INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team ALCOVE

Interacting with complex objects in collaborative virtual environments

Lille - Nord Europe

Theme : Interaction and Visualization

Activity Report

2009

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2. Overall Objectives

2.1. Introduction

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

- This year, three full papers have been accepted in the International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI). One paper was on coil embolization, in collaboration with the MAGRIT team, one was on flexible needle insertions, and one on blood flow simulation in aneurysm. Furthermore, this last paper received the MICCAI 2009 Young Scientist Award on “Computer-assisted Intervention II: Simulation and Robotics”.
- The SOFA ADT has been renewed, continuing the support of our development efforts. Two new engineer will join our team at the end of the year. During the PASSPORT project annual review, the results we achieved using SOFA for connective tissues modeling and liver automatic texturing (Fig. 7) where very well received.

- This year has seen the publication of two papers (one full, one technical note) in the major conference in the field of HCI: ACM CHI. The full paper (published in collaboration with DGP, toronto) presents a study of hand-occlusion with small portable devices. The technote presents a model of performance for selection techniques using Brain-machine interface systems.
- We started this year the very first INRIA I-lab, with Ides-3Com small company. This I-lab will last for 3 years, and settle software tools for advanced 3D interactions, along with research on 3D interaction for selling.

3. Scientific Foundations

3.1. 3D Human Computer Interface

Participants: Géry Casiez, Christophe Chaillou, Samuel Degrande, Laurent Grisoni, 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

Participants: Christophe Chaillou, Samuel Degrande, Patricia Plénacoste, Jérémy Ringard, Johann Vandromme, Haibo Wang.

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

Participants: Christophe Chaillou, Frédéric Giraud, 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

Participants: Jérémie Allard, Olivier Comas, Stéphane Cotin, Jérémie Dequidt, Laurent Grisoni, Christian Duriez, Christophe Guébert, Frédérick Roy.

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 ([29]). 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

Participants: Jérémie Allard, Stéphane Cotin, Hadrien Courtecuisse, Jérémie Dequidt, Christian Duriez, Laurent Grisoni.

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 ([31]). 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 ([32], [30], [33]).

4. Application Domains

4.1. Interactive Simulation of Medical Procedures

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 [29] 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

We started last year some research on patient rehabilitation. This activity is supported by the ANR TecSan Reactive project, that started 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

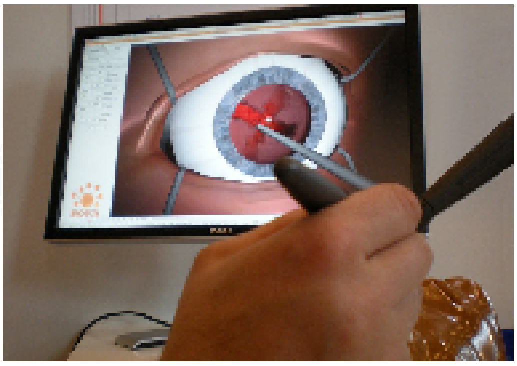
During the year we participate to meetings of the PICOM "Pôle de compétitivité industries du commerce". We worked on a pre-project study, targeted toward virtual design of shops. We think that shop design, and also possibly virtual shops for client, could provide interesting test for advanced interaction 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, Frédérick 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.



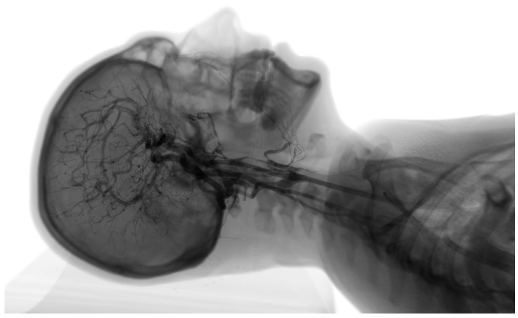


Figure 1. Applications using SOFA: surgical procedure in ophthalmology and interventional radiology

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.

5.2. Software Development for HCI

Participants: Damien Marchal [correspondent], Norbert Barichard, Clément Moerman.

In the context of our research on multi-touch interaction and 3D we have conducted several specific software development[1]. Our first contribution is BlenderTUIO[2]. BlenderTUIO is based on Blender, a well known open-source modeling software, that we have extended to handle multi-touch interaction. With this software our main objective was to be able to quickly set-up new experiments on interaction combining multi-touch and 3D. BlenderTUIO was then released in open-source, and received interest from both academia and the art community[3]. For academia, it is a tool to quickly make 3d application with multi-touch while for the art community BlenderTUIO offers a way to connect specific sensing devices to 3D content through the TUIO protocol. A group of user from several university is currently forming to pursue the development of this tool. A second important software development activity was done in the context of the I-Lab with Idée3Com. An extension was developed to support multi-touch display with VRML/X3D, the extension being used by Idée3Com in a prototype of a multi-touch 3d room-planning software that was demonstrated the November 24 in the exhibition "Les rencontres Net2009".

6. New Results

6.1. Towards Interactive Planning of Coil Embolization in Brain Aneurysms

Participants: Jérémie Dequidt, Christian Duriez, Erwan Kerrien, Stéphane Cotin.

