INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team IPARLA

Visualization and interaction for complex data, on mobile and connected devices

Futurs

THEME COG

Activity Report

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1. Team

IPARLA is a joint project of INRIA and the LaBRI, located in Bordeaux. The LaBRI is a joint laboratory of the CNRS (UMR 5800), the University Bordeaux 1, and the ENSEIRB (Ecole Nationale Supérieure en Electronique, Informatique et Radiocommunication).
The project has been officially created on the 13/11/2003.
Several people are coming from other laboratories. The first lab is the IRISA located in Rennes, that is a joint lab between INRIA, CNRS (UMR 6074), the University of Rennes 1, and the INSA (Institut National de Sciences Appliquées). The second one is the LSC (Laboratory of Cognitive Sciences) from the University Bordeaux 2.

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2. Overall Objectives

The main goal of this project is the visualization of complex data and their manipulation on mobile and connected devices (MCD), like PDA or cellular phones. In order to be sufficiently small and autonomous, they have some limited resources: a restricted computational power and storage capability, a limited bandwidth, and a small display size. These limitations raise some specific problems that we want to address.

One of the main assumptions is that these devices are connected to local or global networks. We will base our research first on wireless standards like IEEE 802.11 (WIFI) or BlueTooth, and then extend it to different protocols like GSM, GPRS, UMTS.

Our first goal is the visualization of some complex (large and rich) data on these devices. Hence, we have to consider all the required transformations from the stored data to the display, and find the more suitable solution. We also want to interact with these complex data (i.e., navigate, select some part, edit, etc.). This leads to the development of a full usable visualization and interaction system.

We have to deal with different data like very large numerical and multi-dimensional data, virtual environments and 3D numerical models (buildings, town, human body, etc.), more abstract data (financial statistics, weather, etc.), or any multidimensional numerical data produced by simulations or captors.

GPRS *General Packet Radio Service.* A GSM data transmission technique that does not set up a continuous channel from a portable terminal for the transmission and reception of data but transmits and receives data in packets. It makes very efficient use of available radio spectrum, and users pay only for the volume of data sent and received.

GSM *Global System for Mobile Communications.* A standard for digital cellular communications (in the process of being) adopted by over 60 countries. The GSM standard is currently used from the 900 MHz to the 1800 MHz bands

UMTS *Universal Mobile Telecommunications System.* Evolution in terms of services and data speeds from the GSM networks.

3. Scientific Foundations

3.1. Network environment

Since 1995, the industry of cell phones and mobile telecommunication has raised significantly. Currently, more than 60% of people (in France) have such devices, compare to none few years ago. Mainly based on voice transmission and the GSM (9.6 kbps) standard, this market has evolved to more general data transmission. At the beginning, only short-text messages were exchanged using the SMS protocol. Now, the user can access to some multimedia data, like with the WAP protocol. Even if this one, combined with the GSM protocol, is not so used, the new network protocol with higher bandwidth, like GPRS (20 to 60 kbps - appeared in 2002) and UMTS (400 kbps to 20 Mbps), will lead to a better adoption of such communications.

To complete the development of these international networks, some standard protocols for local wireless communications have been introduced, like BlueTooth (1 Mbps, 100 m) or IEEE 802.11 (10 Mbps, 500m, recently renamed WIFI). More and more mobile devices, from cell phones to computer through PDA have now integrated them.

SMS A message service offered by the GSM digital cellular telephone system. Using SMS, a short alphanumeric message (160 alphanumeric characters) can be sent to a mobile phone to be displayed there, much like in an alphanumeric pager system. The message is buffered by the GSM network until the phone becomes active.

WAP An open international standard for applications that use wireless communication, e.g. Internet access from a mobile phone.

3.2. Hardware environment

These protocols for general data transmission are progressively integrated to a large range of devices with a spectacular increase of their hardware capabilities (processor, memory, display, etc.). These terminals have currently the same possibilities than a graphic workstation from the beginning of the 80's.

3.2.1. Central Unit

As the difference between a laptop and a workstation has been greatly reduced during the past years, if we consider the computational power and storage capability, the qualitative difference between the mobile devices and the workstation will also surely decrease. But due to the inherent limitations for power consumption, weight and cost, these differences will never completely disappear. As a floating point unit requires a high power consumption, fixed-point arithmetic and integer only computation will still be the best solution for a time in a mobile device.

