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Project-Team ALCOVE

Interacting with complex objects in collaborative virtual environments

Futurs

THEME COG

Activity Report

2004

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2. Overall Objectives

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 these researches.
- 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 move 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 researches are 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 the 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 developping 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 two main subjects : Interaction models and Physically-based autonomous objects. Figure 1 shows the topics that we consider in these subjects.

2.1.1. Interaction models

It is still illusive and probably useless to reproduce real world interactions on virtual objects. Therefore, we propose new basic metaphors for interaction (such as selection, picking, moving, assemblage, deformation), and we design corresponding devices (haptic or kinesthesic).

2.1.2. Physically-based autonomous objects

Programming projects nowadays benefit from advanced software concepts like object-oriented or agent-oriented programming. Our goal is to extend these concepts to physical modeling, in order to design autonomous physical objects that can be used inside a distributed cooperative framework. These objects will use such techniques as multi-resolution (physical and geometrical) and multi-representation.

3. Scientific Foundations

3.1. Interaction models and suitable devices

Keywords: *Causal modelling, DOF separation, Force feedback, cutaneous feedback, manipulation et navigation tasks, piezo-electric actuator mono and multi DOF, tracking and selection tasks*.

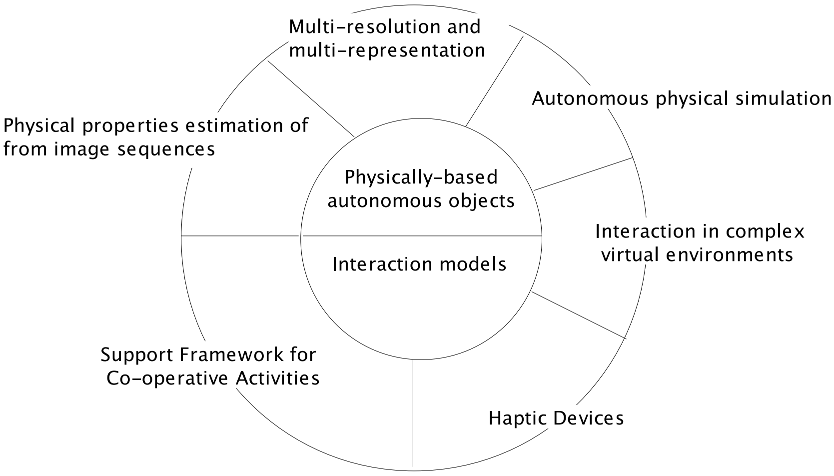

Figure 1. Research areas of Alcove

3.1.1. Interaction models

Participants: Laurent Grisoni, Patricia Plénacoste, Samuel Degrande, Gery Casiez, Nicolas Martin.

The interaction between a user and a computed 3D object is a complex chain starting at the physical devices and ending in the user's mental representation of the activity. We are studying several parts of this chain, in order to understand and improve human-computer interactions.

Specific 6 DoF input devices have been proposed and evaluated. The DigiHaptic is a new kind of 3 DoF device with force-feedback which can be used to navigate inside 3D environment, or to manipulate 3D objects. The DigiTracker is a small 3D pointing device which was studied to be stressless. However, those devices can hardly be used directly, and we have proposed some interaction metaphors to extend or adapt them to 3D virtual environments. Particularly, we are studying an elastic-isotonic mix mode that will enable the use of a small pointing device even with a large display system.

At a higher level, virtuals tools or action metaphors are needed in collaborative virtual environment to let the user focus on her/his activity rather than on the manipulation of the devices. Useless interactions should be removed or replaced with high level virtuals tools. A software framework, based on the M.V.C. paradigm, is proposed to easily develop such tools and metaphors. With this platform, the default behavior of a tool can be dynamically adapted to the object it is acting on, through the definition of application specific interaction rules.

Some new interactions metaphors (or 3D widgets) are studying, which are specific to collaborative 3D workspaces. For example, we propose a personnal point-of-view manipulator that lets each user orients 3D objects in an independent way, while indicating the orientation adopted by the other users.

3.1.2. Haptic devices

Participants: Gery Casiez, Frédéric Giraud, Betty Semail, Christophe Chaillou, Nicolas Leroy.

