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Activity Report 2011

Project-Team IPARLA

Visualization and manipulation of complex data on wireless mobile devices

IN COLLABORATION WITH: Laboratoire Bordelais de Recherche en Informatique (LaBRI)

RESEARCH CENTER
Bordeaux - Sud-Ouest

THEME
Interaction and Visualization

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Project-Team IPARLA

Keywords: 3D Modeling, Computer Graphics, Interaction, Rendering, User Interface, Visualization

Beginning of the Team: 06/11/2003, End of the Team: 31/12/2011.

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2. Overall Objectives

2.1. Introduction

Mobility is the major (r)evolution for current interactive systems. Therefore, one of the biggest challenges for interactive 3D graphics is now to evolve to a mobile context. The main goal of the IPARLA project is to contribute to this evolution.

During the last decade, a large range of consumer electronics devices have been developed, that allow the user to benefit from computing resources in mobile settings. The last generations of cell phones, personal digital assistants, or even portable game devices, combine embedded programmable CPUs (and more recently GPUs) with several flavors of wireless communication capabilities. Such *Mobile and Connected Devices* (MCDs) offer the opportunity to develop a wide variety of end-user software applications over client/server infrastructures.

MCDs induce specific constraints for the incoming data flow (e.g. limited CPU/GPU for real-time computing and small screens) as well as for outgoing data flow (e.g. limited input devices). These technological constraints naturally decrease the cognitive immersion of the user, which affects the performance and the adhesion to the end-user applications. In the IPARLA project, we want to address this issue by jointly developing techno-centered and human-centered techniques for interactive mobile 3D applications.

Although MCDs are an important part of our project, we focus more on the mobility of the user and the involved applications (including the data) than on the device itself. In other words, we do not aim exclusively on the development of applications for MCD, but rather to design flexible solutions that allow easy conversions for the user and the applications between a mobile context and a fixed context. For example, we want to design concepts that enable us to use the same application on a MCD, on a standard PC or in a virtual reality center as illustrated by Figure 1.

In order to reach this goal, our development is strongly oriented to produce **scalable, multi-resolution** solutions that are able to **stream** and deal with **large amounts of data** in a **client-server** context. These five keywords recall the main approaches we have selected to reach our objectives.

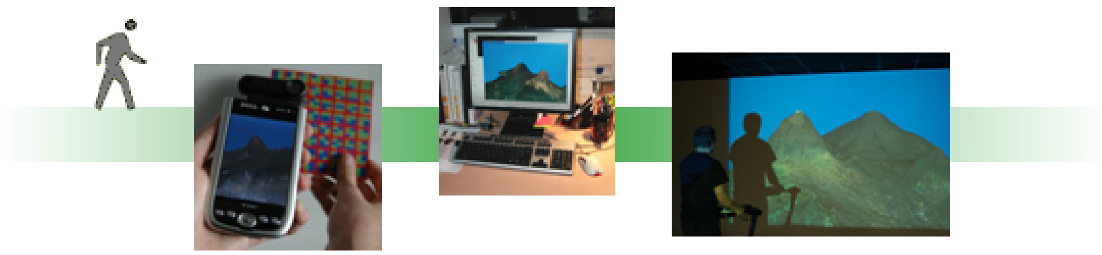

Figure 1. Visualization and Interaction with 3D Content for Mobile Users.

2.2. Highlights of the Year

2.2.1. Shape Visualization

Thanks to the PhD of Romain Vergne, we have developed new techniques to legibly depict the shape of 3D objects. For this purpose, we have explored Non-Photorealistic Rendering approaches [36], realistic approaches by tuning light directions [37] (front cover of the special issue of ACM Transaction of Graphics) or light intensities [38] (best paper award). The success of such an approach has increased this year [17]. Furthermore, we have shown that we can depict the shape in a temporally coherent manner with stylized lines [18] (3rd best paper award).

2.2.2. Cultural Heritage and Computer Graphics

For the last years, we are investigating the convergence between the Computer Graphics tools that we are developing and Cultural Heritage related tools. In 2009, we have initiated the ANR SeARCH project (http://anr-search.labri.fr) on this topic. The results developed with our close partner Archéovision (http://

archeovision.cnrs.fr) have been well recognized, and thanks to our common expertise, in 2011, we have joined the European Network of Excellence V-Must.net (http://www.v-must.net). In this consortium, we particularly explore new interaction and visualization techniques that support museums in their three main goals: the transmission, the conservation, and the study of Cultural Heritage.

2.2.3. Toucheo: Multitouch + Stereo

We have designed a new system, *Toucheo*, that efficiently combines fast and easy multitouch interaction, with 3D stereoscopic immersive visualization. This system is the result of the collaboration between IPARLA, and a company called Immersion. This work is part of the ANR InSTInCT project. We demonstrated the technology at Siggraph 2011 Emergingtech [19], and we published at UIST 2011 [25]. We submitted a joint patent with Immersion for this new system, and it is now available as a commercial product. Toucheo is currently part of the **"Numeriquement votre"** exhibition that takes place at Cap Sciences, Bordeaux.

3. Scientific Foundations

3.1. Geometric Modeling and Acquisition

In computer graphics, we are primarily concerned with the surfaces of geometric objects since the surfaces are what we actually see, animate, and physically process. The IPARLA project aims to develop mobile solutions, and solutions that can be adapted to the different modeling contexts and modeling platforms. We will thus consider multiresolution representations (like subdivision surfaces) and multi-representation (hybrid point-based/ implicit surface - meshes, hybrid 3D and 2D structures, ...).