Many vascular pathologies can now be treated in a mini- mally invasive way thanks to interventional radiology. Instead of open surgery, it allows to reach the lesion of the arteries with therapeutic de- vices through a catheter. As a particular case, intracranial aneurysms are treated by Þlling the localized widening of the artery with a set of coils to prevent a rupture due to the weakened arterial wall. Consider- ing the location of the lesion, close to the brain, and its very small size, the procedure requires a combination of planning and excellent techni-cal skills. An interactive and reliable simulation, adapted to the patient anatomy, would be an interesting tool for helping the interventional neu- roradiologist plan and rehearse a coil embolization procedure. This work describes an original method to perform interactive simulations of coil embolization. The simulation relies on an accurate reconstruction of the aneurysm anatomy and a real-time model of the coil for which sliding and friction contacts are taken into account. Simulation results are validated against real embolization procedure using clinical metrics and exhibit good adequacy. A paper was published at MICCAI conference on this subject this year [16]

6.2. Interactive Simulation of Flexible Needle Insertions Based on Constraint Models

Participants: Christian Duriez, Christophe Guebert, Maud Marchal, Stéphane Cotin, Laurent Grisoni.

[1] http://forge.lifl.fr/PIRVI/wiki/MTUtils
[2] http://forge.lifl.fr/PIRVI/wiki/MTUtils/blenderTUIO
[3] http://forge.lifl.fr/PIRVI/blog

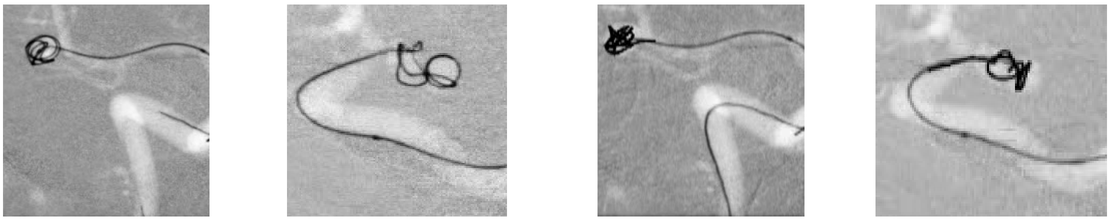


Figure 2. Examples of our simulation results: (left) real coil embolization (right) our simulated coil embolization with 3D coils.

This work presents a new modeling method for the insertion of needles and more generally thin and flexible medical devices into soft tissues. Several medical procedures rely on the insertion of slender medi- cal devices such as biopsy, brachytherapy, deep-brain stimulation. In this paper, the interactions between soft tissues and ßexible instruments are reproduced using a set of dedicated complementarity constraints. Each constraint is positionned and applied to the deformable models without requiring any remeshing. Our method allows for the 3D simulation of different physical phenomena such as puncture, cutting, static and dy- namic friction at interactive frame rate. To obtain realistic simulation, we parametrize the model using experimental data. We validate our method through a series of typical simulation examples and new more complex scenarios. A paper on this subject was published at MICCAI conference this year [18]

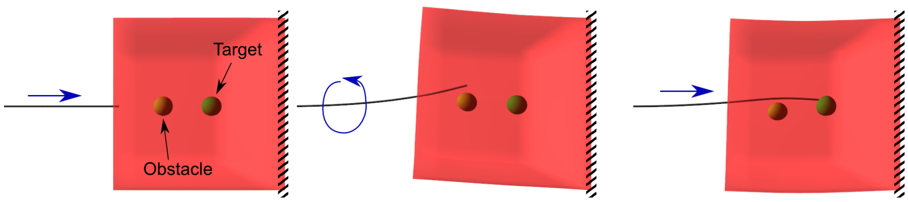


Figure 3. The needle is first inserted one half of the distance into the phantom, then spun 180 degrees, and finally inserted the remaining distance.

6.3. Suturing simulation based on complementarity constraints

Participants: Christophe Guebert, Christian Duriez, Jérémie Allard, Stéphane Cotin, Laurent Grisoni.

This work introduces a new method, based on complementarity constraints, for simulating virtual sutures in soft tissues. Complementarity constraints are known for the modeling of contacts with friction between solid objects, however they can be used for other types of interactions. In this paper, we focus on modeling the physical nature of the interactions with the needle and surgical thread during the suture of soft anatomical structure. In particular we model needle puncture through soft tissues, followed by the friction that occurs when sliding through the tissue, the punture and cutting forces associated to different tissue layers, and the collision with boundary membranes or stiffer structures. Although the proposed constraint formulation is independent of the physical models used for the needle, thread or soft tissue, the choice of these models is key to obtain real-time performance. Therefore we also propose to combine two models that can handle geometrically non-linear deformations: the thread model is based on beam theory and the soft tissue model relies on a volumetric

Þnite element method. A common iterative solver is used for all constraints, in combination with an implicit integration scheme, providing fast and stable simulations even for complex scenarios.

One part of this work was published at SCA conference this year [19]

6.4. Toward Real-time Simulation of Blood-Coil Interaction during Aneurysm Embolization

Participants: Yiyi Wei, Stéphane Cotin, Jérémie Allard.

Over the last decade, remarkable progress has been made in the field of endovascular treatment of aneurysms. Technological advances continue to enable a growing number of patients with cerebral aneurysms to be treated with a variety of endovascular strategies, essentially using detachable platinum coils. Yet, coil embolization remains a very complex medical procedure for which careful planning must be combined with advanced technical skills in order to be successful.

