INRIA

INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team iparla

Visualization and manipulation of complex data for mobile users

Bordeaux - Sud-Ouest

Theme : Interaction and Visualization

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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 the image at the end of this text.

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.

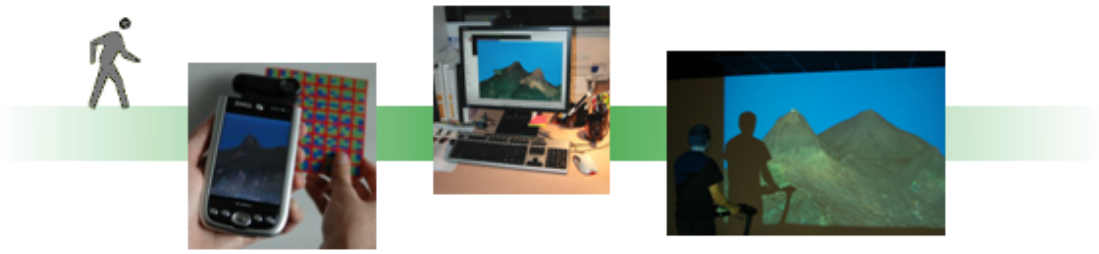

Figure 1. Visualization and Interaction with 3D Content for Mobile Users.

2.2. Highlights

- We received a best paper award at the 2010 Symposium on Interactive 3D graphics and games for our paper “Radiance Scaling for Versatile Surface Enhancement”. This extend even more the visibility on our research in the field of expressive rendering and shape depiction.
- With the new responsabilities of Pascal Guitton, in September 2010 Christophe Schlick became the new leader of the Iparla project-team. This also annonce the recent end of Iparla with the creation of new project(s).

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. Since Iparla project aims to develop mobile solutions, that is, 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 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 Iparla project, we have thus to consider the problem of 3D data acquisition, with 3D scanners of any other devices like the embedded camera 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 data (e.g. gigantic point clouds from 3D scanners). When real-time is reached, 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, at 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, 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 permit to avoid 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 (PhD Thesis of Fabrice Decle). 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. To achieve this goal, we have designed new 3D UIs adapted to the mobile device input space.

The second one has emerged from tactile interaction on mobile devices, but with a wider spectrum. It concerns [multi-]touch 3D interaction (PhD Thesis of Sebastian Knoedel). 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 (PhD Thesis of Florent Berthaut). 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. 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, which are generally stored on CD-ROMs or memory-sticks. 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. The majority of today's mobile devices is 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 can 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, Eigen2 provides a very powerful and easy to use API. Explicit vectorization is performed for the SSE (2 and later) and AltiVec instruction sets, with graceful fallback to non-vectorized code. Expression templates allow to perform these optimizations globally for whole expressions, and to remove unecessary temporary objects.

Eigen is already a famous library with about 3500 unique visitors of the website per month, while the mailing list holds about 150 members with a very high traffic (300 message per month).

5.2. Expressive Rendering shaders

Participants: Romain Vergne, Pascal Barla.

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

Participants: Martin Hachet [correspondant], Fabrice Decle, Sebastian Knoedel.

Web: https://iparla.labri.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 inputs. 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. Elkano

Participants: Benoit Bossavit [correspondant], Fabrice Decle, Xavier Granier.

Web: http://iparla.labri.fr/software/elkano/

Elkano is a scenegraph oriented real-time 3D framework which is used to develop 3D applications, rendering and interaction techniques. Elkano is a cross platform C++ library and a set of client/server applications for Linux, Win32 and Windows Mobile. Elkano is fully scriptable through the Lua scripting language. It also provides schemes for remote visualization of large 3D virtual environments and tools to design adaptive and progressive nodes. The applications designed with Elkano are made to work on such heterogeneous platforms from a handheld device in a mobility context to a cluster of PCs in a virtual reality center.