In recent years, multiresolution modeling has proved to be valuable in 3D geometric surface modeling and rendering. It deals with the generation, representation, visualization, and manipulation of surfaces at various levels of detail or accuracy in a single model. Applications include fast rendering, level of detail editing, collision detection, scientific visualization, as well as compression and progressive transmission. In the context of mobility, the requirement of multiresolution is even essential due to the enormous differences of hardware capacities. Multiresolution is also the link between geometric modeling and rendering, providing for instance an appropriate level of detail for a given viewpoint in order to ensure real-time rendering.

In the context of mobility, the users are directly in front of the real world. In the IPARLA project, we thus have to consider the problem of 3D data acquisition, with 3D scanners or any other devices like embedded cameras of mobile devices. A challenging task is to handle the modeling and rendering of the large amount of data in real-time. Several of our algorithms are designed to work "out-of-core" to process large acquired datasets (e.g. gigantic point clouds from 3D scanners). When this can be done even in real-time, the geometry acquisition can be used for interaction.

Modeling and acquisition can hardly be considered without taking into account the rendering part, and for a mobile usage, without taking into account the user, who is in the center of any mobile application. Cognition and interaction have to be considered during the development of new modeling approaches.

3.2. Appearance, 3D Data Rendering and Visualization

One of the main goals of the IPARLA project is the interactive visualization of complex 3D data on heterogeneous platforms. For example, a very rich and realistic visualization stream including shadows and a complete set of light effects is required when a user has to "feel" parts of a virtual world. Realistic rendering is also required when it comes to augmented reality applications. Keeping the coherence between the virtual world and some virtual objects as well as between real objects and the virtual world is a challenging research domain: appearance has to be sufficiently rich, and illumination has to be sufficiently plausible. For the MCD, these technologies can be used for example for virtual visits, virtual presentations or, more generally, when the MCD is used as an interface to the real world.

On the other hand, in order to easily focus on what is really important to visualize, a legible rendering is more appropriate. As a consequence, expressive rendering (or non-photorealistic rendering - NPR) techniques have recently become popular in the computer graphics community. We believe that these techniques are helpful for depiction because they only represent perceptually salient properties of the depicted scenes and thus avoid to deal with extraneous details that sometimes make images unnecessarily confusing. However, designing efficient expressive rendering systems involves being able to choose the appropriate style to represent the appropriate salient properties. In particular, it requires to gain insights into the perceptual processes that occur in observing an image depending on a given task. We thus consider perceptual and cognitive issues to be inherently a part of the research on Expressive Rendering.

Despite the progress of MCDs, these client devices which are designed for mobility will always have less computing and storage capacity compared to the server. Consequently, we have to think about distributed approaches by re-investigating the entire pipeline, from storage, over transmission, to visualization. We have to define the correct representation for the data, for transmission and streaming. Moreover, we have to define how to visualize the data when received, both for realistic rendering and expressive rendering. We think that expressive rendering reduces the amount of information to transmit by focusing on what is really important.

3.3. 3D User interfaces

The IPARLA project-team conceives, develops, and evaluates user interfaces dedicated to 3D interaction tasks (3D UIs). This research topic is at the frontier between Computer Graphics (CG) and Human-Computer-Interaction (HCI), with a strong link to Virtual Reality (VR). Our objective is to design 3D UIs that favor the mobility of users, from small mobile devices to large, immersive environments. In this large spectrum, touch-screens are currently of special interest for us. Our activities in the scope of interaction follow three main research directions.

The first one, directly linked to the initial focus of the IPARLA project-team, is about 3D UIs for mobile devices. We have continued to address the challenge of improving 3D interaction on mobile devices with the final goal of favoring the use of 3D applications in mobile setups.

The second one has emerged from tactile interaction on mobile devices, but with a wider spectrum. It concerns [multi-]touch 3D interaction. Whereas many interfaces have been proposed to enhance tactile interaction in 2D spatial contexts, very little work addresses 3D interaction. Consequently, standard keyboard/mouse based 3D UIs need to be reinvented. We have focused on this new challenging goal, in particular within the ANR InSTInCT project.

Finally, we explore immersive interfaces for virtual reality, in particular in the scope of music. Beyond music, we are also interested in immersive interaction for cultural heritage. e.g. for reassembling virtual fragments of objects in a fast and easy way. We particularly strive to merge efficient user interaction and powerful geometry-driven matching algorithms.

All this work contributes to the general quest of enhancing 3D interaction for mobile users, from small mobile devices to large, immersive setups.

4. Application Domains

4.1. Application Domains

We think it is out of the scope of this report to establish an exhaustive list of application domains that could benefit from mobile 3D interactive technologies. Consequently, we only present some key applications here.

Assisted navigation. Mobile and connected devices equipped with GPS are currently used as digital assistants for navigation. Such systems can help car drivers for route planning. They also can assist pedestrians or bike users when exploring cities, or when hiking in countryside. Existing solutions are mainly based on 2D or 2.5D visualization of data. Our project aims to provide 3D navigation tools where the data can be accessed from an up-to-date database stored on distant servers. Hence, for example, a hiker visualizes on its mobile device a 3D representation of the surrounding landscape that embeds information such as the way to follow, or the direction to the next mountain refuge.

Augmented reality. Today's mobile devices are equipped with embedded cameras. Consequently, the use of these setups for augmented reality allows to imagine a wide variety of useful applications in our everyday life. For example, in the domain of cultural heritage, some extra information coming from distant servers can enhance the images coming from the cameras of the mobile devices. More precisely, for example the interest of merging synthetic reconstructions of partially destroyed buildings with the images of the real buildings can easily be understood. The same approach can be useful for many domains such as tourism, maintenance, and so on.