We proposed a method for computing the complex blood flow patterns that take place within the aneurysm, and for simulating the interaction of coils with this flow. This interaction is twofold, first involving the impact of the flow on the coil during the initial stages of its deployment (Fig. 4, and second concerning the decrease of blood velocity within the aneurysm, as a consequence of coil packing. We also proposed an approach to achieve real-time computation of coil-flow bilateral influence, necessary for interactive simulation. This in turns allows to dynamically plan coil embolization for two key steps of the procedure: choice and placement of the first coils, and assessment of the number of coils necessary to reduce aneurysmal blood velocity and wall pressure.

A paper on this subject was published at MICCAI conference this year [26]

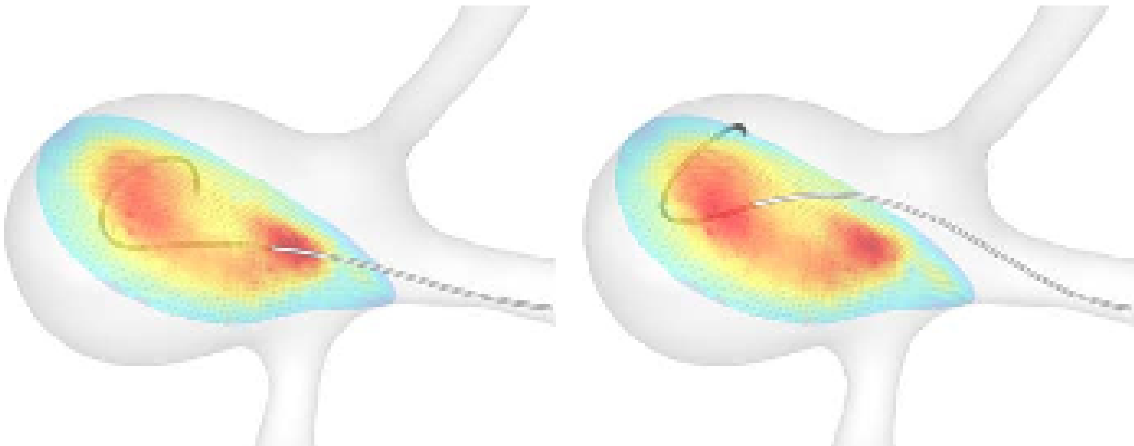


Figure 4. (Left): Coil shape when the effect of blood flow is not taken into consideration; (Right): Resulting shape when considering flow forces on the coil.

6.5. A robust and efficient Lagrangian Constraint Toolkit for the Simulation of 1d structures

Participants: Adrien Theetten, Laurent Grisoni.

This work [15] presents a set of useful lagrangian constraints that can be used on 1d deformable models , in order to create real-time animation of complex structures, such as bridges. Real-time animation of several examples is also provided.

6.6. Multiscale Detection of Gesture Patterns in Continuous Motion Trajectories

Participants: Radu Vatavu, Laurent Grisoni, Stefan-Gheorghe Pentiuc.

This work [27] proposes some metrics, independant from scaling, for detection patterns. We also show that the proposed method is independant from scaling.

6.7. Gesture Recognition Based on Elastic Deformation Energies

Participants: Radu Vatavu, Laurent Grisoni, Stefan-Gheorghe Pentiuc.

This work [28] proposes a framework for extracting geometric patterns within a continuous trajectory, without any knowledge of start and endpoint.

6.8. Hand Occlusion with Tablet-sized Direct Pen Input

Participant: Géry Casiez.

This work presents the results from an experiment examining the area occluded by the hand when using a tablet-sized direct pen input device. Our results show that the pen, hand, and fore-arm can occlude up to 47% of a 12 inch display. The shape of the occluded area varies between participants due to differences in pen grip rather than simply anatomical differences. For the most part, individuals adopt a consistent posture for long and short selection tasks. Overall, many occluded pixels are located higher relative to the pen than previously thought. From the experimental data, a five-parameter scalable circle and pivoting rectangle geometric model is presented which captures the general shape of the occluded area relative to the pen position. This model fits the experimental data much better than the simple bounding box model often used implicitly by designers. The space of fitted parameters also serves to quantify the shape of occlusion. Finally, an initial design for a predictive version of the model is discussed.
This work has been carried out with Daniel Vogel and Ravin Balakrishnan from University of Toronto, Matthew Cudmore and Liam Keliher from Mount Allison University and the results were published at CHI 2009 [24].

6.9. Advances in the control of piezo-electric actuators used in for force-feedback devices.

Participants: Frédéric Giraud, Betty Lemaire-Semail, Zheng Dai.

As a solution to the lack of compactness and simplicity often encountered in haptic interfaces, we propose a device based on friction coefficient control principle. This device includes polarised piezoceramics well adjusted and glued to a 64x38x3 mm copper-beryllium plate supported by four legs. Then, properly energised around a resonant frequency, with legs at antinodes, a stationary wave is created in the plate. Variable friction forces between the legs and the plane substrate are created by the control of the wave amplitude, according to electro-active lubrication. So the user obtains force feedback by holding the plate, and moving it on a plane substrate, as he could do with a mouse interface. Preliminary psychophysical evaluation trends to assess the validity of the device as a force feedback interface[21][20].

