. Despite the undisputable high quality of 3D vascular imaging modalities, artifacts and noise still hamper the extraction of this surface with enough accuracy. Previous studies took the a priori that a homogeneous object was considered to make the reconstruction from the Xray images more robust. This work describes an active surface approach, that does not depend on any particular image similarity criterion and grounds on high speed computation of the criterion derivatives. Mean square error and normalized cross-correlation are used to successfully demonstrate our algorithm on real images acquired on an anthropomorphic phantom. Preliminary results of coil deployment simulation are also given. This work has been carried out with Erwan Kerrier and Marie-Odile Berger from the INRIA Magrit project at the University of Nancy I and the results were published at the Workshop on Augmented environments for Medical Imaging and Computer-aided Surgery(AMI-ARCS'08) [32], a satellite workshop of the MICCAI Conference.

## 6.10. Geometrically exact dynamic splines

**Participants:** Adrien Theetten, Laurent Grisoni, Claude Andriot, Brian Barsky.

In this work [19], we propose a complete model handling the physical simulation of deformable 1D objects. We formulate continuous expressions for stretching, bending and twisting energies. These expressions are mechanically rigorous and geometrically exact. Both elastic and plastic deformations are handled to simulate a wide range of materials.We validate the proposed model in several classical test configurations. The use of geometrical exact energies with dynamic splines provides very accurate results as well as interactive simulation times, which shows the suitability of the proposed model for constrained CAD applications. We illustrate the application potential of the proposed model by describing a virtual system for cable positioning, which can be used to test compatibility between planned fixing clip positions, and mechanical cable properties

## 6.11. Interactive Simulation of Embolization Coils: Modeling and Experimental Validation

**Participants:** Jérémie Dequidt, Maud Marchal, Christian Duriez, Erwan Kerrien, Stephane Cotin.

Coil embolization offers a new approach to treat aneurysms. This medical procedure is namely less invasive than an open-surgery as it relies on the deployment of very thin platinum-based wires within the aneurysm through the arteries. When performed intracranially, this procedure must be particularly accurate and therefore carefully planned and performed by experienced radiologists. A simulator of the coil de- ployment represents an interesting and helpful tool for the physician by providing information on the coil behavior. In this paper, an original modeling is proposed to obtain interactive and accurate simulations of coil deployment. The model takes into account geometric nonlinearities and uses a shape memory formulation to describe its complex geometry. An experimental validation is performed in a contact-free environment to identify the mechanical properties of the coil and to quantitatively compare the simulation with real data. Computational performances are also measured to insure an interactive simulation.

This work was accepted for full paper and oral presentation (6% rate) at MICCAI 2008 [26].

*Figure 9. Interactive Simulation of Embolization Coils: Modeling and Experimental Validation*

## 6.12. GPU-based parallel simulation algorithms

**Participants:** Jérémie Allard, Olivier Comas, Stephane Cotin, Hadrien Courtecuisse.

We investigated the use of massively parallel architectures such as now available in graphics cards (GPU) to increase the achievable realism of interactive simulations. Impressive speed-ups have been achieved for computing deformations, on the order of 20 to 40 times faster than a CPU, for example in the case of the TLED FEM algorithm published at ISBMS 2008 [25]. For simulations requiring precise handling of stiff highly coupled contacts with friction, such as coils or catheters sliding on vessels walls, preliminary results on a Gauss-Seidel solver provides a speed-up of about 6X, due to the sequential nature of the method. For collision detection, we published at SCA 2008 [28] an algorithm using the GPU to efficiently compute collisions and self-collisions on deformable bodies without any pre-computation.

## 6.13. Efficient Contact Modeling using Compliance Warping

**Participants:** Guillaume Saupin, Christian Duriez, Stephane Cotin, Laurent Grisoni.

Contact handling is the key of deformable objects simulation, since without it, objects can not interact with their environment nor with the user. Moreover, a realistic simulation of interaction is necessary for a meaningful haptical rendering. We propose a novel and very efficient approach for precise computation of contact response between various types of objects commonly used in computer animation. Being constraint based, this method ensures physical correctness, and respects Singorini's law. It can be used with any deformation model, and is based on the use of the initial compliance matrix and contact warping. Thus, the contact response can be computed efficiently, and the object deformation can still be done in a physically plausible way provided the underlying model is physical.