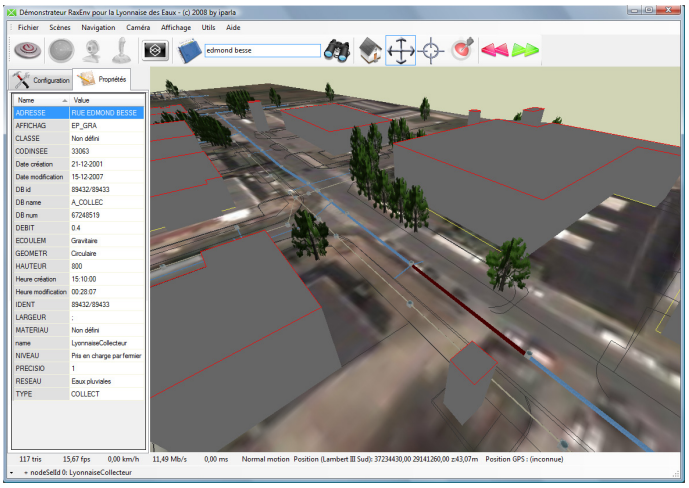

Figure 2. Real-time visualization of the underground water network of Bordeaux. An Elkano-based application developed for the ANR RaxEnv project.

Through the VRML97, X3D, Ogre scene formats, one can easily develop new optimized nodes with streaming capabilities to get the best performance on heterogeneous platforms. We also developed modules to support multi-screen rendering through a homogeneous cluster of devices (PCs or MCDs), OpenGL shaders and streamed level of details of lines in the context of NPR rendering. Geo-referenced models (like earth terrains) are supported. Objects animation, physical engine, light sources management, shadows and GPU buffer objects support were recently introduced.

Elkano is used in many work and projects of Iparla: NatSim, RaxEnv, Partage, Dahlia, etc.

5.5. CEMO

Participants: Xavier Granier, Zhang Zhongxin [Zheijang University].

Web: https://gforge.inria.fr/projects/cemo/

Cemo is a framework for sketch-based 3D modeling. First issued from the work of Dr Zhang Zhongxin from the State Key Lab of CAD&CG (Zheijang University - Hangzhou - China), it is now a common development platform for research in 3D modeling through sketching. This research is part of the Bird Associated team (Bunraku - IPARLA - State Key Lab of CAD&CG).

5.6. MRF - Mallia Rendering Framework

Participant: Xavier Granier [correspondant].

The Mallia Rendering Framework (aka MRF) is a framework library for the development of rendering algorithms. MRF has been used to develop several high quality software rendering applications like a Ray Tracer (marat), a Path-Tracer (manioc, see Figure 3) and also hardware rendering applications using GPU. MRF is a cross platform C++ library for Linux and Win32.

Figure 3. A scene rendering with manioc, a path-tracer.

5.7. HDRSee

Participant: Xavier Granier [correspondant].

Web: http://mhdrviewer.gforge.inria.fr/

HDRSee is a OpenGL/GLSL software that displays High Dynamic Range (HDR) and Low Dynamic Range (LDR) images 4. To display HDR images, HDRSee implements a few tone-mapping operators. Moreover, it is designed with a plugin mechanism that let developers add, as easily as possible, their own tone-mapping operator. All tone-mapping operations are done using Graphics Hardware through pixel shader operations.

5.8. ArcheoTUI

Participants: Patrick Reuter [correspondant], Nicolas Mellado.

ArcheoTUI is a software for the virtual reassembly of fractured archeological 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 2009, we enhanced the ArcheoTUI software with the results of the Master thesis of Nicolas Mellado : a local semi-automatic assembly algorithm based on the ICP (iterative corresponding point) algorithm, that works in real-time.

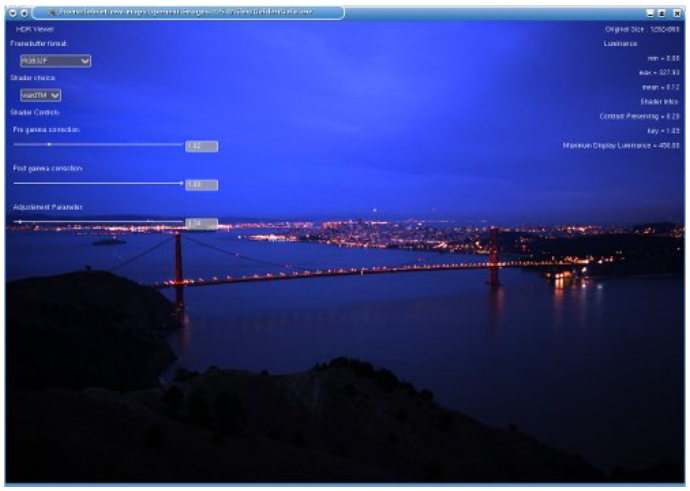

Figure 4. Tone-Mapped Image of a Night Landscape.