Moreover, Using Travelling Wave Ultrasonic Motors needs specific control algorithms in order to allow force feedback operations. For example, mechanical overload on the shaft of a traveling-wave ultrasonic motor often results in the motor suddenly stalling. To avoid this drawback, one can increase the supply voltage or add a control loop in the rotating reference frame of the traveling wave. The consequences are extra power losses or lower dynamic performances. We proposed a method which combines the advantages of classical controls and controls in a rotating frame: both stability and dynamic performances are obtained at low supply-voltage levels. Experimental runs are presented, showing performances of a position control of the motor[14].

6.10. Improvement of a tactile stimulator, and its connectivity

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

The tactile stimulator which is born in the framework of Alcove's project has shown good performances for gratings simulation. To reach such level of performance, an accurate position sensor is used to locate a user's fingertip on the device. Other improvements have been added in order to reduce bulk size of the power electronics which supply power to the tactile stimulator. A specific design was achieved. At the end, a complete stimulator was built and fits in a demo-suitcase. This work allowed to easily carry the stimulator for presentation to a large audience, and was part of the demo session of the 2009 Haptic Symposium in Salt Lake City.

We designed then a program running on a host computer to control the tactile stimulator. This software converts a picture into tactile stimuli. We paid attention to build a software which helps to create new experiences easily. The solution found was to store a catalogue of pictures inside the target DSP and in the host computer. To create an experience, the user just has to choose a of set of pictures arranged in sequence.

Further work was carried out in order to shrink stimulator's size (figure 5. The final goal is to build a stand-alone tactile stimulator, which could be used as a touchpad. To achieve that, we reduced the size of the position sensor. We used optical force sensor to deduce fingertip's position when a user touch the device. Best result were found if a specific algorithm were used to remove sensor's non linearity. In spite of the large amount of software resources, a poor resolution could be achieved only. But this solution os outstanding in terms of final size of the position sensor. We also tried to increase the device's efficiency. To do so, we optimized the substrate thickness, the piezo ceramic used and the vibration wavelength. Finally, we could build a prototype which power consumption is below 2 watts, which is consistent with power consumption of items plugged into an USB port of a computer.

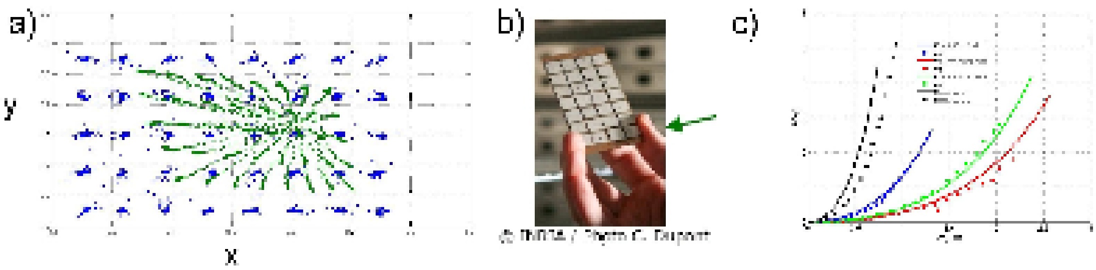


Figure 5. a) Fingertip's position with an optical force sensor before (green) and after (blue) linearization. b) The optimize tactile stimulator . c) Power consumption (W) as a function of the tactile stimuli (W) for the original tactile plate (black) and the optimized one (red). Other results are presented.

6.11. A Performance Model of Selection Techniques for P300-Based Brain-Computer Interfaces

Participant: Géry Casiez.

In this work, we propose a model to predict the performance of selection techniques using Brain-Computer Interfaces based on P300 signals. This model is based on Markov theory and can compute both the time required to select a target and the number of visual ?ashes needed. We illustrate how to use this model with three different interaction techniques to select a target. A first experimental evaluation with three healthy participants shows a good match between the model and the experimental data.

This work has been carried out with Jean-Baptiste Sauvan, Anatole Lécuyer and Fabien Lotte from the INRIA Bunraku project at the University of Rennes I and the results were published at CHI 2009 [23].

6.12. Distant Human Representation for Computer-mediated Communications: Mixing Video and Avatar

Participants: Christophe Chaillou, Wang Haibo, Ding Li.

The research on distant human representation in computer-mediated communications has considerably increased in the last decade. This paper, written in collaboration with Casia & Tsinghua, proposes a novel human representation method. In the proposal, two non-verbal communication channels, facial and gesture expressions, as the crucial supplements to verbal cues, are executed by mixing video and avatar. In more detail, the facial and gesture information are first extracted from live image sequences. Then the extracted facial information, in the form of texture image, is mapped on an avatar which represents a human user. Meanwhile, the extracted gesture information is used to drive the avatar by the featurematching techniques. Our experimental results [17] show that the proposed method are sufficient to distantly represent human user.

We also propose a gaze estimation method that considers both eye gaze and coordinated head orientations [25].

6.13. Computer-Aided Collaborative Work into War Rooms: A New Approach of Collaboration

Participants: Jérémy Ringard, Samuel Degrande, Christophe Chaillou.