Piezo-electric actuators are quite interesting for haptic devices. First, there are well suited for low speed-high force applications, so they do not need any reduction gear, avoiding backlash and control loss. Moreover, thanks to their energy conversion principle, such drawbacks as cogging torque or slot effects concerning electromagnetic actuators do not appear here. Besides, multi degrees of freedom are available on a few actuators, (for instance 2D translator), although classical electromagnetic ones only allow one rotation or one linear moving. Last, most piezo-electric actuators are locked for no voltage feeding, which may be interesting for keeping the last position of the haptic device.

3.1.3. Tactile actuator

Participants: Nicolas Martinot, Christophe Chaillou, Betty Semail, Christophe Giraud.

Since several years, researches concerning touch parameters in interaction situation play an increasing role in the fields of robotics and haptics since fast development in sensors and actuators miniaturizations could allow to study and reproduce touch small scale phenomena. 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. Using dedicated force and movement sensors, François MARTINOT and Patricia PLENACOSTE have started this work by an ergonomical analysis of touch human gestures to predict final users behaviours and advice design guidelines for a desktop tactile display used in active touch conditions.

François MARTINOT is currently measuring the contact interaction phenomena with small microphones to elaborate a touch mark by wavelet transform which could be used for control and evaluation purpose. Mélissande BIET is currently designing a 2 dof travelling wave device based on a piezoelectric technology that could provide cutaneous feelings. In collaboration with the IEMN laboratory (Philippe PERNOD) we participate to the study of a dense pin arrays based on electrostrictive and magnetostrictive technology.

A travelling Wave tactile device (Frederic GIRAUD). This device is made of a stator from a Travelling Wave piezo-electric motor. When the finger tip touches the surface, different friction sensations are felt according to the travelling waves speed. The sensation can be improved if the finger tips speed is measured and taken into account for the travelling waves speed reference.

3.2. Virtual complex objects

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

3.2.1. Collision between deformable objects

Keywords: *Collision detection, collision response, distance field, physically-based animation*.

Participants: Fabrice Aubert, Damien Marchal.

In the context of a real-time simulator engine, the time dedicated to the collision process is critical. The major drawback involves the deformable objects and self collisions.

For many years, we have been investigating the use of spheres approximating the volume of virtual objets: Spheres are very attractive, since it is straightforward to check their intersection and compute a penalty-based collision response. However, they have revealed some major drawbacks : they fail to represent surface body properly, they sometimes poorly approximate the volume of certain virtual bodies and in case of rapid motions, they do not allow an efficient and physically correct computation of the collision response.

During his Master Thesis [43], D. Marchal has investigated other real-time approaches for collision detection and penalty computation.

During his PhD (started at oct. 03), Damien Marchal investigates new fast collision detection methods. At present, this study is mainly focused on distance map computation that can be updated after any deformation [24].

3.2.2. Physically based simulation and multiresolution

Keywords: *agent-based architecture, physical simulation, splines*.

Participants: Laurent Grisoni, Julien Lenoir, Samuel Boivin, Cyril NgoNgoc.

We proposed a set of tools for real-time simulation of continuous deformable 1D object. We proposed useful mechanical constraints formulation, such as sliding point, that aim at providing all the necessary tools for real-time surgical thread simulation. Among others, we also proposed multiresolution algorithm for 1D spline object simulation, that allows for dynamic adaptation of the object resolution to the current geometric configuration, which allows for maintaining real-time while creating complex thread configuration, such as tied knot. A PhD started this september, in collaboration with CEA, to work on real-time simulation of significant section electrical cable.

Ngo Ngoc and Boivin have proposed a new physical model to accurately simulate clothes, including non-linear behaviors. This model has three different components (traction, bending and shearing). It automatically computes up to 32 parameters including a term of internal friction from the data generated by the Kawabata machine on a real piece of fabric. These parameteres are then used to generate very realistic computer graphics animations of clothes. Ngo Ngoc and Boivin also demonstrate the quality of their results by simulating many different fabrics and doing side-by-side visual comparison of real and synthetic clothes.

3.2.3. Inverse dynamics

Keywords: *computer graphics, computer vision, inverse modeling, inverse rendering, mechanical simulation, physical parameter identification, rendering*.

Participants: Samuel Boivin, Cyril Syllebranque.

We propose a new method for estimating the physical properties of complex objects from an image sequence. Actually, we want to approximate the mechanical properties of a deformable object directly from a real video. We have been working on a new algorithm being able to recover the five physical parameters of a cloth based on a simple mass-spring model, directly from a synthetic image sequence. This technique uses a complex error metric which estimates the difference between the rendered and the original video. This difference is then used by a minimization scheme to iteratively enhance the parameters of the cloth. This technique shows some good results about the recovery of parameters from synthetic images: side-by-side comparisons of videos do not show any visible artifacts and the numerical difference between the actual and the recovered parameters is smaller than 5%.