Crisis management and distant assistance. Mobile and immersive technologies can be mixed. In particular, we want to enhance interaction between mobile users that are surrounded by the real environment and distant "control centers" where high quality visualizations are provided. On the one hand, information such as GPS positions and video streams can be received by control centers from all the mobile units. On the other hand, control centers that have a global knowledge of the situation can send helpful information to the mobile users, such as 3D models of pertinent objects. The interest of such an approach can easily be understood for many applications in the scope of crisis management or distant assistance.

Entertainment. Entertainment and especially video games are key applications directly related with our project as well. Some mobile devices have been designed for entertainment, and video games have been specifically developed for such setups. The results of our research in the scope of rendering or interaction directly contribute to the development of the entertainment industry. Moreover, we are investigating new approaches for entertainment, in particular concerning the continuum between different platforms. For example, we can imagine a user to start a game at home with a PC/console, and to continue later the same game with MCD in public transportation.

5. Software

5.1. Eigen

Participant: Gaël Guennebaud [correspondant].

Web: http://eigen.tuxfamily.org/

Eigen is a fast, versatile, and elegant C++ template library for linear algebra and related algorithms. In particular it provides fixed and dynamic size matrices and vectors, sparse matrices and vectors, matrix decompositions (LU, LLT, LDLT, QR, eigenvalues, etc.), some basic geometry features (transformations, quaternions, axis-angles, Euler angles, hyperplanes, lines, etc.), automatic differentiations, etc. Thanks to expression templates, Eigen provides a very powerful and easy to use API. Explicit vectorization is performed for the SSE (2 and later), AltiVec and ARM NEON instruction sets, with graceful fallback to non-vectorized code. Expression templates allow to perform these optimizations globally for whole expressions, and to remove unnecessary temporary objects.

Eigen is already a famous library with about 15000 unique visitors of the website per month, while the mailing list holds about 250 members with a very high traffic (400 message per month). After two years of development since the 2.0 release, we released this year the new major 3.0 version.

- Version: 3.0.4
- Programming language: C++

5.2. Expressive Rendering shaders

Participants: Pascal Barla, Benoit Bossavit.

Shaders developped in the course of our research on expressive rendering have been published under the CeCILL-B license, and distributed on the Animaré project webpage (https://iparla.inria.fr/collaborations/animare/). The goal of such a publication is to let members of the scientific community test and compare with our techniques. This also includes plugins for MeshLab and Nuke.

5.3. Navidget - Easy 3D Camera Positioning from 2D Inputs

Participant: Martin Hachet [correspondant].

Web: https://iparla.inria.fr/software/navidget/

Navidget is a new interaction technique for camera positioning in 3D environments. Unlike the existing POI techniques, Navidget does not attempt to automatically estimate where and how the user wants to move. Instead, it provides good feedback and control for fast and easy interactive camera positioning. Navidget can also be useful for distant inspection when used with a preview window.

This new 3D User interface is totally based on 2D input. As a result, it is appropriate for a wide variety of visualization systems, from small handheld devices to large interactive displays. A user study on TabletPC shows that the usability of Navidget is very good for both expert and novice users. Apart from these tasks, the Navidget approach can be useful for further purposes such as collaborative work and animation.

We have developed a C++/OpenGL library, called LibNavidget, which allows you to integrate Navidget in your own applications. A sample application is included in the package.

5.4. ArcheoTUI

Participants: Patrick Reuter [correspondant], Nicolas Mellado.

ArcheoTUI is a software for the virtual reassembly of fractured archaeological objects via tangible interaction with foot pedal declutching. ArcheoTUI is designed to easily change assembly hypotheses, beyond classical undo/redo, by using a scene graph. The software connects to the database of the broken fragments that are organized in an SQL database. In 2011, we extended the ArcheoTUI software in order to account for a physically-based deformation prototype. Moreover, we integrated multi-touch input with a constraint-based reassembly method.

6. New Results

6.1. Modeling

6.1.1. Reassembly

Participants: Nicolas Mellado, Patrick Reuter, Gaël Guennebaud, Pascal Barla, Christophe Schlick.

In the context of cultural heritage, 3D laser scanning and photogrammetric 3D acquisition of broken content is becoming increasingly popular, resulting in large collections of detailed fractured archaeological 3D objects that have to be reassembled virtually. We recently investigated a semi-automatic reassembly approach for pairwise matching of digital fragments, that makes it possible to take into account both the archeologist's expertise, as well as the power of automatic geometry-driven matching algorithms. In order to increase matching efficiency and robustness, we currently focus on shape analysis with higher level representation to guide ICP-like algorithms.

6.2. 3D Data Rendering and Visualization

6.2.1. Soft shadows

Participant: Gaël Guennebaud.

Shadows are a fundamental visual effect which both increase the level of realism of a 3D scene, and help to identify spatial relationships between objects. This latter observation makes them particularly important in the context of interactive 3D applications. Generating high quality soft shadows in real-time is still an open challenge. In the continuity of our previous collaboration with the State Key Lab of CAD&CG of Zhejiang University (China) [39], we developed a perceptually based metric dedicated to the prediction of ideal shadow map resolutions [16]. This metric allows us to adaptively generate shadow map tiles. As a result, we managed to render wide and complex exterior scenes with high quality while maintaining high performance (see figure 2).