This paper [22] presents the realization of a new software and hardware platform for collocated collaborative work. Our objective is to take the most of the various competences of the teammates. We have created an architecture named MVT (model, view, tool) for supporting collaborative interaction in warroom- like environments. This software distribution offers various interactions modalities, allowing multi-skilled teams to collaborate using different input devices, thanks to multiple and heterogeneous visualization and interaction channels.

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 (ANR-07-TECSAN-020) 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.

- INSTINCT Partners : INRIA Bordeaux, Immersion, CapSciences

  This project focuses on the conception, the development and the evaluation of new tactile interfaces to promote the diffusion of 3D interactive applications among the public. The interaction with tactile surfaces, and more precisely multi-touch surfaces, are changing the way people interact with computers. The INSTINCT project aims at contributing to this trend by focusing on 3D applications. The partners will develop intuitive interfaces based on existing products and also develop new interfaces to enhance interaction (use of tactile feedback for example). The project started in October 2009.

- 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. 6 illustrates the three main themes we plan to study during this program.

  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

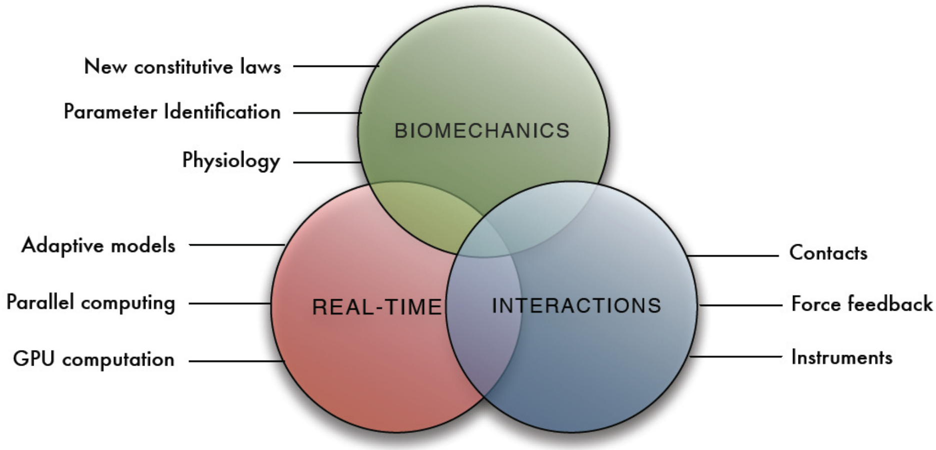


Figure 6. The National Research Initiative on Medical Simulation will address a series of interdependent problems in the multidisciplinary field of Medical Simulation.

- INTACCT Partners research institute Charles Sadron (Strasbourg) laboratory of physics and mechanics of textile (Mulhouse)

  INTTACT is a one-year project founded by a PEPS grant (CNRS). This project deals with the programmation of tactile stimuli in order to give a user information through the sense of touch. The goal is to propose tactile stimulators which are able to produce the physical sensation of touching finely textured surfaces, like fabrics for example. This project involves people from several research domains.

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

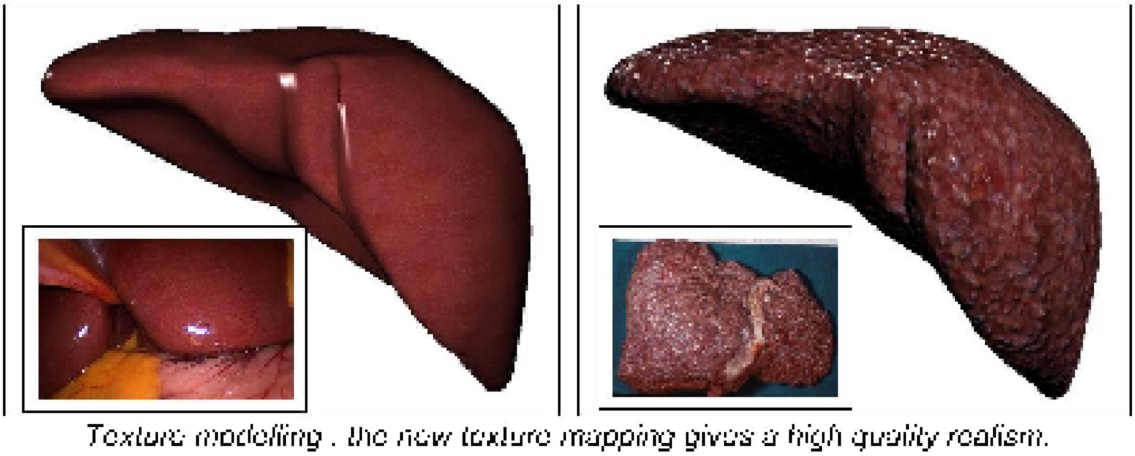


Figure 7. New results on automated texturing obtained using SOFA in the PASSPORT project.

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 collaborations

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. During this year, we mainly focused on developing new approaches to extract the semantic information of human face and gestures from monocular video such that users are able to be represented effectively in a virtual environment. The major challenges lie in how to track effective features under the various influencing factors, such as illumination and pose variations, as well as how to distinguish the semantic cues from other meaningless information. Accordingly, we have carried out our research in the following several aspects:

- Build a 3D gesture database and develop a multi-scale strategy that matches body silhouette at each frame against the database ones to extract semantic gestures.
- Propose a gaze estimation method that considers both eye gaze and coordinated head orientations.
- Develop a 3D head modeling system and integrate it into a feature-based 3D pose tracking approach.