However, it is now necessary to extend our method to real videos. We are currently working on many movies containing an interaction with a real deformable parallelepiped. Each video consists in almost the same test, but the parallelepiped's material is changing from a video to another. The next challenge is to compute the physical properties of each prism directly from these video. We also hope to compare the quality of our reconstruction using the CIMIT's Truth Cube.

3.3. Physical-based autonomous objects

3.3.1. mutipresentation and autonomous physical simulation

Participants: Laurent Grisoni, Jérémy Dequidt, Samuel Degrande.

We proposed a new architecture for real-time physical simulation, that combines agent-based approaches with physical simulation. several examples have been proposed, raising all the potential advantages of such approach. The question of interaction between physical systems has also been studied closely, as it is the key problem within such agent-based system. Practical tests have been made, showing that it is actually possible for relax the classical synchronization condition, and nevertheless provide plausible simulation in simple cases. Flexible collaborative systems proposing physically simulated objects could also potentially be proposed using such architecture, we are currently achieving first tests.

3.3.2. Component based software framework

Participants: Samuel Degrande, Sylvain Gaeremynck.

In current 3D collaborative virtual environments, behaviors of 3D objects are classically implemented in animation scripts or eventually with simple mechanical simulators. In order to mix physically-simulated objects with programmatically-emulated objects in the same environment, and to let them interact together, we need to encapsulate each object into a 3D object abstraction. During his PhD thesis, Sylvain Gaeremynck is studying a component based software framework that will enable time-synchronous objects to cohabit with time-asynchronous objects, through a specific scheduling system.

4. Application Domains

4.1. Medical simulation

4.1.1. Background

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 reacts like actual human patients.

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

4.1.2. Developpement of medical simulators

We continue our contribution to the developpment 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. Tne next step will be the realistic modeling of the lens. A first approach based on finite-element modeling is currently under investigation.

4.1.3. Towards a new real-time simulation engine

Following our first experience with the SPORE real-time simulation engine, we have started the development of a next generation engine that will be more flexible than the previous one. This development will be a joint-effort between Alcove, Epidaure (INRIA Sophia), Evasion (INRIA Grenoble) and the CIMIT (Boston). Our purpose is also to collaborate with other research teams worldwide involved in simulation.

4.2. Collaborative work on virtual objects

4.2.1. Background

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 choosen 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 peripherics, and which could be considered as an extension of their current working environment in the broad sense. Our proposal is built around a virtual representation which immerses the user in a known environment (a meeting room), without beeing a copy of the reality. By minimizing navigation and manipulation gestures, it enables several actors, geographically distants to each other, to focus on the realization of a common technical task. Some abstractions of visual representations and interactions are implemented to help the users to understand and apprehend concepts, the 2D/3D objects beeing rather a support to the co-operation activities.

4.2.2. Sofware Framework for Collaborative Virtual Environments

After some preliminary studies, we have defined a set of software components needed to construct a generic framework dedicated to Collaborative Virtual Environments. Those components are divided into 3 levels :

- a network communication layer, in charge of the handling of the shared objects.
  A distributed architecture with a duplicated 3D database is choosen to ensure interactivity of manipulation and visualization. The network communication layer has to efficiently maintain the coherency between all instances of a duplicated shared data.
  It also provides all services needed to manage the virtual work session (entry/exit of avatars, concurrent access...).

- an object management layer.
  To ease the developpement of collaborative activites, 3D objects are defined using a descriptive language such as VRML97. An extension to the language is needed in order to be able to define shared data.
  Local interaction mecanisms with 3D objects (indices to help selection, ways of manipulation...) are also integrated into this layer.
- an interface management layer.
  Each user having a personnal mental representation of her/his work, this layer provides the user with the ablity to organize or adapt her/his own virtual interface. The interface is organized in several spatial domains, each domain having is specific behavior and usage. Users' actions are abstracted independently of the environment before to be remotely transmitted.
  High level metaphorics tools used to act on objects or interact with the interface (such as the transfert of object from one spatial domain to an other one, or point of view concept) are, also, provided.