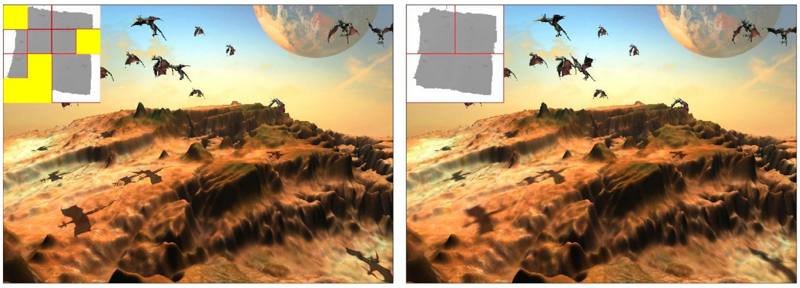

Figure 2. Our soft shadow rendering system generates adaptive shadow map tiles and can therefore render softer shadows (right @ 25 fps) faster than their hard shadow counter part (left @ 15 fps).

6.2.2. Synthesis and control of breaking waves

Participants: Nicolas Maréchal, Pascal Barla, Gaël Guennebaud, Patrick Reuter.

Modeling complex breaking waves over arbitrary bathymetry is a tedious problem. Currently, most of the existing methods are based on physical simulations by solving the navier-stokes equation. Controlling the shape of breaking waves is almost impossible with such approaches, and the simulation does not run in real-time. In order to overcome these limitations, we propose a phenomenological approach based on a real-time simulation using airy's wave theory. Our system handles phenomena such as shoaling, refraction and grouping (see figure 3), and the rendering style can be adapted by the user.

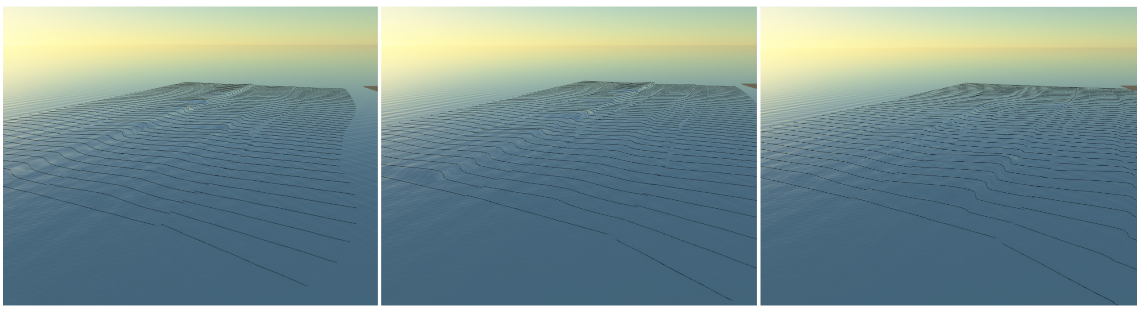

Figure 3. Breaking waves generated using our system over an arbitrary bathymetry. 2D wave shape profiles are shown for better legibility.

6.2.3. *Analysis and visualization of surface relief*

Participants: Lucas Ammann, Pascal Barla, Gaël Guennebaud, Xavier Granier, Patrick Reuter.

Given a base surface with relief, we developed an analysis technique that leverages the complexity found in detailed 3D models for illustrative shading purposes. The key originality of our approach is to extract the relief features such as concavities, convexities and inflections at multiple scales and directions using local cubic-polynomial fitting. We use this information to guide a variety of shading techniques. Our approach is parametrization-free and meshless, allowing for a wide variety of applications ranging from scientific visualization to special effects for the movie industry.

6.3. Expressive Rendering

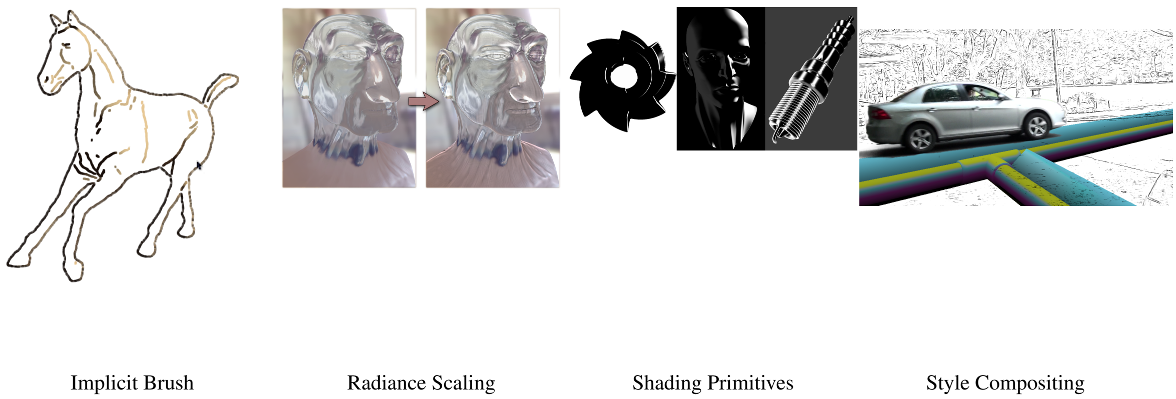

Figure 4. Conveying visual information through expressive rendering

6.3.1. *Line-based Rendering*

Participants: Pascal Barla, Jiazhou Chen, Xavier Granier, Christophe Schlick.

We have introduced [18] a new technique called Implicit Brushes to render animated 3D scenes with stylized lines in real-time with temporal coherence. An Implicit Brush is defined at a given pixel by the convolution of a brush footprint along a feature skeleton; the skeleton itself is obtained by locating surface features in the pixel neighborhood. Features are identified via image-space fitting techniques that not only extract their location, but also their profile, which permits to distinguish between sharp and smooth features. Profile parameters are then mapped to stylistic parameters such as brush orientation, size or opacity to give rise to a wide range of line-based styles. This work has won the **3rd best paper award** at Eurographics annual conference.