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

After finalizing a work plan for Wei Yiyi's Ph.D. thesis mid-2008, she obtained a fellowship from the French Embassy to start a Ph.D. thesis in October 2008. This thesis is done in collaboration between the ALCOVE team at INRIA Lille and LIAMA in Beijing. Following Wei Yiyi's interest in fluid simulation, we developed a first model of 2D fluid within the SOFA framework during the last months of 2008. Early 2009 we decided to extend the method the 3D fluid, with a particular focus on blood flow simulation in the neighborhood of aneurysms. This was motivated by one of our ongoing projects as well as the work Yiyi was pursuing. We obtained very good results a few weeks before the end the first 6 months of Yiyi's stay in France and decided to submit an article to the international conference on Medical Image Computing and Computer Assisted Intervention (MICCAI). This work was accepted for oral presentation (about 40 out of 700 papers submitted) and Yiyi's was awarded the Young Investigator Award during the meeting which took place in September 2009.

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

The collaboration between the Human-Machine Interaction Lab and Alcove project team has been intensified.

A first exchange took place with the scientific stay of Pr. Betty Semail, invited during two weeks at Beihang university: four scientific seminars has been given on tactile devices, coupling of tactile and kinaesthetic devices, piezo-electricity and control tools. We have also prepared the second part of the master thesis of Yi Yang, a student from Beihang University who was planed to come in Lille and to begin later a co-supervised PhD thesis. In December 2008, Pr. Yuru Zhang came in Lille for a week and she gave also a seminar on force feedback devices, moreover she had the opportunity to touch and test the tactile feedback device designed by Alcove. Then, as it was scheduled, the master student Yi Yang came in Lille from April to July 2009.

As for the scientific results of this collaboration, a first device coupling tactile and kinaesthetic feedbacks has been designed. During his stay in Lille, the master Student Yi Yang acquired skills about the design and control of the tactile plate developed by Alcove. He succeeded to adapt the plate on the end effector from the cable-driven force feedback device which was developed in Beihang University. The work was successful and the student came back in China with one item of the tactile plate, its power supply and the control board.

The goal of such an approach is to respect the idea that when a user touches an object, he can feel in the same time the hardness or softness of this object, as well as its surface texture if any, at least, its friction behaviour. The coupled device allows such a feeling: when a user touches an object in the virtual world, the cable-driven end effector, which is able to move on a large surface (as for now it is a 2D device) renders a force feedback at the hand level (the user grasps the end effector with his five fingers). Then, once the contact is established, according to a finger position sensor, the forefinger may move on the tactile plate (as it would do in the virtual world) so as to feel the surface texture.

9. Dissemination

9.1. Leadership within scientific community

- Christophe Chaillou is reviewer for International Journal of Image and Graphics. He was invited for examination of 6 PhD defences (two as president, two as reviewer and two as examiner) and one HDR as reviewer. He participated in board recruitment at Inria for DR and CR (Saclay Unit)
- Jérémie Allard served as a Session Chair during the IEEE Int. Conf. on High Performance Computing and Communications (HPCC 2009), and was a reviewer for Medical Image Analysis (MedIA), Simulation in Healthcare, IEEE Visualization 2009, IEEE VR 2010, Eurographics 2010.
- Géry Casiez was reviewer for CHI 2010, UIST 2009 and CGA. He also participated to one PhD Thesis commitee.
- Christian Duriez was reviewer for ICRA 2009, Worldhaptic 2009, IEEE trans. on applied perception journal, IROS2009, ISBMS 2010, Presence journal, He attended the phD
- Jérémie Dequidt was reviewer for Medical Image Analysis (MedIA) - Computer-Assisted Interventions special issue and for AFIG 09. He was also member of the program committed for ISBMS'10.
- 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.

- Frédéric Giraud is reviewer for the IEEE Transactions on Ultrasonics, Ferroelectricity and Frequency Control. He was invited for examination comity of one PhD defence as an external Examiner (Department of Electrical and Computer Engineering, University of Toronto).

9.2. PhD defended in 2009

Three PhD have been defended in 2009 : Gaston N'Boungui [13], Zheng Dai [11] and Richard Demersseman [12].

9.3. PIRVI : a working framework for projects in CHI, Virtual Reality and Images

The PIRVI[4] framework was initiated in 2008 as a way to encourage collaborations between research teams and industry in the field of Vision and Virtual Reality. Five teams from The LIFL and the LAGIS are contributing to the PIRVI : ALCOVE, FOX-MIIRE, SMAC, NOCE and VISION&IMAGES. Within the PIRVI the ALCOVE team provides its scientific expertise in the field of computer graphics, vision and computer-human interfaces as well as by demonstrating and building collaboration based on its dedicated equipments: virtual reality room and multi-touch tactile displays. In 2009 the PIRVI organized several demonstration days in which ALCOVE took a big role. During these days ALCOVE has presented its research works to many potential industrial partners and political figures. Some significant dates:

- February 19th: demonstration day for a selected panel of industrial partners.
- March 12th: demonstration for the visit of the Secretary of State for Digital Economy (Nathalie Kosciusko-Morizet).
- November 6th: demonstration day for the AFM (Association Familliale Mulliez) which is a very well-known industry group in France (Auchan, Decathlon, Saint-Maclou...).
- Septembre 15: demonstration day for the Pôle Image (companies working in the field of visual entertainment, gaming, design and graphics).