3.2.2. 3D Architecture

Nowadays, different companies are working on the development of 3D processors for the visualization on mobile devices. Some companies, like Imagine Technology (with its Power VRMBX processor, in collaboration with ARM), EyeMatic (in collaboration with Texas Instrument), NeoMagic are working on such solution. With the release of the specification of OpenGL|ES 1.0 in 2003 (and 1.1 in 2004), such solution is increasing. As an example, BitBoys, ATI, NVIDIA, have already released their OpenGL|ES chips, respectively Acceleon, IMAGEON, GoForce 3D. It is clear that this approach is fundamental for the industry, for a commercial aspect (to be the first on the market), but also to re-use existing code based on the OpenGL/Direct3D architecture. The OpenGL|ES standard is promoted by many companies involved in the mobile device market, like Nokia, ARM, Toshiba, ... (see at http://www.khronos.org/opengles/openglesadopters.html for the complete list). As an example, OpenGL|ES is the development library for the Nokia N-Gage, a device that combines a multimedia player, a mobile console, and cell phone, with 3D capabilities.

OpenGL|ES Subset of the OpenGL API, designed for the embedded systems

3.2.3. Display

But even with such hardware, the qualitative aspect of the display will not increase a lot, for one main reason: the display size will always be restricted. As a PDA, for example, has to fit in one hand, it is reasonable to think that the physical size of the display will not increase a lot in the near future. Currently, the resolution has reached the SVGA standard (800x600), we one can expect this will be quite stable.

3.3. Software environment

A large number of people are already working for the development of new software tools (API, visualization tools, etc.) for the mobile devices. One of the main problems is currently the need of floating point architecture, that is missing on the mobile processors, and that is essential for the classic 3D pipeline.

Among those companies, we can cite Superscape (http://www.superscape.com/), as an example, that is developing interactive graphic applications since 15 years (for games, education, electronic commerce, etc.). Its expertise on working for limited resources devices (memory, processor) allows to reach the cell phone market and to participate actively to the MPEG4 development. More recently, Superscape is offering a new product (Swerve) that contains a 3D modeling package based on 3DS Max (Swerve Author), an embedded client for cell phones to provide some services to the applications (Swerve Client), and some tools for communications and games. Swerve provides a 3D rendering engine based on polygonal representations, some standard data structures (basic primitives, scene graph) and a classical rendering scheme (Z-buffer, Gouraud shading, texturing, etc.). Note that Superscape has signed an open partnership with ARM to integrate Swerve on their next generation DSP.

We can cite also Parallel Graphics (the first to offer a VRML viewer for PDA, that includes also a Virtual Environment editor), Ekkla (http://ekkla.free.fr/) and Hybrid Graphics (that are developing OpenGL API for mobile devices - http://www.hybrid.fi/mobile.php), and EyeMatic (that has announced some media players allowing to display human figures - http://www.nevenvision.com/).

4. Application Domains

Keywords: *and telecommunications*, *digital images*, *mobile devices*, *multimedia*, *realistic and non-photorealistic rendering*, *virtual and augmented environments*, *visualization*.

As it is very difficult to make an exhaustive list for all the possible application domains involving the visualization of complex data, and the interaction on mobile devices, we only mention here few that seem representative.

Assisted Navigation: In this context, the mobile devices can help the user to determine its position in an environment, and to decide its way, by the visualization of a virtual environment, augmented with some information. The urban environments are an interesting target for these applications, and we already have some technologies and the knowledge (automatic generation, simplification, visualization, etc.). The car industry is already providing some navigation solutions, but the current solution can definitively be improved. The display has a poor quality (generally 2D graphs or stored pictures) and all the data have to be embedded (CD-ROM, etc.). This last point is a real problem for the cost of the solution and for the information availability. Moreover for a dynamic environment, like urban one, these data have also no guaranty to be up-to-date. This Assisted Navigation approach can be extended to a rural environment. In such place, a PDA with a GPS receptor will replace the classical paper map, and will provide the hiker with a simplified visualization of its position and a symbolic display of the planned path.

Embedded Augmented Positioning: For this application, the user visualizes a representation of an existing environment, augmented with some information (augmented like in "Augmented Reality"). Some touristic places already provide the visitors with PDA that contains a tour guide, with a combination of place descriptions and explanations (reconstructed buildings that have been destroyed, construction schemes, etc.). The museums represent an interesting market for this approach. But we can consider also on-site maintenance or intervention after a disaster: the technician visualize the location of the intervention, the fireman can have one-site some crucial information, like the kind of fluid that go through a pipe in fire. As a last example, this approach can be used for a virtual visit on-site. A constructor can show to its clients, the planed building and construction, and a prospector can visualize the current structure of the surface and of the underground. Combining the on-site information (the reality) with some virtual information (augmented reality) is a promising way of action planning.