6.3.2. *Shape Depiction through Shading*

Participants: Pascal Barla, Xavier Granier, Christophe Schlick.

Recently, a number of techniques have been proposed to exaggerate the depiction of shape through the shading of 3D objects. However, existing methods are limited to a single type of material, simple light sources, and they give a fake percept where 3D shape seems to be flattened or embossed, or produce temporal artifacts. We have recently shown that adjusting lighting amplitude for each direction (Radiance Scaling [38], selected as a **best paper** at I3D 2010 and extended as a TVCG journal paper [17]) may enhance the shape depiction. The technique has been ported to Meshlab (http://meshlab.sourceforge.net/).

6.3.3. *Dynamic Expressive Shading Primitives*

Participant: Pascal Barla.

Shading appearance in illustrations, comics and graphic novels is designed to convey illumination, material and surface shape characteristics at once. Moreover, shading may vary depending on different configurations of surface distance, lighting, character expressions, timing of the action, to articulate storytelling or draw attention to a part of an object. We have developed [31] a method that imitates such expressive stylized shading techniques in dynamic 3D scenes, and which offers a simple and flexible means for artists to design and tweak the shading appearance and its dynamic behavior. The key contribution of our approach is to seamlessly vary appearance by using a combination of shading primitives that take into account lighting direction, material characteristics and surface features.

6.3.4. Non-Uniform Compositing of Styles

Participants: Jiazhou Chen, Xavier Granier.

In order to investigate how the composition of different styles may help in directing user attention, we have developed [22] a non-uniform composition that integrates multiple rendering styles in a picture driven by an importance map. This map, either issued from salience estimation or designed by a user, is introduced both in the creation of the multiple styles and in the final composition. Our approach accommodates a variety of stylization techniques, such as color desaturation, line drawing, blurring, edge-preserving smoothing and enhancement.

6.4. Interaction

6.4.1. Toucheo: Multitouch + Stereo

Participants: Martin Hachet, Benoit Bossavit, Aurélie Cohé.

We propose a new system that efficiently combines direct multitouch interaction and 3D stereoscopic visualization (see Figure 5). In our approach, the users interact by means of simple 2D gestures on a monoscopic touchscreen, while visualizing occlusion-free 3D stereoscopic objects floating above the surface at an optically correct distance. By coinciding the 3D virtual space with the physical space, we produce a rich seamless workspace where both the advantages of direct and indirect interaction are jointly exploited. In addition to standard multitouch gestures and controls (e.g. pan, zoom, and standard 2D widgets) from which we take advantage, we have designed a dedicated multitouch 3D transformation widget. This widget allows the near-direct control of rotations, scaling, and translations of the manipulated objects. To illustrate the power of our setup, we have designed a demo scenario where participants reassemble 3D virtual fragments. This scenario, as many others, takes benefit of our proposal, where the strength of both multitouch interaction and stereoscopic visualization are unified in an innovative and relevant workspace [19] [25]. See *highlights*.

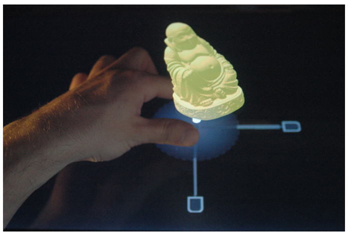

Figure 5. Toucheo

6.4.2. Touch-based interaction

Participants: Jérémy Laviole, Aurélie Cohé, Martin Hachet.

We have continued exploring 3D User Interfaces for [multi-]touch screens. In particular, in [26], we conducted a user study to better understand the impact of directness on user performance for a RST docking task, for both 2D and 3D visualization conditions. We have also designed a new 3D transformation widget, called tBox, that can be operated easily and efficiently from simple gestures on touch-screens. In our approach, users apply rotations by means of physically plausible gestures, and we have extended successful 2D tactile principles to the context of 3D interaction [23].

6.4.3. Immersive environments

Participant: Martin Hachet.

We have continued working on immersive environments. In particular, with the "Digital Sound" group of LaBRI, we have studied how sound processes should be visualized in immersive setups [13]. Another collaboration is with the REVES Inria project-team, where we have explored how to design 3D pieces of architecture in a CAVE [21].

6.4.4. Brain-Computer Interaction

Participant: Fabien Lotte.

With Fabien Lotte joining the IPARLA team as a research scientist in January 2011, a new research topic related to interaction is being explored: Brain-Computer Interfaces (BCI). BCI are communication systems that enable its users to send commands to the computer by means of brain activity only, this activity being generally measured using ElectroEncephaloGraphy (EEG). This is therefore a new way to interact with computers and interactive 3D applications. In this area, we have explored new techniques to analyze and process EEG signals in order to identify the mental state of the user [14] [20]. This has led to improved robustness and mental state recognition performances. Another challenge in BCI is that it requires the collection of several examples of EEG signals from the user in order to calibrate the system. This makes the calibration step long and inconvenient. In order to alleviate this problem, we have proposed to generate artificial EEG signals from a few EEG signals already available. Our evaluations have shown that it can indeed significantly reduce the calibration time [28]. Together with the Inria VR4I-team, we have also explored the use of a new mental state to drive a BCI: attention and relaxation states. We have shown that it is indeed possible to identify relaxation and concentration in EEG signals, and that it can be used to drive a BCI [24]. Finally, we have critically analyzed the usefulness and potential of BCI for 3D video games [27].