4.2.3. Conceptual Assembly/Disassembly

A vast majority of the activities around manufacturated objects does not just need simple manipulation mecanisms (rotations or translations of one object, or of parts of it), but rather more complex actions like assembly, disassembly or adaptation of objects. User's interactions are then to be constrained according to the connection between objects.
Some Computer Assisted Design modelisation systems include the possibiltiy to define geometrical or mechanical constraints between points, edges or planes of the objects. Those constraints are pre-defined during the construction of the models. However, for interactive applications, assembly operations have to be freely performed by the user. Constraints are then to be dynamically created. One solution is to use a simulation engine which can compute on-the-fly the mechanical interactions between parts of objects, using collision detection and taking into account mechanical properties such as sliding.
We are studying an alternative, with a concept of abstract assembly, where 'contact zones' are defined on objects. Those 'contact zones' act as magnets, easing user's actions. Such a concept can be used within applications where the conceptual part of the activities is more important than the manipulation of the object by it-self. Our collaborative platform is dedicated to such activities. This work is implemented by Alexandre Lambin, expert ingenior under contract since September 2003.

5. Software

5.1. Spin 3D

Participant: Samuel Degrande [correspondent].

Spin|3D is a synchronous collaborative software platform, which implements the Collaborative Virtual Environment concepts presented in 4.2. Spin|3D is developped in collaboration with France Telecom R&D (Lannion's site). A multi-disciplinary team (computer scientists and psychologists) composed of a dozen of members (one half in Lille, one half in Lannion) works on that project. We aim at providing a complete software environment to ease the development of collaborative applications.
For that purpose, Spin|3D is built on a core layer which can be extended with dynamically loaded external modules. Two kind of external modules can be plugged : viewer plugins, to display objects not directly handled by the core layer (such as an HTML plugin, for example), or autonomous external applications which communicate with the core through a local Corba bus (with that mecanism, a legacy software such as a CAD modeler can be connected to Spin|3D, without needing any heavy cross-integration).

The LIFL works, mainly, on "low level" layers, furnishing the communication framework and the object handling layer. France Télécom, on its side, studies human/human communications through the development of avatars, and works on the definition of end-users applications.

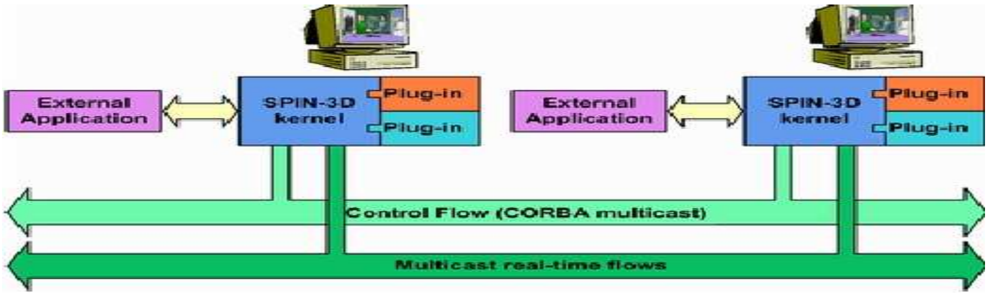

Figure 2. Architecture of an application based on Spin|3D

Figure 3. A terminal view of a Spin|3D application

The main target applications are digital project reviews, support for medical diagnostics, virtual laboratory works and network games. We have proposed a virtual lab-work (to help students learn the use of an oscilloscope and a signal generator) in the Divilab European project (IST-1999-12017). France Télécom, with the IRCAD, has developped, during 2003, a prototype of a medical diagnostic application, called Argonaute 3D [42]. Some other applications, in the digital project review domain, are in preparation.

5.2. Design of surgical simulators

Participants: Philippe Meseure, Sylvain Karpf [correspondent].

We have designed a generic framework, called MISS, for the design of surgical simulators. It mainly relies on SPORE, and provides some usefull tools to ease the implementation of minimally invasive surgical simulation. It defines classes for the cinematic of a trocart-like insertion tools, proposes the simulation of various tools such as forceps, coagulator... and includes various visual effects (smoke, coagulation,...).

Figure 4. Two applications from MISS : coelioscopy simulation and intestines surgical simulation

5.2.1. SPIC

Participants: Philippe Meseure, Sylvain Karpf [correspondent].