Remote Consultation and Supervision: For this domain, we want to visualize some abstract data. This is one on the richest application domain. To give a rough overview of the possibilities, we will introduce several examples. In the scientific community, it is common that a process (simulation, experiment, etc.) can be as long as multiple days. To supervise it, there are currently only two solutions: a group of people that alternate for the supervision, or to check from time to time, with the possibility to miss an important event during the experiment. Even more, the video systems are not well suited for this context, as they provide only the user with visual information. And most of the scientific experiments have a large number of parameters. The goal of our work will be to allow visualization, on the mobile device, of all the abstract data from the captors. Complete information will then be available to the user, for any of his location. This can be extended with some additional functions (alarms, processing tools, etc.).

This general approach can be used for different contexts:

- a physician can have an instant access to all the captor parameters of a patient on supervision, and in case of troubles, can visualize the results of the tests.
- a technician can supervise all the production machines, from any place in the factory.
- during his patrol, a guard can still have access to all the alarms, captors, and videos.

- a financial decision maker can have access at most of the complex financial information (Stock Market, financial results, publications, etc.) and can be averted on specific events.
- as another small example, a single-handed yachtsman has to stay in permanent contact with its information system, even when he is operating on the deck.

Remote Control: A directly connected extension is the availability for the user to remotely control a process with his mobile device. This can be done either through a global network, from a long distance, or through the local network when the user is on place. The main advantage is the unification of the needed hardware and software that will simplify the user job. Even more, this will ease the preparation of an action, as it will provide a smooth transition from the plan, to the realization.
Video Games: To conclude this quick overview, the video game domain is another great target for our work. For them, independently of the platform (PC, games consoles) the interactive visualization of complex virtual environment is the key-point for the current game engine. Unfortunately, the approaches that have been developed cannot be directly adapted to mobile devices, due to their limited resources for the 3D rendering. And nowadays, the goal of this industry is to offer to the user a smooth transition between different medium for the same game: the user can play in the same way at home on his own PC/console, as in the public transportation, on his mobile device. It is also challenging to allow multi-player games with such devices.

5. Software

5.1. A software to create digital terrains from scanned topographic maps

Keywords: *DEM*, *GIS*, *contours*, *interpolation*, *map processing*.

Participants: Joachim Pouderoux [correspondent], Jean-Christophe Gonzato, Pascal Guitton.

AutoMNT is a software to create Digital Elevation Models (DEM) from scanned topographic maps. DEM are used in many applications from GIS, training simulator, archeology, video games etc. A DEM is a height field, that is a regular grid where each node is associated with an elevation (altitude) value. Our software has been designed as a graphical user interface (GUI) for Microsoft Windows. The user can load a map and apply different operations in order to extract contour lines, label each contour with its elevation and finally interpolate data in order to estimate the elevation of every point of the model. As this process is tedious and time consuming, AutoMNT embeds algorithms to make this process as automatic as possible.

5.2. Contribution to HyperFun

Keywords: *constructive solid geometry*, *function representation*.

Participants: Christophe Schlick [correspondent], Benjamin Schmitt [Digital Media Professionals, Japan], Alexander Pasko [Hosei University, Japan], Tamy Boubekeur.

The HyperFun (http://www.hyperfun.org) project is a free software development for modeling, visualization and animation of 3D shapes based on a so-called "Function Representation" (F-Rep). The F-Rep model can be seen as a generalization of the Constructive Solid Geometry (CSG) model where a much greater variety of solid primitives and combining operators are allowed. Many contributions to the HyperFun project, mainly based on constructive sculpting and constructive texturing [6], where developed in the team during the thesis of Benjamin Schmitt (co-advised by Christophe Schlick and Alexander Pasko, from Hosei University in Japan), that ended up in January 2003 when he leaved for a post-doctoral position at Digital Media in Japan. The collaboration with the HyperFun project is still going on as we plan to implement the hardware point based rendering technique that we developed to get interactive rendering of F-Rep models.

5.3. Plugin for PointShop 3D

Keywords: *point rendering*, *solid texturing*.

Participants: Tamy Boubekeur [correspondent], Patrick Reuter, Christophe Schlick.

A plugin - available for download at http://www.cotex.fr.st - of our interactive constructive solid texturing approach[15] has been developed for the PointShop3D system - available at http://graphics.ethz.ch/pointshop3d/.

6. New Results

6.1. Modeling

6.1.1. Point-Based Reconstruction

Participants: Patrick Reuter, Tamy Boubekeur, Irek Tobor, Christophe Schlick.