6. New Results

6.1. Modeling

6.1.1. Subdivision surfaces

Participants: Gaël Guennebaud, Simon Boye, Christophe Schlick.

Subdivision surfaces are a very powerful and widely used representation to generate high quality surfaces out of coarse polygonal control meshes. Unfortunately, they are also very well known to generate severe artifacts around extraordinary vertices. To address this quality issue, we introduced a novel approach to define subdivision surfaces called Least Squares Subdivision Surfaces (LS^3) [17]. The key idea is to exploit the smoothing capacity of local patch approximations. While the resulting procedure has the same complexity as simpler subdivision schemes, our method offers much higher visual quality, especially in the vicinity of extraordinary vertices (figure 5-ab). Our fitting procedure allows for a local control of the surface from the normals, making LS^3 very well suited for interactive freeform modeling applications.

6.1.2. Reassembly

Participants: Nicolas Mellado, Patrick Reuter, Christophe Schlick.

In the context of cultural heritage, 3D laser scanning 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 (figure 5-c). Our underlying matching algorithm advances state of the art Iterative Closest Point algorithms with pruning and orientation weighting [19].

6.2. 3D Data Rendering and Visualization

6.2.1. Soft shadows

Participants: Gaël Guennebaud, Shen Li, Baoguang Yang, Jieqing Feng.

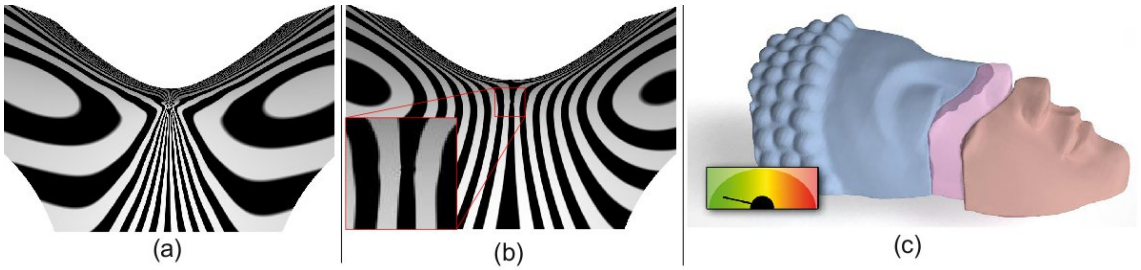

Figure 5. Loop subdivision (a) compared to our LS^3 procedure (b). (c) Semi-automatic reassembly of two archaeological fragments.

Shadows is 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) [42], we developed a perceptually based metric dedicated to the prediction of ideal shadow map resolutions [13]. 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 6).

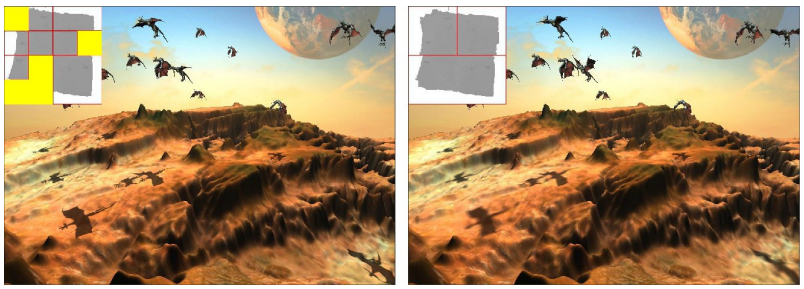

Figure 6. Our soft shadow rendering system generate adaptive shadow map tiles and can therefore render softer shadows (right @ 25 fps) faster than their hard shadow counter part (left @ 15 fps).