Spic is the first application of the MISS framework. It allows the simulation of coelioscopy and laparoscopy. It provides a virtual camera for the environment simulation and two inserted tools which the user can choose and change during simulation. A specific device has been designed to provide an adequate user interface, but, for cost reason, do not include any force feedback. Instead, we use a real shell which prevents the forceps from penetrating through the virtual cavity. This implies a good calibration of the manipulator, which is hopefully possible [40].

However, since the organs are mobile, we have to find another way to interact properly with them. We have chosen the previously described proxy/god-object method to allow the virtual forceps and the organ to behave realistically, even if the surgeons imposes impossible position to the forceps. This work is currently under progress. We are also concerned with the simulation of realistic operations: This implies to design specific models: we have already proposed a model for the fallopian tubes and go on with the modeling of the ovaries, uterus and peritoneum.

We are also involved in the pedagogy associated with such simulators. A user-friendly interface has been designed by Cédric Tailly to propose simple exercices to learn anatomic recognition and the handling of the camera and forceps. More realistic exercices are currently being investigated, and the use of specific tools is now possible (evacuator, coagulator, water injector, cutting forceps,...).

5.2.2. Cataract Surgery Simulation

Participants: Sylvain Karpf [correspondent], Frédéric Blondel.

The cataract operation consists in extracting the opaque cristalline lens from the eye and replace it by an implant. This project lies within the framework of Minimal Invasive Surgical Simulator (MISS), which aim is to create pedagogical simulators for doctors.

To do so, we develop both physical and virtual interfaces. The physical interface is based on the phantom and forces feedback. The virtual interface uses different mechanical models implemented in the SPORE physical engine, such as 2D and 3D objects for cutting. Other effects are managed in a pure geometrical maner.

Six people have worked on this simulator, most of all during a trainee period. This simulator allow us to enrich the SPORE project 4.1, particularly with new mechanical models. The first one is surfacic mass/spring mesh with the ability to be torn or cut (F. Blondel [40], D. Marchal and C. Syllebranque); it is used to simulate the capsulorhexis stage. The second one is articulated rigid body (M. De La Gorce); we plan to model the lens implant. Finally, D. Marchal worked on a volumetric mass/spring mesh in order to simulate the eye lens to be destroyed. Moreover, V. Pegoraro have added the stereographic display of any scene and C. Syllebranque [44] has designed a visual effect connected to the mechanical model to simulate the hydrodissection stage. By now, F. Blondel is putting the finishing touches to an operational caspulorhexis stage simulation. To produce a realistic gesture, the design of a physic tool (based on a Phantom device and a model of the eye), and its calibration with the virtual tools, are also in progress.

Figure 5. Prototype of the Cataract Surgery Simulator : Tearing, Cutting and Hydrodissection

6. New Results

6.1. A new haptic device

We investigated the use of the DigiHaptic [16][2][38] in a 3D steering task. Unlike other devices intended to interact in 3D with one end-effector, the DigiHaptic has three levers that the user may handle simultaneously or not in elastic mode to rate control objects. We compared it to the SpaceMouse - another elastic device - to evaluate the influence that degrees of freedom (DOF) separation have in terms of accuracy (coordination and errors) and speed (time). The task consisted of steering paths that required the use of two or three DOF simultaneously. We found that users performed faster on the SpaceMouse but were less coordinated and accurate than on the DigiHaptic for the most complicated paths.

6.2. 1D deformable objects for real time and physically based animations

The first goal of this work is to propose a 1D deformable model. Such a model finds lots of applications in virtual reality or in animation especially in simulation of thready deformable object like rope, string, lace...

We propose a real time 1D deformable model based on a spline geometry animated with physical law of Lagrange. This model is based on the works of Yannick Rémion and its LERI's team. This type of model

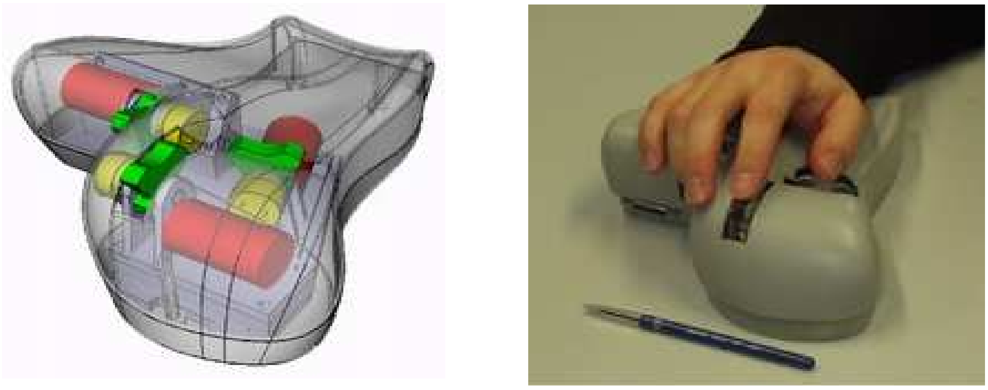

Figure 6. The DigiHaptic

reveals to be particularly adapted to surgical simulation for the thread modelling in suture or organs (intestines, fallopian tubes).