Recent 3D acquisition technologies provide a huge number of unorganized 3D points. Our goal is to develop new methods to reconstruct implicit surfaces from such large unorganized point sets. The driven idea of our approach is to divide the problem into three relatively independent steps: first, partition the global reconstruction domain into smaller overlapping local subdomains by using adaptive domain decomposition methods, second, solve the reconstruction problems in the local subdomains using some well-chosen function basis, and finally, blend the solutions together using the partition of unity method.

We first investigated the use of radial basis functions with global support to achieve the second step. We thus proposed two methods using different space partitioning strategies: the first one [16] uses an adaptive decomposition based on a octree and blends the solution of all the leaf nodes together, while the second one uses a perfect binary tree and blends together at each nodes, the solutions of its two children. Both methods have a nice linear behavior for the required reconstruction time and memory usage, with the respect of the number of initial points.

More recently, we have investigated an alternative to radial basis functions during the local reconstruction step. Our new techniques is based on the "Enriched Reproducing Kernel Particle Approximation" (ERKPA) which was developed in the field of mechanics, during the late 90s, to solve some partial differential equations on mesh-less structures. The nice property of ERKPA is to allow the inclusion of sharp edges in the reconstructed implicit surface.

6.1.2. Point-Based Texturing

Participants: Patrick Reuter, Tamy Boubekeur, Christophe Schlick.

Our point-based reconstruction techniques described above, are not limited to the reconstruction of an implicit surface, but also apply to the reconstruction of continuous functions of any dimension. As a direct extension, we used the reconstruction methods to define a new class of procedural solid textures that can be reconstructed from the attributes of unorganized point sets.

We developed a new interactive environment for constructive texturing of surface of arbitrarily defined 3D objects [15]. A user can texture the surface by defining space partitions that are combined using constructive texturing, and by specifying attributes that are applied in the space partitions. In order to give an interactive feedback, a point-based multi-resolution representation of the surface is used not only for rendering, but also for the evaluation of the texture. We always keep a feedback to the initial geometric representation of the object (polygonal mesh, parametric or implicit surface, voxel arrays, etc) which means that the final textured object can be easily exported to standard graphics software that cannot directly handle discrete surface points (e.g. CAD systems, photorealistic rendering software, etc).

6.1.3. Adaptive Sampling of Implicit Surfaces

Participants: Florian Levet, Julien Hadim, Patrick Reuter, Christophe Schlick.

In this work [14][4], we propose a solution to adapt the *differential point rendering* technique to implicit surfaces. Differential point rendering was initially designed for parametric surfaces as a two-stage sampling process that strongly relies on an adjacency relationship for the samples which does not naturally exist for implicit surfaces. This fact made it particularly challenging to adapt the technique to implicit surfaces. To overcome this difficulty, we extended the *particle sampling* technique developed by Witkin and Heckbert in order to locally account for the principal directions of curvatures of the implicit surface. The final result of our process is a *curvature driven anisotropic sampling* where each sample "rules" a rectangular or elliptical surrounding domain and is locally oriented according to the directions of maximal and minimal curvatures. Like in the differential point rendering technique, these samples can then be efficiently rendered using a specific shader on a programmable GPU.

We put our sampling technique in the modeling section and not in the rendering one, because our final goal with anisotropic particles is not specifically to render the corresponding implicit surfaces, but rather to consider these particles as a set of control parameters that can be used to manipulate the surfaces, for instance, in a virtual sculpting environment.

6.1.4. Multi-resolution and Appearance

Participants: Julien Hadim, Patrick Reuter, Christophe Schlick, Xavier Granier.

When it comes to simplification of a 3D geometry, for the streaming or for device-dependent quality rendering, multi-resolution is a natural approach and has been widely used. Unfortunately, most of these solutions are geometry-specific and cannot be directly applied to the appearance, which spans in a 4D directional space.

We are currently developing new representation for the light interaction with a 3D model that will allow a better preservation of the object appearance through a multi-resolution simplification. With such model, we will be able to increase the richness of the visualization, even for displays with a limited resolution. The lighting variation will provide some information about the underlying simplified geometry.

6.1.5. Sketching Interface

Participants: Xavier Granier, Gwenola Thomas.

On mobile devices, the interaction is mainly done with a stylus. Thus, for the 3D modeling, the natural metaphor will be the Sketching for Modeling. Since it is difficult to perform precise 3D rotation with a stylus, we are developing currently a shape from shading approach for 3D modeling, in which the user will only have to place light direction and the resulting shading in order to create a 3D volume.

During his internship, a student have developed some new approaches that allow a fast creation of an Height field, through simple drawing lines. We are currently investigating the possibility of 3D model edition using similar techniques.

6.1.6. Automatic creation of digital territory environments

Participants: Joachim Pouderoux, Jean-Christophe Gonzato, Pascal Guitton, Salvatore Spinello.