This work was accepted as a full paper and oral presentation at CGI 2008 [34].

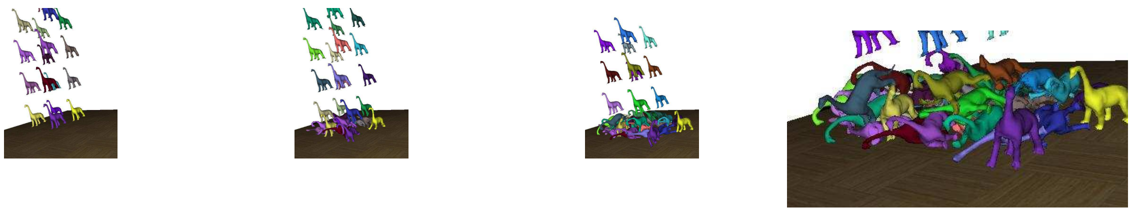

*Figure 10. Snap-shots of the results obtained using the method on a critical scenario*

## 6.14. Contact model for haptic medical simulation

**Participants:** Guillaume Saupin, Christian Duriez, Stephane Cotin.

In surgery simulation, precise contact modeling is essential to obtain both realistic behavior and convincing haptic feedback. When instruments create deformations on soft tissues, they modify the bound- ary conditions of the models and will mainly modify their behavior. Yet, most recent work has focused on the more precise modeling of soft tissues while improving efficiency; but this effort is ruined if boundary condi- tions are ill-defined. In this paper, we propose a novel and very efficient approach for precise computation of the interaction between organs and instruments. The method includes an estimation of the contact compli- ance of the concerned zones of the organ and of the instrument. This compliance is put in a buffer and is the heart of the multithreaded lo- cal model used for haptics. Contact computation is then performed in both simulation and haptic loops. It follows unilateral formulation and allows realistic interactions on non-linear models simulated with stable implicit scheme of time integration. An iterative solver, initialized with the solution found in the simulation, allows for fast computation in the haptic loop. We obtain realistic and physical results for the simulation and stable haptic rendering.

This work was accepted as a full paper and oral presentation at ISBMS 2008 [35].

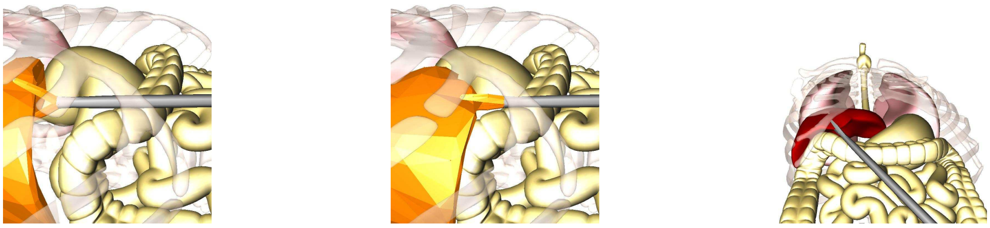

*Figure 11. Snap-shots of virtual grasping with laparoscopic graspers*

## 6.15. Contact Skinning

**Participants:** Christian Duriez, Hadrien Courtecuisse, Juan-Pablo de la Plata Alcalde, Pierre-Jean Bensoussan.

In this work, we propose a new approach to model interactions through a skinning method. Skinning is a frequently used technique to animate a mesh based on skeleton motion. In the case of a hand motion sequence used to manipulate and grasp virtual objects, it is essential to accurately represent the contact between the virtual objects and the animated hand. To improve the level of realism, our approach allows to solve accurately friction contact laws. In addition, contact constraints defined on the surface of the hand can be applied onto the skeleton to produce plausible motion. We illustrate our work through two examples: the real-time simulation of a grasping task and a character animation based on motion capture.

This work was accepted as a short paper and oral presentation at Eurographics 2008.