6.4.5. Tangible user interfaces

Participant: Patrick Reuter.

Tangible user interfaces have proven to be useful for the manipulation of 3D objects, such as for selection and navigation tasks, and even for deformation tasks. Deforming 3D models realistically is a crucial task when it comes to study the physical behavior of 3D objects, for example in engineering, in sculpting applications, and in other domains. With recent progress in physical deformation models and the increasing computing power, physically-realistic deformation simulations can now be driven at interactive rates. Consequently, there is an increasing demand for efficient and user-friendly user interfaces for physically-realistic deformation in real-time. We designed a general concept for designing physically-realistic deformations of 3D models with a tangible user interface, and instantiated our concept with a concrete prototype using a passive tangible user interface that incarnates the 3D model and that runs in real-time [32].

7. Contracts and Grants with Industry

7.1. Contracts with Industry

7.1.1. Luxology

We have signed a non-disclosure agreement to access the beta version of Luxology's Modo software, a leading program for 3D content creation. This will allow us to study the latest versions of the Software Development Kit and potentially port our techniques to the Modo environment in the future.

7.1.2. Google

Google fund us for the development of a BLAS interface on top of the Eigen library.

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ALTA

Grant: ANR Program "Blanc" (Research National Agency)
Dates: 2011 - 2015
Partners: ARTIS [leader], REVES, IPARLA
Overview: The project ALTA aims at analyzing the light transport equations and at using the resulting representations and algorithms for more efficient computation. We target lighting simulations, either offline, high-quality simulation or interactive simulations.

8.1.2. SeARCH

Grant: ANR Program "Contenus et Interactions" (Research National Agency)
Dates: 2009 - 2012
Partners: IPARLA [leader], Ausonius (CNRS - Université de Bordeaux), CEAlex (CNRS - Alexendrie - Egypte), ESTIA (Bidart - France)
Overview: The SeARCH project [35] is particularly motivated by a concrete archeological context: one of the partners is the Centre d'études Alexandrines (CEAlex, USR 3134) that works on the reconstruction of the lighthouse of Alexandria and its surrounding statues. Most of the fragments of the lighthouse and the statues are underwater. Some of the fragments, especially from the statues, have already been lifted to the surface. The SeARCH project strives to develop semi-automatic techniques for the virtual reassembly of 3D objects. The first involved step is the digital acquisition of the fragments, on-site, and under aggravated circumstances, combined with some post-processing steps of the acquired fragments. The second step is the reassembly of the fragments that should not only be as automatic as possible, but should also allow taking into account the long-year work experience of the cultural heritage professionals by new efficient interaction and visualization techniques.

8.1.3. InSTInCT

Grant: ANR Program "Contenus et Interactions" (Research National Agency)
Dates: 2009 - 2012
Partners: IPARLA [leader], Alcove (Inria - Lille Nord Europe), Immersion, Cap Sciences
Overview: The InSTInCT project focuses on the design, development, and evaluation of new simple and efficient touch-based interfaces, with the goal of bringing widespread visibility to new generations of interactive 3D applications, aimed in particular at general public audiences. To this goal, we propose a pluridisciplinary approach allowing to address all aspects of the problem, from technical to end-usage challenges. Within the project we will first focus on bringing new hardware technologies leveraging a broad set of modalities and inputs (finger orientation, haptic feedback, etc). Second, we will propose new touch-based interaction techniques dedicated to interactive 3D tasks (manipulation, navigation, volume exploration). Third, we will aim at exporting the concept of touch-based 3D interaction to spawn new uses, targeting the full range of professionnal to general public applications. A fundamentally original aspect of the InSTInCT project, is to include broad experimental campaigns in the real-life conditions of Cap Science exhibits, from the earliest project stages. These test campaigns will be used to guide developments and will allow true-to-life and wide scale evaluation of the 3D interfaces we propose.

8.1.4. Animaré

Grant: ANR Program "Jeune Chercheur" (Research National Agency)
Dates: 2008 - 2011

Partners: IPARLA [leader], ARTIS (Inria Rhone Alpes)
Overview: Expressive Rendering is a recent branch of Computer Graphics that offers promising novel styles, and is increasingly used in many application domains such as video games or movie production. At the present time, only expert artists are able to create compelling animations, and still, this is an extremely time-consuming process, with many constraints that strongly limit creativity. The reason is that current models are not sophisticated enough to provide intuitive manipulations and versatile styles. The motivation behind this project is to overcome these limitations both for 2D and 3D animation systems.

8.2. European Initiatives

8.2.1. FP7 Projects

8.2.1.1. V-MuST

Title: V-Must.net

Type: COOPERATION (ICT)

Defi: Virtual Museum Transnational network

Instrument: Network of Excellence (NoE)

Duration: February 2011 - January 2015

Coordinator: CNR (Italy)

See other partners and information: http://www.v-must.net

Abstract: The V-MusT network enables heritage professionals around the world to connect, collaborate and advance the development and use of virtual museums. A Virtual Museum is a personalized, immersive, interactive experience that aims to enhance our understanding of the past in museums or on the internet.