6.2.2. Vector-based lighting

Participants: Xavier Granier, Christophe Schlick.

We extend to caching [14] the use of our volumetric representation that captures low-frequency indirect illumination, structure intended for efficient storage and manipulation of illumination on graphics hardware. It is based on a 3D texture that stores a fixed set of irradiance vectors. This texture is built during a preprocessing step by using almost any existing global illumination software. Then during the rendering step, the indirect illumination within a voxel is interpolated from its associated irradiance vectors, and is used by the fragment shader as additional local light sources. The technique can thus be considered as following the same trend as ambient occlusion or precomputed radiance transfer techniques, as it tries to include visual effects from global illumination into real-time rendering engines. But its 3D vector-based representation offers additional

robustness against local variations of geometric of a scene. We demonstrate that our technique may also be employed as an efficient and high quality caching data structure for bidirectional rendering techniques.

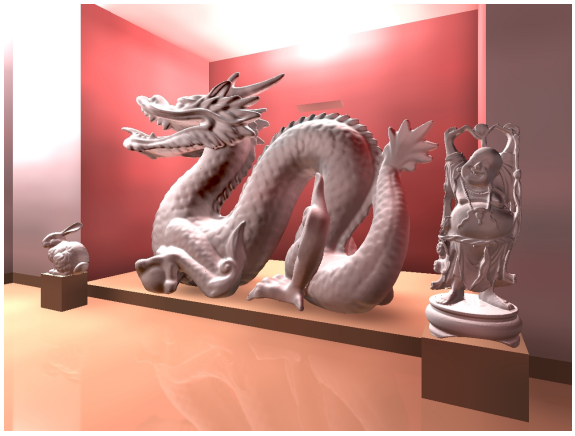

Figure 7. Virtual Museum of 3D Objects for Computer Graphics

6.2.3. Efficient compression of spatially varying materials

The quality of the computed illumination depends on the model representing the reflective behavior of surfaces. Compared to traditional surfaces, these models are characterized by their higher dimensionality. Moreover, the emergence of digital capture devices leads to dense measures of real phenomena. We have thus to investigate new models that can efficiently reduce the required size for representing such phenomena. For spatially varying materials, we have developed alternative representations that are more prone to compression by decorrelating spatial from directional variations [11] while being still suitable for real-time rendering on GPU.

6.3. Expressive Rendering

6.3.1. Expressive Visualization for Augmented Reality

Participants: Jiazhou Chen, Xavier Granier.

For augmented reality, legible visualization of masked object is important for the user to understand the general structure of the scene and the relative depth order between all the components (real of virtual ones). We have developed [23] an on-line framework for the visualizing of underground structures that improves X-Ray vision and Focus and Context Rendering for Augmented Reality. Our approach does not require an accurate reconstruction of the 3D environment and runs on-line on modern hardwares. For these purposes, we extract characteristic features from video frames and create visual cues to reveal occlusion relationships. To enhance the perception of occluding order, the extracted features are either directly rendered, or used to create hybrid blending masks: we thus ensures that the resulting cues are clearly noticeable.

6.3.2. Light Warping and Radiance Scaling

Participants: Pascal Barla, Xavier Granier, Christophe Schlick, Romain Vergne.

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. Based on our Light Warping (LW) method [41], we developed a new method, called Radiance Scaling [32]. It complements LW by modifying lighting amplitude, which results in a more flexible and faster technique that is best adapted to interactive applications. The LW technique has been ported to the Frapper software, developped by the Filmakademie (a famous German graphics school) and into Meshlab (http://meshlab.sourceforge.net/). This work has been awarded as a best paper at I3D 2010 conference and selected for an extended publication in TVCG [18].

6.4. Interaction

6.4.1. Touch-based interaction

We have continued exploring 3D User Interfaces for [multi-]touch screens.

In particular, in [28], 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. This study showed that direct-touch shortens completion times, but indirect interaction improves efficiency and precision, and this is particularly true for 3D visualizations. The study also showed that users' trajectories are comparable for all conditions (2D/3D and direct/indirect). This tends to show that indirect RST control may be valuable for interactive visualization of 3D content. To illustrate this finding, we present a demo application that allows novice users to arrange 3D objects on a 2D virtual plane in an easy and efficient way.