For some applications, it may be useful that the model verify some specific conditions expressed as constraint equations. These constraints are taken into account in the dynamic system thanks to the Lagrange multipliers method. In this context of constrained simulation, one of the major contributions is the proposition of a new class of constraints called smooth constraints. These constraints allow, for example, a thread to pass through a specific point in space. Such constraints is particularly useful to simulate a suture in a surgical context, but answer to specific need in animation (shoelace, hang rope,...) too.

Some applications, such as the suture of an organ, deal with the simulation of many models interacting all together. For such a simulation, we propose a software architecture allowing the simulation of articulated objects (rigids or deformables) whatever the physical formalism are. This proposition has many applications like surgical simulation, swing simulation...

Multi-resolution permits a local adaptation of the model in order to be precisely defined in the interaction area and not time-consuming. The computation time is then concentrated in the interesting area and it is less important in the other place. A criteria based on the curvature of the curve is used to get a finer model. This technique is particularly well suited for knot simulation by permitting the model to increase its number of degrees of freedom and giving it a geometric flexibility in the tightening area.

The results of this work, can be found in [23][22][21] and also in the Julien Lenoir's Phd [12].

6.3. Collision between deformable objects

This work (presented in [24]) is mainly focused on collision handling between virtual objects that can be deformed and cut. The collision model is based on the tetrahedral volumetric representation.

This representation allow us to efficiently compute a distance map using an original algorithm derived from Fast Marching method. Once the object is deformed, the update process of the distance map can be done in an interactive time. From this distance map an edge-based penalty response is deduced to prevent further objects penetration.

6.4. Travelling Wave Ultrasonic Motor

A new modelling of travelling wave ultrasonic motors is established in [13] in order to provide the torque control law for this kind of actuators. More particulary, self control is implemented, avoiding the classical drawbacks of frequency control, that is pull-out phenomenon. With such a robust control, force feedback application are available, and experimented on an active stick.

But force feedback operations have to be improved at low rotational speed. In fact, in Travelling Wave Ultrasonic Motor, stator and rotor are pressed together: a "dead zone" effect exists, wich is almost equivalent to a large static friction torque. In that case, a position control is prefered, while the position reference derives from the torque measurement. In [20] a position control is thus proposed, which presented excellent behavior at low rotational speed and robustness besides external load torque. Experimental results have been carried out on a very small ultrasonic motor and force-feedback application have been tested without speed-reducer.

6.5. Generalized God-Objects

We show in [26] a method to interact with physically-based environments in a way which guarantee their integrity whatever the mechanical properties of the virtual interaction tool and the control device. It consists in an extension of the god-object concept. The interaction tools are modeled as physical bodies which tend to reach, if possible, the position maintained by the user. Their behavior is computed via the dynamic laws of motion by the simulation engine, as the other bodies in the scene. This mechanism also provides a unified framework which allows the control of virtual objects via devices providing force feedback or not.

6.6. A 3D isotonic device : the Digitracker

For a variety of reasons, only a few computer devices allow to achieve pointing, tracking and selecting tasks in a precise, fast and intuitive way in 3D workspaces. We work on the ergonomic and technical principles that have conditioned the proposal of a desktop input device called "DigiTracker" [25][39]. The user controls the position of a virtual object by grasping an isotonic end-effector between the thumb and the forefinger while his forearm is laying on the desk. This equivalent to an absolute three degrees of freedom mouse is especially suitable for closed virtual workspaces. The low technological cost of this solution could provide a really worth alternative to complex VR tracking systems. Possible applications are remote positioning tasks or CAD in simultaneous use with a device dedicated to rotations control .

7. Contracts and Grants with Industry

France Télécom R&D

We work in collaboration with France Télécom since 1994. In a first period, from 1994 to 1997, a CTI contract was established to develop a first prototype of a collaborative work interface, called Spin. Two PhD thesis were defended in the LIFL, one of them beeing supported by the contract.