*Figure 12. Snap-shots of one result obtained using the method: grasping with a virtual hand*

# 7. Contracts and Grants with Industry

## 7.1. France Télécom R&D

We work in collaboration with France Télécom since 1994. From 1994 to 2005, several contracts were established (3 PhD thesis, 3 co-development contracts). A pre-industrial software platform for collaborative virtual environments, called Spin|3D, has been developed in collaboration with France Télécom R&D (Lannion center).
We did participate with France Telecom to several projects (european, and national), and we are currently collaborating on the Part@ge ANR project.

## 7.2. CEA

We are collaborating with Claude Andriot (LIST Team, CEA, Fontenay-Aux-Roses). The first step was a co-funded PhD Thesis (Adrien Theetten), that has been defended in december 2007. That work aimed at modeling slightly deformable 1D objects for CAD applications (simulation of the behavior of large cables) in urban projects, building design, ...

Current partnership with the laboratory of CEA-LIST Fontenay aux Roses :

- CEA gave the university advising responsibility to Laurent Grisoni and Christian Duriez for the PhD thesis of Guillaume Saupin. This thesis is fully funded by CEA, and has been defended on the 26th of november, on real-time animation of deformable models. In this thesis, a multi-grid method has been proposed that is based on basic linear volumic wavelet decomposition. A generic method for contact resolution has also been proposed, that allows for heterogeneous mechanical models to interact all together.
- M. Hafez is copromoter of the PhD thesis of R. Demersseman who works on magneto-rheological fluids in order to design a tactile display. This study has begun in November 2005.

## 7.3. Hopale fundation

We have started a Ph.D. thesis with Jean-Philippe Deblonde on the study and development of adaptive interaction techniques with an application to the rehabilitation of brain injured patients using virtual reality. This thesis, co-funded by the Hopale foundation and the Nord Pas-De-Calais region, comes in addition to the ANR TecSan Reactive project that started in January 2008. Within this project, we study among other some numerical tools for evaluating user gesture efficiency interactively.

## 7.4. Idées3com

Idées3com is a new start-up specialized in Web 3D content creation for e-shopping and advertising. Several collaborations are currently in preparation, around natural 3D interactions, and enhanced 3D metaphors. Idées3com is one of the industrial partner of the Hopale project, an ANR founded TechSan project.

# 8. Other Grants and Activities

## 8.1. National initiatives

- Part@ge (ANR 2006 - RNTL - Partners : INSA Rennes, INRIA (Alcove, I3D), CNRS (LaBRI, Mouvement et Perception), ESIEA, FT R&D, CEA-LIST, VIRTOOLS, HAPTION, CLARTE, RENAULT, THALES, SOGITEC).

  This project aims to propose a software platform for collaborative work, studying it from the point of view of a human interacting in collaboration inside a 3D environment. Part@ge will use a multi-criteria analysis in order to propose several innovative solutions:

  – functions associated with collaboration in a 3D environment: starting from technical design up to maintenance skill acquisition, the need to communicate and collaborate around 3D digital models is a major stake for the industry.

  – technical infrastructures helping collaboration: there is a great diversity of technical platforms needed for collaborative 3D activities: from PDAs to *war-rooms*. Each of them has specific features that are more suited to specific applications.

  – tools to spread 3D collaborative activities : to maximize the spread of Part@ge's innovative tools, three platforms already developed by some of the partners will be used : OpenMask, Spin and Virtools.

   - scientific and technical new solutions: the heart of the project is composed by several research studies which intend to solve some current scientific and technical problems : models for CVE, communication and presence, advanced collaboration, usage of collaboration.

  The INRIA is involved in a large part of this project.

- VORTISS (ANR-06-MDCA-015) Partners : LSIIT(strasbourg), IRCAD(strasbourg), IRCOM/SIC (poitiers). This project is leaded by Laurent Grisoni.).

  This project aims at designing a robust and unified model which allows a faithful restitution of the shape and behaviour of organs in surgical simulators. This model relies on a coupling between several components: a precise geometric and visually realistic model of the organ which is reconstructed from medical images, a rigorous topological model allowing incisions, cuttings, tearings and destruction while assuming the structure consistency, a hybrid mechanical model and an interaction model which is adapted to deformable bodies with variable topology and allows the control of haptic devices. To deal with the precision vs computation speed compromise, the four components are necessarily multiresolution. The resolution of each model is chosen independently even if the model control remains highly connected to the other components.