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
  - Jérémie Dequidt : Parallel programing, Advanced Computer Graphics, Data Compression, Numerical Analysis
  - 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 : Computer graphics, VR, haptics, graphics cards

[4] see http://www.lifl.fr/pirvi

- Engineer students (ICAM - Lille)
  - Christian Duriez : Finite Element Method
- Faculty students (University of Lille I)
  - Fabrice Aubert : 3D Programming, Introduction to Computer Graphics, Introduction to Programming
  - Géry Casiez : HCI, Introduction to programming
  - Patricia Plénacoste : HCI - Ergonomics.
  - Frédéric Giraud : Modeling and Control of electrical devices, Introduction to electrical engineering

10. Bibliography

Major publications by the team in recent years

[1] M. BIET, F. GIRAUD, B. SEMAIL. *Squeeze film effect for the design of an ultrasonic tactile plate*, in "IEEE Transactions on Ultrasonic, Ferroelectric and Frequency Control", december 2007.

[2] G. CASIEZ, D. VOGEL, R. BALAKRISHNAN, A. COCKBURN. *The Impact of Control-Display Gain on User Performance in Pointing Tasks*, in "Human-Computer Interaction, Taylor and Francis", vol. 23, n^{o} 3, 2008, p. 215–250.

[3] G. CASIEZ, D. VOGEL, Q. PAN, C. CHAILLOU. *RubberEdge: Reducing Clutching by Combining Position and Rate Control with Elastic Feedback*, in "UIST'07, the 20th ACM Symposium on User Interface Software and Technology", ACM Press, 2007, p. 129–138.

[4] J. DEQUIDT, M. MARCHAL, C. DURIEZ, E. KERRIEN, S. COTIN. *Interactive Simulation of Embolization Coils: Modeling and Experimental Validation*, in "Proceedings of MICCAI", D. METAXAS, L. AXEL, G. SZEKELY, G. FICHTINGER (editors), Lecture Notes in Computer Science, Springer, September 2008, p. 695–702.

[5] J. DEQUIDT, D. MARCHAL, L. GRISONI. *Time-Critical Animation of Deformable Solids*, in "Journal of Computer Animation and Virtual Worlds (CASA 2005)", vol. 16, 2005, p. 177-187.

[6] C. DURIEZ, S. COTIN, J. LENOIR, P. NEUMANN. *New Approaches to Catheter Navigation for Interventional Radiology Simulation*, in "Computer Aided Surgery", 2006.

[7] J. LENOIR, P. MESEURE, L. GRISONI, C. CHAILLOU. *A Suture Model for Surgical Simulation*, in "International Symposium on Medical Simulation, Cambridge, Massachusetts (USA)", june 2004.

[8] F. MARTINOT, P. PLÉNACOSTE, C. CHAILLOU. *Mechanical Responses of the Fingerpad and Distal Phalanx to Friction of a Grooved Surface : Effect of the Contact Angle*, in "Haptic Interfaces for Virtual Environment and Teleoperator Systems (part of IEEE-VR)", 2006.

[9] L. RAGHUPATHI, L. GRISONI, F. FAURE, D. MARCHAL, M.-P. CANI, C. CHAILLOU. *An Intestine Surgery Simulator: Real-Time Collision Processing and Visualization*, in "IEEE Trans. On Visualization And Comp. Graphics", vol. 10, n^{o} 6, Nov/Dec 2004, p. 708-716.

[10] A. THEETTEN, L. GRISONI, C. ANDRIOT, B. BARSKY. *Geometrically Exact Dynamic Splines*, in "Journal of Computer Aided Design", vol. 40, n^{o} 1, 2008, p. 35–48.

Year Publications

Doctoral Dissertations and Habilitation Theses

[11] Z. DAI. *Actionneurs piézo-électriques dans des interfaces homme - machine à retour d'effort*, Université des sciences et technologie de Lille, 2009, Ph. D. Thesis.

[12] R. DEMERSSEMAN. *Caractérisation et modélisation causale d'un frein à liquide magnétorhéologique en vue de sa commande*, Université Lille I, 2009, Ph. D. Thesis.

[13] G. N'BOUNGUI. *Actionneur Pi'ezo'electrique Commandable en Frottement Variable*, Universit'e Lille I, 2009, Ph. D. Thesis.

Articles in International Peer-Reviewed Journal

[14] F. GIRAUD, B. SEMAIL, A. JULIEN, J. ROBINEAU, J.-T. AUDREN. *Stability Analysis of an Ultrasonic Motor for a New Wave Amplitude Control*, in "IEEE Transactions on Industry Applications", vol. 45, 2009, p. 1343–1350.

[15] A. THEETTEN, L. GRISONI. *A robust and efficient Lagrangian Constraint Toolkit for the Simulation of 1D structures*, in "Journal of Computer Aided Design", 2009, to appear.