The main goal of this subject is to create quasi-automatically a virtual environment from digital supports like scanned topographic maps, pictures. The map contains complex data to recover: DEM (Digital Elevation Model) from contour lines, environment objects from forest, houses, roads etc. The reconstruction of original DEM from contour lines consists in a combination of semi-automatic operations by using classical image analysis, neuronal networks and morphological mathematics: selection of contour lines [7], of skeleton, broken contours reconstruction, altitude affectation and finally interpolation of the DEM[5]. We developed a software named *AutoMNT* (http://iparla.labri.fr/softwares/automnt) that load any topographic map and convert it in a classical DEM model [21].

We are currently working on retrieving other essential information (road, forest, town, etc) and to integrate them in a complete Geographic Information System (GIS) database in order to view them in different environments: Reality Centers, standard PC, Web and PDA.

6.1.7. Light Source Acquisition

Participant: Xavier Granier.

Accurately capturing the near field emission of complex luminaires is still very difficult. We have developed a new acquisition pipeline of such luminaires that performs in a two-step procedure an orthogonal projection onto a given basis. First, we use an optical low-pass filter that corresponds the reconstruction filter to guarantee high precision measurements. The second step is a numerical process on the acquired data that finalizes the projection. Based on this concept, we have developed new experimental setups for automatic acquisition and performed a detailed error analysis of the acquisition process. This work has been submitted to the Journal of Applied Optics.

6.2. Rendering

6.2.1. Point-based Visualization using Subdivision Surfaces

Participants: Tamy Boubekeur, Patrick Reuter, Christophe Schlick.

We have developed an algorithm to efficiently generate a triangulated surface from point sets [11]. The goal is to provide an efficient visualization of unstructured point sets with current graphics hardware. The central idea is to generate a set of overlapping polygonal surfaces, based on a local 2D Delaunay triangulation. In the overlapping zones, a modified subdivision scheme is used to eliminate artifacts. A rendering environment called *Osiris* (http://www.labri.fr/Perso/ boubek/osiris.html) has been developed to show the quality of rendering of such surfaces. We are now working on a complete alternative to surface splatting, based on our fast surface reconstruction, for interactive modeling and rendering of point clouds.

6.2.2. Non-Photorealistic Urban Environments Rendering

Participants: Jean-Charles Quillet, Gwenola Thomas, Kadi Bouatouch.

We are interested in navigation through large virtual urban environments. Usually, 3D urban models contain a set of buildings that are simple blocks on which some realistic textures are mapped. When rendering those environments on a PDA, the cost for texture storing and transmission can be prohibitive. We propose to use a Non-Photorealistic-Rendering style based on feature lines for urban environments modeling and rendering. In the literature on feature lines rendering, lines are extracted on a 3D model searching for geometric properties (principal directions of curvature, silhouette) or in an image (gradient, segmentation). We have chosen to work in image space because of the richness of information we can extract. We have implemented and integrated under Gimp a pipeline of image processing. The entrance is the image of a building facade. Feature lines are created from vectorization of contour lines. The initial line set is dense and noisy. Considering some knowledge on the facade structure (majority of horizontal / vertical lines), we post-process this set in order to obtain a minimal set of lines which will be transmitted more rapidly than textures on a network. We are working on a hierarchical classification of lines in order to transmit them progressively on the network. For the final rendering, our future work is to adapt stylization techniques (pen and ink) for a more aesthetic (but still interactive) rendering on the PDA. We will also explore mixed rendering (water-color) for a legible rendering.

6.2.3. Image-Based Rendering

Participants: Kadi Bouatouch, Gwenola Thomas, Gerald Point.

A classical rendering pipeline is not well suited to mobile terminals due to their limited performances. A better alternative is to use an image-based rendering (IBR) approach. To render highly complex scenes on mobile terminals, we have developed an IBR algorithm in the framework of a client/server architecture. The server computes some reference images and transmits them to the client that can be a PDA or a mobile phone. On the client side, navigation through a scene is performed by warping a reduced set of reference images. In this way, the rendering complexity is only dependent on the image resolution, not on the geometry complexity. A first implementation has proved the feasibility of the IBR approach on PDA. This year we address the problem of camera placement that allow an efficient warping avoiding artifacts, such as holes, due to occlusions and exposures. Providing a general solution to this problem is a hard task; in [18] we present results in the case of urban scenes.

6.2.4. Quality Control on Rendering

Participants: Xavier Granier, Kadi Bouatouch.