9. Dissemination

9.1. Participation to the Scientific Community

9.1.1. Conference organisation

- AFIG 2011 : Membre du comité scientifique des journées AFIG, Octobre 2011, à l'ESTIA à Bidart (Jean-Christophe Gonzato)
- 24h de l'innovation 2011 : Comité local de l'organisation, Octobre 2011, à l'ESTIA à Bidart (Patrick Reuter)

9.1.2. Symposium co-chair

- IEEE Symposium on 3D User Interfaces (3DUI) 2011 (Martin Hachet)

9.1.3. Program committee

IPARLA is involved in the program committee of:

- Web3D 2011 (Patrick Reuter),
- Eurographics 2011 (Pascal Barla),
- IEEE Virtual Reality 2011 (Martin Hachet)
- Eurographics 2011 Short Papers (Martin Hachet),
- Eurographics 2012 STAR (Martin Hachet),
- IEEE Symposium on Computational Intelligence, Cognitive Algorithms, Mind, and Brain in the IEEE Symposium Series on Computational Intelligence 2011 (Fabien Lotte)
- International Workshop on Pattern Recognition in NeuroImaging 2011 (Fabien Lotte)
- International Conference on Multimodal Interaction 2011 (Fabien Lotte)
- Neurocomp 2011 autumn school on Brain-Computer Interfaces (Fabien Lotte)
- ACM symposium on Non-Photorealistic Animation and Rendering - NPAR 2011 (Pascal Barla)

9.1.4. Reviews

The members of IPARLA have also participated to the reviewing process for conferences and journals:

- **Journals:** The Visual Computer, Computer & Graphics, Computer Graphics Forum, ACM Transaction on Graphics, IEEE Transaction on Visualization and Computer Graphics, Journal of Multimedia, Journal of Multimodal User Interfaces, Int. Journal of Human-Computer Studies, Pattern Recognition, Image and Vision Computing, IEEE Transactions on Biomedical Engineering, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Journal of Neural Engineering, Behavioral and Brain Functions, Biomedical Signal Processing and Control, IEEE Intelligent Systems, IEEE Signal Processing Letters, IEEE Transactions on Systems, Man and Cybernetics - part B, IEEE Transactions on Signal Processing, International journal of PsychoPhysiology, Journal of Neuroscience Methods, Journal of Physiology Paris, Neurosciences Letters
- **Conferences:** Eurographics 2012, Web3D 2011, ACM SIGGRAPH 2011, ACM SIGGRAPH Asia 2011, International BCI Workshop 2011, ICMI 2011, IEEE SSCI 2011, PRNI 2011, IEEE SMC 2011

9.1.5. Committees

In 2011, the members of IPARLA have been involved in the following responsibilities:

- ANR programme CONTINT Evaluation committee (Martin Hachet)
- University of Bordeaux 1, CNRS, Institut d'Optique Graduate School - Coordination Committee (Xavier Granier)
- LaBRI - Manager of MVI3D research theme (Xavier Granier)
- LaBRI - Deputy Manager of the Image, Sound and Video team (Xavier Granier)
- Inria - Evaluation commission (Gaël Guennebaud)
- Inria Bordeaux - Commission for young researchers (Martin Hachet and Pascal Guitton)
- Inria Bordeaux - Commission of technology and development (Gaël Guennebaud)
- Inria Bordeaux - Local center committee (Pascal Guitton, Martin Hachet)
- AFIG - Co-treasurer and executive board member (Jean-Christophe Gonzato)
- Selection committee, PR0812, Université Bordeaux (Christophe Schlick)
- Selection committee, PR2226, Université Strasbourg (Christophe Schlick)
- Selection committee, MCF451, Université Rennes (Martin Hachet)

9.1.6. Jury of PhD thesis

- S. Hilaire, Irisa, Rennes, January 2011 (Martin Hachet)
- A. Martinet, LIFL, Lille, September 2011 (Martin Hachet)
- C. de Rousier, Université Grenoble, Novembre 2011 (Christophe Schlick)
- M. Haydar, Ibisc, Evry, December 2011 (Martin Hachet)
- F. Larrue, Université Bordeaux Ségalen, December 2011 (Martin Hachet)
- D. Devlaminck, Ghent, Belgium, September 2011 (Fabien Lotte)
- B. Reuderink, Twente, the Netherlands, October 2011 (Fabien Lotte)

9.1.7. Jury of HDR

- L. Barthe, Université Toulouse - IRIT, July 2011 (Christophe Schlick)
- R. Chaine, Université Lyon - LIRIS , December 2011 (Christophe Schlick)

9.1.8. Expertises

The expertise of some members has been required for some projects:

- CIR (Credit Impot Recherche) (Martin Hachet, Christophe Schlick)
- ANR (National Research Agency), "programme blanc" (Martin Hachet), "Content and Interaction" 2011 (Xavier Granier, Christophe Schlick), Starting Grant 2012 (Xavier Granier).

9.1.9. Demos

- Toucheo, Siggraph EmergingTech, Vancouver, Aout 2011.
- Toucheo, ”Numériquement votre”, Cap Sciences, Sept-Dec 2011.
- PapARt, ”Un chercheur, une manip”, Palais de la découverte, Sept-Dec 2011
- PapARt, ”Au doigt et à l’oeil”, Educavox, Cenon, Dec. 2011
- Navidget, MetroNum, Bordeaux, Dec. 2011
- BCI, Navidget, PapARt, Fete de la science, Inria Bordeaux, Oct. 2011