In 1999, France Télécom showed its interest in our research by creating a project-team in its Lannion's site, recruting the first PhD student who was on the CTI contract, and supporting a third PhD student who defended his thesis in 2001 on the articulation between action and communication in non-immersive virtual environments [41].

In order to jointly develop a pre-industrial framework, based on the first prototype studies, a second contract (External Research Contract) was signed between the University of Lille 1 and France Télécom in 2000, for 2 years, for a global amount of 1,1MF HT. Since 2001, the Spin|3D team in France Télécom is composed of 5 full-time members.

In 2003, two other contracts have been signed between the University of Lille 1, the INRIA and France Télécom. The first one, for an amount of 240kEuros HT, concerns the finalization of the core framework, and the integration of some new features. The second one supports one half of Nicolas Martin's PhD thesis, the other half beeing financed by the INRIA.

Our partners from France Télécom now focus on the development of applications, one commercial product beeing scheduled for the end of 2005.

CEA

We started working in collaboration with CEA in 2004 on the simulation of cables.

8. Other Grants and Activities

8.1. National initiatives

- Project e-simulation (RNTS) : development of a platform for ophtmalogist (for e-training in diagnostic and therapy).
- SIMV@L (RNTS 2003 - Partners : Thales Training and Simulation, Ecole des Mines de Paris, Ecole de Chirurgie de l'APHP, Evalab (Lille II), Primal Cry, Graphix/Alcove team)
  This project aims at proposing and validating a certification process for medical simulators. Our team brings its expertise in the field of real-time simulation engines.

8.2. European initiative

- Odysseus (Eureka - Partners : IRCAD (Strabourg), France Telecom, Storz (Germany), SimSurgery (Norway), INRIA (Alcove, Evasion, Epidaure)).
  The three main objectives of this project are :
  - develop an operationnal patient 3D-reconstruction tool or commercial service
  - develop a 3D tele-diagnosis software based on the SPIN platform
  - develop a urology and liver-surgery simulator

  We are involved in the last two sub-projects

8.3. STIC Asian project on virtual reality

We participate in developping a research network that regroups french teams (IRIT, LIRIS, LSIIT, Lab. Info. Alcove, I3D, Iparla, Siames) and Korean, Chinese, Japanese, Taiwan, and Singapore labs. The research topic is virtual reality around Geometric Modelling, Real-time images, 3D interaction and CVE.

8.4. Visiting scientists

8.4.1. Inverse Dynamics and Eye reconstruction

S. Boivin has invited Pr. Brian Barsky to the lab from Dec 13th to Dec 17h in order to begin a new scientific collaboration. This should lead to a strong collaboration between Alcove and the University of Berkeley especially regarding the eye surgery, starting on next september.

8.4.2. ETRI

S. Boivin presented the ALCOVE project to people of ETRI visiting INRIA. This will lead to a scientific collaboration between Alcove and ETRI.

9. Dissemination

9.1. Leadership within scientific community

- We organized, with the IRCICA, the International Scientific Workshop "Tactile stimulators : Technology and Uses" in March 23th, 2004 at Lille. The program of this workshop can be found on http://www.ircica.univ-lille1.fr/STIMTAC/eng.htm.
- Christophe Chaillou is a member of the program committee of VRIC and ISMS.
- Samuel Degrande is a member of the WEB3D 2004 program committee.

9.2. Teaching

- Master students (University of Lille I) :
  - Christophe Chaillou : digital image processing.
  - Samuel Boivin : computer graphics and computer vision (rendering and inverse rendering)
  - team Alcove : Interaction with virtual objects
- Engineer students (Polytech'Lille)
  - Sylvain Karpf : Computer architecture, Computer Graphics
  - Christophe Chaillou : Computer Graphics, HCI, VR, Data and Image Compression
  - Gery Casiez : Haptic, Data compression, OpenGL, GTK
- Engineer students (ENIC - Lille)
  - Julien Lenoir : Graphics Hardware
  - Gery Casiez : Haptic, Computer Graphics, Computer Networks
- Faculty students (University of Lille I)
  - Fabrice Aubert : 3D Programmation, Introduction to Computer Graphics
  - Patricia Plénacoste : HCI - Ergonomics.
- IUT A (Lille) :
  - Damien Marchal : Introduction to Computer Graphics : Programming with Opengl and Modelling with Blender.

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