Nowadays, the whole rendering process in computer graphics, from acquisition (with a digital camera) or modeling to display (on CRT/LCD displays) through the shading evaluation is mostly based on trichromatic colors like RGB. Unfortunately, the reflection of a light on a surface is based on a component by component, which can reduce the preservation of the color appearance. We are working on a new approach[19] for color-based reflection that introduces a low overhead for an easy integration in current rendering systems, and low-powered devices. Moreover, this approach has to introduce an easy and global control on the reflection behavior.

We are also working in a two-step process[1] to compute high-quality solution for global illumination. The first step of this algorithm consists in a view-independent solution based on hierarchical radiosity with clustering, integrated with particle tracing. This first pass results in solutions containing directional effects such as caustics, which can be interactively rendered. The second step consists in a view-dependent final reconstruction that uses all existing information to compute higher quality, ray-traced images.

6.3. 3D Interaction

Before working on mobile and connected devices, a main interest of our team was work on 3D interaction, and especially for virtual reality setups with large displays. In this section, we will introduce the results of our research for this domain. Even if the difference between the display areas is huge (30 m^2 vs. 30 cm^2), we believe that part of our experience based on reality centers can be adapted on PDA. We will thus describe new interaction models (video capture, CAT) and some possible applications.

Large-displays, used as collective visualization interfaces, allow several co-located participant to be immersed in virtual environments (VE). In spite of their potential for group works, large-displays are often under-used because the users cannot interact easily and efficiently with the visualized VE. Bringing interaction possibilities to large displays VR environments must not suppress the users' movements. Thus, we don't want to use devices linked to computers using wires like DataGlove or Polhemus.

6.3.1. Novel interfaces for interaction with handheld computers

Participants: Martin Hachet, Joachim Pouderoux, Pascal Guitton.

Recent advances in mobile computing allow the users to deal with 3D interactive graphics on handheld computers. Although the computing resources and screen resolutions grow steadily, user interfaces for handheld computers do not change significantly. Consequently, we designed a new 3 degrees of freedom interface adapted to the characteristics of handheld computers[13]. This interface tracks the movement of a target that the user holds behind the screen by analyzing the video stream of the handheld computer camera. The position of the target is directly inferred from the color-codes that are printed on it using an efficient algorithm. The users can easily interact in real-time in a mobile setting. The visualization of the data is good as the target does not occlude the screen and the interaction techniques are not dependent on the orientation of the handheld computer. We used the interface in several test applications for the visualization of large images such as maps, the manipulation of 3D models, and the navigation in 3D scenes. This new interface favors the development of 2D and 3D interactive applications on handheld computers. We are currently leading experiments for the evaluation of the device.

6.3.2. Real time gesture recognition

Participants: Jean-Baptiste de la Rivière, Pascal Guitton.

We wanted to extract the hand or body posture of an unequipped user from a live video flow to perform interaction in a large display setting. This induced the constraints of a real-time analysis of binary input images. According to a predefined interaction technique, this data will be interpreted to achieve 3D selection, manipulation or navigation. While most of such systems rely on appearance-based approaches, we have chosen to investigate how far a model-based one could be efficient. The real-time algorithm we are developing modifies a 3D hand or body model pose in order for its projection to match the input silhouette. Great tracking speeds were reached, while using several cameras helps to disambiguate the model pose extraction [17] [10]. Further improvements include the integration of a tight collaboration between image-based and model-based approaches.

6.3.3. CAT: a new 6 DOF freestanding input device

Participants: Martin Hachet, Pascal Guitton, Patrick Reuter, Florence Tyndiuk.

The study of the characteristics of the large-displays allows us to propose a set of recommendations for interaction with the VE. From these recommendations, we criticize the existing input devices, and propose a new input device: the CAT (Control Action Table).

The CAT is a 6 degrees of freedom device mixing isotonic and isometric resistance modes. It consists of a freestanding sensitive tabletop, which can be freely oriented in space. The manipulation of this tabletop allows performing 3D tasks as described in [3]. A tablet, fixed on the top, allows performing 2D tasks such as the selection of objects or the control of the system [2]. The CAT design favors a non-constraining, quick and efficient interaction for novice users. This new input device favors the development of real applications using VE visualized on large-displays.

6.3.4. Study of human factors involved

Participants: Florence Tyndiuk, Gwenola Thomas, Christophe Schlick.

The main object of this work is to understand the differences in human performances during travel and manipulation tasks in Virtual Reality. The better understanding of how subjects use virtual reality interfaces can help to construct interfaces more adapted to cognitive users' processes. We have settled a double experimentation that we have performed on one hundred subjects. For each subject, we measure a set of cognitive factors as attention and motor skills and their performances in two virtual reality tasks (manipulation and travel) with two distinct screens (large and small) and the CAT interactor. After a first analysis of the statistical data, a first interesting result dealing with the screen size influence has appeared. The preliminary conclusion is that subjects with lower motor or attentional abilities improve their performances with larger screens whereas the others do not show significant changes when they use distinct screens. With some small adaptations, the experiment can be performed for an analysis of interactions on small devices.