9.1.10. Popularizing presentations

- “Les Indiana Jones de la 3D”, Uni-thé ou café, Inria Bordeaux Sud-Ouest, France, February 2011 (Patrick Reuter)
- “Interaction 3D avec des mondes numeriques 3D”, Journées "‘Au doigt et à l’oeil", An@é-Educavox, Cenon, France, Decembre 2011 (Martin Hachet, Jérémy Laviole)
- “Quand le cerveau prend la main”, Uni-thé ou café, Inria Bordeaux Sud-Ouest, France, September 2011 (Fabien Lotte)
- “Les Interfaces cerveau-ordinateur”, Dejeuner sur Web, Toulouse, France, June 2011 (Fabien Lotte)
- “Utiliser son activité cérébrale pour contrôler un ordinateur : le point sur les interfaces cerveau-ordinateur”, Conference “Les Machines peuvent-elles imiter le cerveau humain ?”, Cité des Sciences, Paris, France, May 2011 (Fabien Lotte)
- “Ciné-débat Minority report”, Débat sur l’évolution des interfaces tactiles, 3D et cérébrales, December 2011 (Martin Hachet, Jérémy Laviole)

9.2. Teaching

The members of our team are implied in teaching computer science at University Bordeaux 1, University Bordeaux Ségalen, University Bordeaux 3, ENSSAT Engineering school and ENSEIRB Engineering School. General computer science is concerned, as well as the following graphics related topics:

License MASS - Web programming - 54h - L2 - Université Bordeaux Ségalen - France (Patrick Reuter)

License MASS - Image analysis & synthesis - 36h - L3 - Université Bordeaux Ségalen - France (Patrick Reuter)

Master - Image Synthesis - 48h - M1 - Université Bordeaux 1 - France (Xavier Granier, Gaël Guennebaud, Nicolas Mellado)

Master Sciences Cognitive - Virtual Reality - 40h - M2 - Universite Bordeaux Ségalen - France (Martin Hachet, Fabien Lotte, Christophe Schlick)

Enseirb engineering school, Virtual Reality - 10h (Martin Hachet)

Enseirb engineering school, Image Synthesis - 14h (Nicolas Mellado)

Enseirb engineering school, C++ - 12h (Nicolas Mellado)

ENSSAT engineering school, Multimedia & Networks computer science unit at, 3rd year (Master 2) - Virtual Reality, accessibility and BCI - 4h (Fabien Lotte)

Some members are also actively participating to the creation of the new department of Institut d’Optique Graduate School in Bordeaux.

One member of the team gave lectures (4h) in Brno/Czech republic about "Semi-Automatic Reassembly for Cultural Heritage" within the European Project FP7 called "European methodological studies for archaeologists" (Nicolas Mellado).

PhD & HdR

PhD : Olivier Hugues, "Vision augmentée à bord des navires et navires intelligents", defended december 12, 2011, Pascal Guitton

PhD : Robin Skowronsky, "Perception de l'environnement et réalité virtuelle sur station mobile", defended November 3, 2011, Jean-Sébastien Franco

PhD in progress : Simon Boyé, "Novel representations for geometric modeling", Sept. 2009, Gaël Guennebaud & Christophe Schlick

PhD in progress : Nicolas Mellado, "3D Acquisition et Réassemblage semi-automatique", Sept. 2009, Patrick Reuter & Christophe Schlick

PhD in progress : Jiazhou Chen, "Stylization for Augmented Reality", Sept. 2009, Xavier Granier

PhD in progress : Heqi Lu, "Appearance Analysis for Acquisition and Rendering", Nov. 2010, Xavier Granier

PhD in progress : Aurélie Cohé, "Manipulation d'objets 3D avec des surfaces tactiles", August 2009, Martin Hachet

PhD in progress : Jérémy Laviole, "3D user interfaces for computer graphics", Oct. 2010, Martin Hachet

PhD in progress : Yann Savoye, "Cage-based Animation Parametrization For 3D video", Oct. 2008, Jean-Sébastien Franco

10. Bibliography

Major publications by the team in recent years

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[3] M. HACHET, F. DECLE, S. KNOEDEL, P. GUITTON. *Navidget for Easy 3D Camera Positioning from 2D Inputs*, in "Proceedings of IEEE 3DUI - Symposium on 3D User Interfaces", 2008, best paper award, http://hal.inria.fr/hal-00308251/en.

[4] C. OZTIRELI, G. GUENNEBAUD, M. GROSS. *Feature Preserving Point Set Surfaces based on Non-Linear Kernel Regression*, in "Computer Graphics Forum", 2009, vol. 28, n° 2, p. 493–501, Best student paper, http://hal.inria.fr/inria-00354969/en/.

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[12] R. SKOWRONSKY. *Perception de l'environnement et réalité virtuelle sur station mobile*, Université Sciences et Technologies - Bordeaux I, November 2011.

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[13] F. BERTHAUT, M. DESAINTE-CATHERINE, M. HACHET. *Interacting with 3D Reactive Widgets for Musical Performance*, in "Journal of New Music Research", October 2011, vol. 40, n^{o} 3, p. 253-263, http://hal.inria.fr/hal-00633750/en.

[14] N. BRODU, F. LOTTE, A. LÉCUYER. *Exploring Two Novel Features for EEG-based Brain-Computer Interfaces: Multifractal Cumulants and Predictive Complexity*, in "Neurocomputing", 2012, http://hal.inria.fr/inria-00632546/en.

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[21] M. CABRAL, P. VANGORP, G. CHAURASIA, E. CHAPOULIE, M. HACHET, G. DRETTAKIS. *A Multimode Immersive Conceptual Design System for Architectural Modeling and Lighting*, in "3D User Interfaces (3DUI), 2011 IEEE Symposium on", Singapour, Singapore, J. J. J. LAVIOLA, M. HACHET, M. BILLINGHURST (editors), IEEE, 2011, p. 15-18 [*DOI :* 10.1109/3DUI.2011.5759211], http://hal.inria.fr/inria-00606833/en.

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