We have also designed a new 3D transformation widget, called tBox, that can been 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 [24]. This new 3D user interface enhance 3D interaction on touchscreens.

6.4.2. Immersive music

We have continued our collaboration with the "Digital Sound" group of LaBRI. This collaboration has led to interesting results. In particular, we have studied how sound processes should be visualized in immersive setups [20]. We also have introduced the concept of *hierarchical live-looping*, and we have proposed a full virtual instrument that takes benefit of this concept [21]. In [22], we describe *PIIVERT*, a new input device that has been specifically designed for playing music in 3D immersive environments.

7. Contracts and Grants with Industry

7.1. Contracts with Industry

7.1.1. Light Warping in Frapper

We have assisted the porting of the Light Warping method to Filmakademie's software Frapper. We expect the technique to be used in further productions of the German school, like short movies or commercials.

7.2. National Initiatives

7.2.1. 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 (Bidard - France)

Overview: The SeARCH project 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.

7.2.2. 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.

7.2.3. 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.

7.3. European Initiatives

7.3.1. V-MUST ("Virtual Museum and Cultural Heritage")

Grant: Network of Excellence (FP7) on Digital Library
Dates: 2011-2015

8. Other Grants and Activities

8.1. International grants

8.1.1. Associated Team: Bird

"Interactions entre les mondes Réels et Virtuels / Interactions between Real and Virtual Worlds"

Grant: INRIA-DREI
Dates: 2008-2010
Partners: Bunraku - IRISA - Rennes and State key Lab of CAD&CG - Zheijang University - Hangzhou - China
Overview: The main purpose of this collaboration is to provide new tools for managing the interaction between real and virtual worlds. We first want to ease the interaction between real users and virtual worlds during modeling and collaborative tasks. Concerning generation of virtual worlds, we will focus not on fully automatic solutions, but on semi-automatic ones that will take into account human decisions. This integration of the user is essential to provide intuitive processes and better immersion. Based on the different interfaces between virtual and real world (from a simple stylus to a set of cameras), we have to capture accurately the motions, the gestures, and to interpret the intentions of humans, in order to correctly integrate these actions and intentions.
Web: http://www.irisa.fr/prive/donikian/EA/

8.1.2. JST - CNRS Project

"Improving the VR experience"
Grant: CNRS
Dates: 2008-2010
Partners: LSSIIT - Strasbourg and Bunraku - IRISA - Rennes and Tokyo University - Tokyo and Keio University - Tokyo and Osaka University - Osaka
Overview: Virtual Reality (VR) is a scientific and technical domain, making the most of computer science and behavioral interface to simulate the behavior of entities in a virtual world. One of the most important and difficult topics of VR is to obtain the best possible feeling of immersion. To reach this goal, it is necessary to combine a correct representation of the behaviour of entities in the 3D scene, an intuitive and natural interaction, and a relevant visualization, all of this in real time. To overcome this scientific challenge, we have identified the three following points:

- Intelligent behaviour of virtual entities: improvement of the believability of virtual humans by combining together reactive and cognitive behaviours. We would like to explore multilayered approaches allowing to combine reactive path planning and collision avoidance together with cognitive task planning,
- Non photorealistic rendering of virtual worlds: non photorealistic rendering (NPR, also mentionned as expressive rendering) is a very promising way to visualize virtual worlds. NPR is based both on very ancient graphical technics (drawing, painting) as well on very recent ones (cartoons),
- Interaction with virtual worlds: improvement of the gesture in immersive environment. Among others, by physically constraining the motion of the hand or a hand-held tool thanks to haptic or pseudo-haptic techniques.