7. Contracts and Grants with Industry

7.1. Easy-Do-It

Participant: Christophe Schlick.

Title: Visualization of tutorials and technical documentations on connected and mobile devices.
Dates: 2003-2005
Overview: The Easy-Do-It company is specialized in the creation and diffusion of multimedia contents for training. They provide the maintenance technician with the documentations and the animations that will optimize their interventions, and the general consumer with tutorials and how-to. Their technology is currently based on some video supports (VHS, SVCD and DVD).

The goal of this contract is to develop a client-server architecture and an adapted streaming algorithm for the diffusion of their multimedia content on PDA. This collaboration is also supported by the EITICA, a technology transfer organism of the Aquitaine Region.
Web: http://www.easy-do-it.com

7.2. France-Télécom

Participants: Kadi Bouatouch, Jean-Charles Quillet, Gwenola Thomas.

Title: Modeling and rendering of non-photorealistic urban environments and digital territories.

Dates: 2004-2005
Overview: This project concerns the modeling and rendering of non-photorealistic urban environments and digital territories. The target platforms for visualization are small devices. We will propose a whole graphic pipeline (data modeling, transmission and rendering) that is adapted to small devices constraints. We will implement a client-server application where the server owns a huge 3D database which is rendered on the client (a small device). As an alternative to photorealistic rendering and texture based rendering which generate large models, we will explore non-photorealistic techniques as line based rendering. Point-based rendering will also be considered. Some multi-resolution models of cities or territories (efficiently transmitted and rendered) will be constructed with those techniques.

8. Other Grants and Activities

8.1. International grants

8.1.1. Associated Team: LIGHT

"Lab for Interactive Graphics on Handheld and Tabletop displays"
Grant: INRIA-DREI
Dates: 2004-2007
Partners: IMAGER Lab - University of British Columbia - Vancouver - Canada

8.1.2. STIC-Asie Project on Virtual Reality

Grant: French Ministery for Foreign Affairs, CNRS, INRIA
Dates: 2004-2005
Partners: France, China, Corea, Japan, Singapore, Taiwan

8.2. Local grants

8.2.1. "Platform for the development of robust multimedia software on connected terminals"

Participants: Pascal Guitton, Xavier Granier, Jean-Christophe Gonzato, Gerald Point.

Grant: Conseil Régional d'Aquitaine
Dates: 2003-2004
Partners: Compose project (INRIA Futurs), Test Team (LaBRI), SOD Team (LaBRI), IPARLA
Overview: This project aims at conceiving a software platform for the development of multimedia applications on mobile terminals. We are focusing on the conception of a server, which distributes data to the mobile terminals.

8.3. National grants

8.3.1. PERF-RV: "French Platform for Virtual Reality"

Participants: Pascal Guitton, Martin Hachet, Jean-Baptiste de la Rivière, Gerald Point.

Grant: RNTL ("Réseau National des Technologies Logicielles" - French Ministry of Research)
Dates: 2000-2004
Partners: IRISA, CEA LIST, Ecole des Mines Paris, Image Institut, LRP, LIMSI, ADEPA, Clarté, Dassault, EADS, EDF, Giat, IFP, PSA, Renault, PSA, LaBRI
Overview: This project aims at conceiving a technical platform enabling the development of Virtual Reality Applications. We are focusing on the 3D interaction tasks, and more precisely on the interaction with applications performed on large displays like Reality Centers.
Web: http://www.telecom.gouv.fr/rntl/FichesA/Perf-Rv.htm

8.3.2. EPSN: "Computational Steering Environment for Distributed Numerical Simulations"

Participants: Pascal Guitton, Christophe Schlick, Gwenola Thomas, Florence Tyndiuk.

Grant: ACI GRID ("Action Concertée Incitative Globalisation des Ressources Informatiques et des Données" - French Ministry of Research)
Dates: 2002-2004
Partners: Scalapplix (INRIA Futurs), IECB (Bordeaux 1, Bordeaux 2, CNRS, INSERM), SRSMC (UMR CNRS), SMEL (Montpellier 2), LaBRI
Overview: This project aims at conceiving a framework enabling the fusion between numerical simulations and Virtual Reality. We are focusing on the driving of the simulation using virtual reality techniques and peripherals.
Web: http://www.labri.fr/Recherche/PARADIS/epsn/

8.3.3. Show

Participants: Christophe Schlick, Patrick Reuter, Irek Tobor, Xavier Granier.