- REACTIVE Partners : Hopale (Berck), CEA-LIST, Idées3COM

  Stroke is the leading cause of loss of autonomy in France (100 000-145 000 French (es) / year). The elderly population is the most affected, and the survivors suffer from disorders often compounded by cognitive problems. The project REACTIVE aims to develop a rehabilitation tool for patients that are cerebrovascular injured. This tool is based on the use of Virtual Reality (VR). The main idea is to combine the motion work and the cognitive work, in an environmental situation, in the hope of improving the transfer of learning. It is divided into 4 items : the environmental situation, analysis and integration of disability in the interaction techniques, new motion and sensorial interfaces, and the evaluation by the therapists and patients.

- ARC simple Partners : CHU University Hospital of Nancy, INRIA Magrit project

  The SIMPLE project, an INRIA cooperative research action (ARC), aimed at developing methods to simulate coil deployment in an intracranial aneurism, running in real time and adaptable to any patient data. It was completed in October 2008. We have obtained a series of results during this ARC, essentially regarding vessel reconstruction, modeling of coils, in-vivo measurement of blood flow and its influence on coil embolization, and validation of the different steps using phantom data :

   - coils have a non-trivial shape at rest, going from simple helicoidal to more complex 3D shapes. Furthermore, the exact mechanical properties of the coil are unknown. We have proposed a method for describing a digital model for the complex coil shapes, as well as an experimental setup to estimate the model parameters for any given coil. A real-time simulation of coil deployment was then proposed, where the dynamics of the coil and its contacts with the inner surface of the aneurysm were modeled.This led to a publication and an oral presentation at the MICCAI 2008 conference [26].
   - numerical simulations, such as coil deployment, are very sensitive to the boundary conditions given by the vessel walls. We have developed a series of approaches for segmenting the vessel's surface in a multimodal environment, leveraging the advantages of each modality in the process. A description of this approach was published in the proceedings of AMI-ARCS'08 [32].
   - in-vivo measurement of blood flow: a coil evolves in an environment where blood pressure, blood velocity and pulsatility might influence its motion and deployment. We have initiated a series of experiments and models for describing these aspects. Although preliminary, our current results show the complex relationships between blood flow, anatomy and coil gemotry during coil embolization.

  – validation: several of the previous approaches have been quantitatively validated against phantom data. This is a first step to put our simulation tool into the OR: apply the results of the above works to patient data, with various types of coils, and initiate validation against actual X-ray images of coil deployment and collect feedback from the physicians.

- AEN SOFA Partners : INRIA Asclepios and Evasion projects

  A national research initiative on medical simulation was officially launched in September 2008. The main objective is to accelerate / foster research activities in the field of Medical Simulation, with the long term goal of developing patient-specific simulations. This ambitious objective will initially translate into improved realism - and therefore higher credibility - of training systems. These research activities are essential to the development of patient-specific simulation systems dedicated to the planning of medical procedures. Most of these research activities rely on competencies shared across the different teams involved in this program. The second set of research activities relates to peripheral themes, for which the main effort consists in adapting existing algorithms of methods to a new set of problems.

  One of the main difficulties of Medical Simulation research is its multidisciplinary aspect. The diagram in Fig. 13 illustrates the three main themes we plan to study during this program.