9. Dissemination

9.1. Participation to the Scientific Community

9.1.1. Conference organisation

9.1.2. Symposium co-chair

- IEEE Symposium on 3D User Interfaces (3DUI) 2010 (Martin Hachet)

9.1.3. Guest Editor

- IEEE Transactions on Visualization and Computer Graphics, vol. 16, no. 1, January/February 2010 (Martin Hachet)

9.1.4. Program committee

Iparla is involved in the program committee of:

- Eurographics 2011 (Pascal Barla),
- IEEE Virtual Reality 2011 (Martin Hachet)
- Eurographics 2011 Short Papers (Martin Hachet),
- SIGGRAPH Asia 2010 (Martin Hachet),
- Graphics Interface (GI) 2010 (Xavier Granier)
- International Symposium on Visual Computing 2010
- Non Photorealistic Animation and Rendering 2010
- Shape Modeling International 2010
- Eurographics Annual Conference Area Papers on Cultural Heritage 2011

9.1.5. Demonstartion co-chair

- Joint Virtual Reality Conference of EGVE-ICAT-EuroVR 2010 (Martin Hachet)

9.1.6. Reviews

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

- **Journals:** The Visual Computer, Computer & Graphics, Journal of Multimodal User Interfaces, Int. Journal of Human-Computer Studies, Pattern Recognition, Image and Vision Computing.
- **Conferences:** Siggraph 2010, Eurographics 2011, Siggraph Asia 2010, Eurographics Symposium on Rendering 2010 (EGSR), Graphics interface (GI) 2010, UIST 2010, CHI 2011, IEEE VR 10-11, ICCV 2010, CVPR 2010-2011, ACCV 2010, 3DPVT 2011, CVMP 2010, Web3D 2010.

9.1.7. Committees

In 2010, the members of Iparla have been involved in the following responsibilities:

- INRIA - Young Researchers Mission (Pascal Guitton)
- INRIA - COPIL Management member (Pascal Guitton)
- INRIA - Alumni executive board member (Pascal Guitton)
- INRIA Bordeaux - commission for young researchers (Pascal Guitton)
- INRIA Bordeaux - commission for new building (Pascal Guitton)
- INRIA Bordeaux - local center committee (Pascal Guitton, Martin Hachet)

- INRIA Bordeaux - commission for technological development (Martin Hachet)
- INRIA Bordeaux - Administrative Staff Recruitment Committee (Pascal Guitton)
- Interstices - Editorial committee member (Pascal Guitton)
- Fuscia - Editorial committee member (Pascal Guitton)
- AFIG - Co-treasurer and executive board member (Jean-Christophe Gonzato)
- AFRV - President (Pascal Guitton)

9.1.8. Jury of PhD thesis

- R. Vergne, Bordeaux LaBRI (Xavier Granier, Christophe Schlick, Pascal Barla)
- F. Berthaut, Bordeaux LaBRI October 7 (Pascal Guitton, Martin Hachet)
- L. Aguerreche, Rennes Irisa, June 2010 (Martin Hachet)
- S. Hilaire, Rennes Irisa, January 2011 (Martin Hachet)

9.1.9. Jury of HDR

- M. Hachet, INRIA Bordeaux Sud-Ouest/LaBRI (Pascal Guitton)

9.1.10. Expertises

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

- Pole de competitivite OPTITEC (Martin Hachet)
- ANR (National Research Agency), "programme blanc internationaux" (Martin Hachet)

9.1.11. Demos

9.2. Teaching

The members of our team are implied in teaching computer science at University Bordeaux 1, University Bordeaux 2, University Bordeaux 3, and ENSEIRB Engineering School. General computer science is concerned, as well as the following graphics related topics:

- Univ. Bx 1 - Master 2 - Image Synthesis (Xavier Granier, Gaël Guennebaud, Jérôme Baril)
- Univ. Bx 1 - Master 2 - Virtual Reality (Pascal Guitton, Martin Hachet)
- Univ. Bx 1 - License 3 - Introduction to Image Processing (Jean-Sébastien Franco)
- IUT Bx 1 - License Pro Image - Computer Graphics (Xavier Granier, Romain Vergne)
- ESTIA - Master - Graphical User Interfaces (Patrick Reuter)

Some members are also in charge of some fields of study:

- IUT Bx 1 - License 1 GACO (Jean-Christophe Gonzato)
- Univ. Bx 2 - License 2 Science and Modeling (Patrick Reuter)

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