Grant: ACI "Masse de données" (French Ministry of Research)
Dates: 2003-2005
Partners: Grenoble, Nancy, Sophia, IPARLA
Overview: The goal of this collaboration is to develop a software architecture for the 3D visualization of very large dataset (more than hundred millions of polygons or points). IPARLA has in charge the client-server architecture for the data streaming, and also the point-based rendering.

8.3.4. GRINTA

Participants: Pascal Guitton, Gerald Point, Xavier Granier, Jean Eudes Marvie.

Grant: GRID 5000 (French Ministry of Research and Coneil Général d'Acquitaine)
Dates: 2003-2004
Partners: RunTime (INRIA Futurs), Scalapplix (INRIA Futurs), SOD (LaBRI), IPARLA
Overview: This project aims at developing a large PC grid on French territory. We are focusing on the development of a specialized PC cluster for the visualization of large and complex data.
Web:http://www-sop.inria.fr/aci/grid/public/

8.4. European grants

8.4.1. ENTHRONE: "End-to-end QoS through Integrated Management of Content, Networks and Terminals"

Participants: Kadi Bouatouch, Gwenola Thomas.

Grant: PCRD 6 (6th -European Framework Program)
Dates: 2003-2007
Partners: Thalès, France Telecom, TDF, Optibase, EPFL, IPARLA, etc.
Overview: This project aims at developing an integrated management solution which covers an entire audio-visual service distribution chain, including content generation and protection, distribution across heterogeneous networks and reception on user terminals. Our contribution concerns the generation, transmission and rendering of 3D models. The 3D model representation will adapt to the network performances.

9. Dissemination

9.1. Participation to the Scientific Community

9.1.1. Participation to conference organization

Members of IPARLA have been involved in number of program committee and organizing committee for conferences:

- Shape Modeling International 2004 and 2005, Eurographics 2004: program committee (Christophe Schlick)
- Eurographics 2004, Eurographics Symposium on Virtual Environments: program committee (Pascal Guitton)
- Graphics Interface 2004 and 2005: program committee (Xavier Granier)

They have also participated to the reviewing process for conferences (Siggraph 2004, Eurographics 2004, Graphics Interface 2004, ACM User Interface Software and Technology 2004) and journals (The Visual Computer).

Christophe Schlick is also member of the editorial board of the journal Computer Graphics Forum (Eurographics).

Pascal Guitton is also member of the editorial board of the book: "Le traité de la rélaité virtuelle" (3rd edition)

9.1.2. Committees

Pascal Guitton is:

- member of the leading committee for RTP number 7 Image Synthesis, Visualization and Virtual Reality (RTP for "Réseau Thématique Pluridisciplinaire" - CNRS)
- member of the scientific committee of GRID 5000 projects (French Ministry of Research)
- member of the scientific committee of INRIA Futurs
- correspondent for the "formation doctorale" at the INRIA Futurs.
- member of the jury for the SPECIF PhD thesis award
- member of the scientific committee of Visitor project (Grenoble, Marie Curie action)

Christophe Schlick is a member of the scientific committee for GDR Algorithmique, Langages et Programmation (CNRS).

Gwenola Thomas is a member of the administrating committee of the AFIG.

Xavier Granier is a member of the specialist committee of the University Bordeaux 1.

9.1.3. Expertise

The expertise of some members has been required for

- Comité d'évaluation du LORIA (Nancy, CNRS, INRIA): Pascal Guitton
- Comité d'évaluation de la Fédération de Recherche "Physique et image de la ville (Nantes, CNRS, Ecole Centrale, Ecole des Mines, Ecole d'Architecture, LCPC, CSTB): Pascal Guitton
- ACI "Masses de données": Christophe Schlick and Gwenola Thomas
- Evaluation of the ARTIS Project and the EVASION Project (INRIA Rhône-Alpes): Christophe Schlick

9.2. Teaching

In complement of the normal teaching activity of the university member (at the University Bordeaux 1 and the University Bordeaux 2), Xavier Granier have participated to the "Image Synthesis" Master course and have prepared and teached the "Shading Language" course of "License Pro".

9.3. Participation to Conferences and Seminars, Invitations

The project members have participated to number of international workshop and conferences (cf and national ones (cf [17][11][14]). [12][21][5][7][16][9][15][8][2][3]) and national ones (cf [17][11][14]).

They also have been invited for seminars by the CEA/CESTA (Xavier Granier - "Méthodes Hiérarchiques de Radiosité en Image de Synthèse").

Xavier Granier have also been invited to do an on-line scientific presentation for INRIA [20].

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