International Peer-Reviewed Conference/Proceedings

[16] J. DEQUIDT, C. DURIEZ, S. COTIN, E. KERRIEN. *Towards Interactive Planning of Coil Embolization in Brain Aneurysms*, in "Proceedings of the International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)", G.-Z. YANG (editor), Annual Conference Series, LNCS, sept 2009, p. 377–385.

[17] L. DING, H. WANG, C. CHAILLOU, C. PAN, J. WANG. *Distant Human Representation for Computer-mediated Communications: Mixing Video and Avatar*, in "VRIC'09, The 11th International Conference on Virtual Reality (Laval Virtual)", Apr 2009 ch .

[18] C. DURIEZ, C. GUÉBERT, M. MARCHAL, S. COTIN, L. GRISONI. *Interactive Simulation of Flexible Needle Insertions Based on Constraint Models*, in "Proceedings of MICCAI 2009", G.-Z. YANG, D. HAWKES, D. RUECKERT, A. NOBLE, C. TAYLOR (editors), vol. 5762, Springer, sep 2009, p. 291–299.

[19] C. GUÉBERT, C. DURIEZ, S. COTIN, J. ALLARD, L. GRISONI. *Suturing simulation based on complementarity constraints*, in "Proceedings of SCA 2009 (poster)", aug 2009.

[20] G. N'BOUNGUI, B. SEMAIL, F. GIRAUD. *friction control with a piezo-electric vibrating actuator*, in "13th International European Power Electronics Conference, EPE 2009, Barcelona", sep 2009.

[21] G. N'BOUNGUI, B. SEMAIL, F. GIRAUD. *Piezo-electric actuator for a force-feedback application: preliminary evaluation*, in "World haptics", 2009, p. 85–90.

[22] J. RINGARD, S. DEGRANDE, S. LOUIS-DIT-PICARD, C. CHAILLOU. *Computer-Aided Collaborative Work into War Rooms: A New Approach of Collaboration*, in "HCI - International", Human-Computer Interaction, Springer-Verlag, Jul 2009, p. 835–844.

[23] J.-B. SAUVAN, A. LÉCUYER, F. LOTTE, G. CASIEZ. *A Performance Model of Selection Techniques for P300-Based Brain-Computer Interfaces*, in "CHI'09, the 27th Conference on Human Factors in Computing Systems", ACM Press, 2009, p. 2205–2208.

[24] D. VOGEL, M. CUDMORE, G. CASIEZ, R. BALAKRISHNAN, L. KELIHER. *Hand Occlusion with Tablet-sized Direct Pen Input*, in "CHI'09, the 27th Conference on Human Factors in Computing Systems", ACM Press, 2009, p. 557–566 CA .

[25] H. WANG, C. PAN, C. CHAILLOU. *Tracking eye gaze under coordinated head rotations with an ordinary camera*, in "The Ninth Asian Conference on Computer Vision", Springer in the Lecture Notes in Computer Science (LNCS) series, 2009 cn .

[26] Y. WEI, S. COTIN, L. FANG, J. ALLARD, C. PAN, S. MA. *Toward Real-time Simulation of Blood-Coil Interaction during Aneurysm Embolization*, in "Proceedings of the International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)", September 2009, p. 198–205 CN .

Scientific Books (or Scientific Book chapters)

[27] R. VATAVU, L. GRISONI, S.-G. PENTIUC. *Multiscale Detection of Gesture Patterns in Continuous Motion Trajectories*, in "LNCS/LNAI Gesture in Embodied Communication and Human-Computer Interaction (Gesture Workshop 2009 post-proceedings)", S. KOPP, I. WACHSMUTH (editors), vol. 5934, Springer, 2009 RO .

[28] R.-D. VATAVU, L. GRISONI, S.-G. PENTIUC. *Gesture Recognition Based On Elastic Deformation Energies*, in "Gesture-Based Human-Computer Interaction and Simulation", LNCS 5085, 2009.

References in notes

[29] J. DEQUIDT, M. MARCHAL, C. DURIEZ, E. KERRIEN, S. COTIN. *Interactive Simulation of Embolization Coils: Modeling and Experimental Validation*, in "Proceedings of MICCAI", D. METAXAS, L. AXEL, G. SZEKELY, G. FICHTINGER (editors), Lecture Notes in Computer Sceince, Springer, September 2008, p. 695–702.

[30] C. DURIEZ, H. COURTECUISSE, J. P. DE LA PLATA ALCALDE, P.-J. BENSOUSSAN. *Contact Skinning*, in "Eurographics 2008 (short paper)", ACM Press, 2008, p. 313-320.

[31] F. FAURE, S. BARBIER, J. ALLARD, F. FALIPOU. *Image-based Collision Detection and Response between Arbitrary Volumetric Objects*, in "ACM Siggraph/Eurographics Symposium on Computer Animation (SCA), Dublin, Irlande", july 2008.

[32] G. SAUPIN, C. DURIEZ, S. COTIN, L. GRISONI. *Efficient Contact Modeling using Compliance Warping*, in "Computer Graphics International Conference (CGI) Istambul, Turkey,", june 2008.

[33] G. SAUPIN, C. DURIEZ, S. COTIN. *Contact model for haptic medical simulation*, in "International Symposium on Computational Models for Biomedical Simulation", Lecture Notes in Computer Science (LNCS) series, Springer, july 2008.