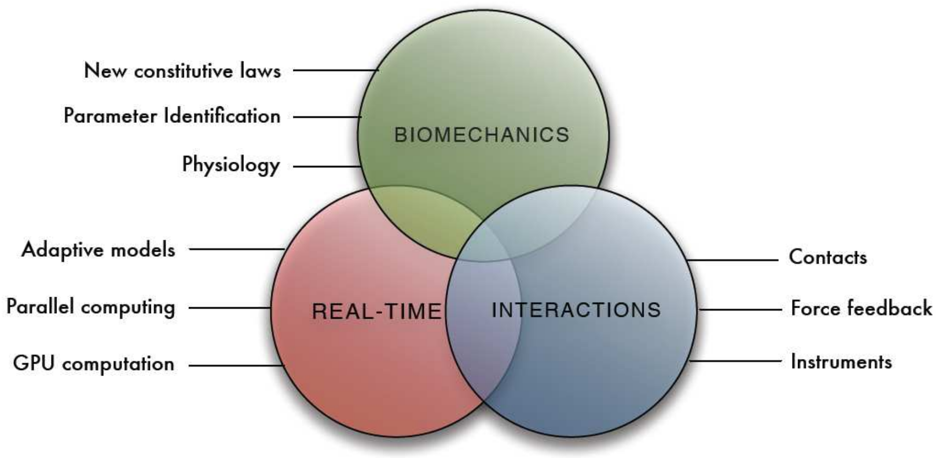


*Figure 13. The National Research Initiative on Medical Simulation will address a series of interdependent problems in the multidisciplinary field of Medical Simulation.*

  It clearly shows the interdependency between research themes, which reinforces the idea that only a coordinated program, where teams work together, can advance the state-of-the art significantly.

  – Biomechanical behavior modeling
  – Interactions
  – Real-time optimization,
  – Patient-specific models,
  – Validation

## 8.2. European initiative

- Passport (FP7 project: Physiological human call)

  In 2006, over 45.000 European citizens died of cirrhosis of the liver and 44,000 additional citizens of liver cancer, knowing that the same year 48,700 new liver cancer cases were declared. Surgical procedures remain the options that offer the foremost success rate against such pathologies. Regretfully, surgery is not so frequent due to several limitations.

  Indeed, eligibility for liver surgery is based on the minimum safety liver volume remaining after resection (standardized FLR), but this minimum value varies over time and from one patient to another according to biological and mechanical properties of the liver. Since 1996, a large set of preoperative planning software has been developed, but all of them provide only the volume of the liver before and after resection. However interesting, this limited information is not sufficient to improve the rate of surgical eligibility. PASSPORT for Liver Surgery aims at overcoming these limitations by offering a patient-specific modelling that combines anatomical, mechanical, appearance and biological preoperative modelled information in a unified model of the patient. This first complete "Virtual liver" will be developed in an Open Source Framework allowing vertical integration of biomedical data, from macroscopic to microscopic patient information.

  From these models, a dynamic liver modelling will provide the patient-specific minimum safety standardized FLR in an educative and preoperative planning simulator allowing to predict the feasibility of the gesture and surgeons? ability to realise it. Thus, any patient will be able to know the risk level of a proposed therapy. Finally, we expect to increase the rate of surgical treatment so as to save patients with a liver pathology. To reach these purposes, PASSPORT is composed of a high level partnership between internationally renowned surgical teams, leading European research teams in surgical simulation and an international leading company in surgical instrumentation.

## 8.3. Chinese collaboration

The collaboration deals with several topics around interaction. we have two partners, Chinese Academy fo Sciences, Intitut of Automation and Beihang University.

### *8.3.1. A New Human Representation Mixing Avatar and Video*

This project was launched between the LIAMA and the Inria-Alcove (Prof. Christophe Chaillou), and three Chinese students (two PhDs Wang Haibo and Ding Li and one Master Lu Wanping) are currently involved in this project. This project progresses smoothly now, with two publications in international conferences this year. The difficulties lie in that we need to obtain the real time and semantic information from video for the Webcam in the unconstrained environments so that the users are able to communicate each other in a virtual environment by the distant Webcam. Therefore some new methods have to be developed to process video effectively and efficiently.

C Chaillou visited Liama for one week in september and Pan chunhong was invited professor during one month in june.

### *8.3.2. Virtual reality based planning technology for hand-eye coordinated surgical operation*

The objective of the research project is to develop a high performance virtual reality surgical assistant system, which supports realistic simulation of surgical procedures involving rigid or deformable tissue manipulation, haptic rendering, hand-eye coordination, and skill evaluation. The system can not only be used for surgical planning and rehearsal, but also can be used for surgical training. Dental surgical operation is adopted as en example to validate our idea and typical operation include drilling/burring/probing will be studied. two phD students (Ge YU Beihang and Wei Yiyi CASIA-Lille joint PhD student) are currently involved in this project.

In May 2008, Stephane Cotin spent a week at LIAMA, to discuss with the different partners of the project In Dec. 2008, Dangxiao Wang visited Lille for about ten days. He worked with SOFA team to get familiar with the deformation algorithms in SOFA.

#### *8.3.3. Coupling of kinaesthetic and tactile feedback devices for touch simulation*

The project will be divided into several tasks: the design of a 3DOF cable-driven force feedback device, the connection and coupling with the vibrating tactile plate providing only local friction variation, then, accounting for the first evaluation results, a new tactile device will be designed in order to fulfil requirements of the shape of the end effectors, as well as the specifications for texture rendering. At last, a 6 dof force and tactile device will be proposed. A master degree student from Beihang University  Sun Zhitao  has spent 6 months in Lille from February till July 2008, to work on coupling tactile and force feedback devices. B. Lemaire-Semail was invited during two weeks in Beihang University in september 2008. She gave 4 lectures about haptic devices and control and Pr Zhang yuru spent 10 days at Lille in December.

# 9. Dissemination

## 9.1. Leadership within scientific community

- Jérémie Allard was reviewer for Medical Image Analysis (MedIA), ISBMS 2008, VRST 2008, Eurographics 2009.
- Géry Casiez was member of the program committee for VRST 2008 and VRIC 2008 and reviewer for CHI 2009, UIST 2008 and IJHCS. He was also session chair at VRST 2008. He also participated to one PhD Thesis commitee.
- Christian Duriez was reviewer for IEEE transaction on mechatronics, SIGGRAPH 2008, Eurographics 2009, ICRA 2008 and 2009, Worldhaptic 2009. He will participate to the phD thesis commitee of Nadjet Talbi.
- Laurent Grisoni was program comitee member of ACM Symposium on Solid and Physical Modeling 08, reviewer in 2008 for JCAD, Eurographics (09), Gesture Workshop LNCS, Int. J. for Computational methods in eng. sci. and mechanics, J. of comp. aided Design. He attended in 2008 four PhD defense commitees (two as co-advisor, one as reviewer, one as examiner)
- Christophe Chaillou was program comitee member of Vriphys 08 and Edutainment 2008, reviewer for "Revue électronique d'informatique graphique" . He attended in 2008 five PhD defense commitees (three as co-advisor, one as reviewer, one as examiner). He was reviewer for the ANR and MESR. Participation to hiring commitees in Inria Grenoble and Strasbourg University.

## 9.2. PhD defended in 2008

Three PhD have been defended in 2008 : Guillaume Saupin [13], Radu Vatavu [14] and Pan Qing [12].

## 9.3. PIRVI : a working framework for projects in Interaction, Virtual Reality and Computer Graphics

We began in 2008 to implement a working framework to encourage collaborations, between research teams and industry, in the area of the Virtual Reality (see http://www.lifl.fr/pirvi). This framework is based on high tech equipments (such as virtual reality room, tactile displays) and scientific expertise (in computer graphics, vision and interaction). The PIRVI propose to schedule and manage projects to obtain demonstrations for research teams and industry. Five teams from LIFL and LAGIS contribute to the PIRVI : ALCOVE, FOX-MIIRE, SMAC, NOCE and VISION&IMAGES.

## 9.4. Teaching

- Master students (University of Lille I) :
  - Laurent Grisoni : computer graphics (Animation, geometric modeling)
  - Frédéric Giraud : Fundamentals of Piezo-electricity.
  - Christian Duriez: digital image processing.
- Engineer students (Polytech'Lille)
  - Géry Casiez : HCI, Haptics
  - Laurent Grisoni : Animation, Advanced Computer Graphics, data compression and security (DCT, wavelets, watermarking, cryptology)
  - Christophe Chaillou : Hardware and Computer architecture
  - Patricia Plénacoste : HCI - Ergonomics
  - Betty Lemaire-Semail : electromagnetism, piezo-electric control
- Engineer students (ENIC - Lille)
  - Géry Casiez : Haptics, graphics cards
- Engineer students (ICAM - Lille)
  - Christian Duriez : Finite Element Method
- Faculty students (University of Lille I)
  - Fabrice Aubert : 3D Programming, Introduction to Computer Graphics
  - Géry Casiez : 3D Programming, Pascal programming, Linear programming and graph theory
  - Patricia Plénacoste : HCI - Ergonomics.
  - Frédéric Giraud : Modeling and Control of electrical devices, Introduction to electrical engineering

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