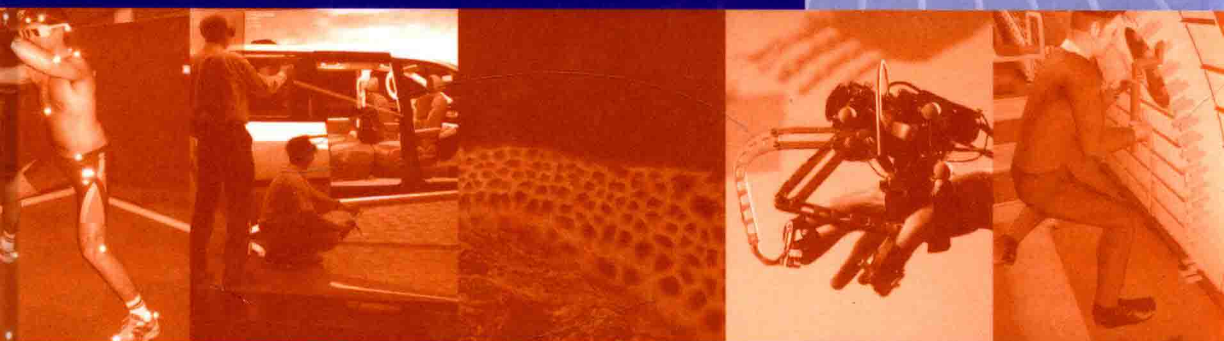
Virtual Reality: Concepts and Technologies



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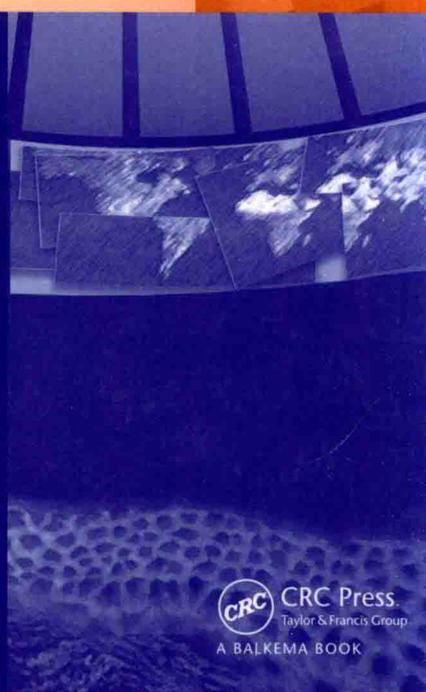

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Virtual Reality: Concepts and Technologies

Editors

Philippe Fuchs
Ecole des Mines, ParisTech, Paris, France

Guillaume Moreau
Ecole Centrale de Nantes, CERMA, Nantes, France

Pascal Guitton
INRIA, University of Bordeaux I, Bordeaux, France

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Virtual Reality: Concepts and Technologies

Preface

Virtual reality has developed in France and in the rest of the world over the last twenty years. It potentially opens up new perspectives for our society. But let's be realistic – first of all, virtual reality creates many scientific challenges for researchers and professionals. Being aware of the immensity of the task at hand, we have participated enthusiastically in helping virtual reality in France blossom. For our part, Philippe Fuchs and Guillaume Moreau conducted theoretical and applied research on the interface of the subject in a virtual environment at the Ecole des Mines de ParisTech. Pascal Guitton conducted research on virtual reality applications at LaBRI.

Providing information about the advances in this field was our task during our research work. Philippe Fuchs wrote his first book *"les interfaces de la réalité virtuelle" (Interfaces of virtual reality)* in 1996. Realising that no recent book was available in French, Guillaume Moreau, Jean-Paul Papin and Philippe Fuchs wrote the first edition of the "*Traité de la Réalité Virtuelle*" *(Treatise on Virtual Reality)* in 2001. However, no researcher can ever have a precise, essentially interdisciplinary knowledge of all the sectors of virtual reality. We wanted other French researchers to participate in writing the second edition of the treatise. Their support was obtained all the more easily as all these researchers were already collaborating in common projects, including the PERF-RV platform. New chapters are written by the researchers of ENIB, IRISA, INRIA, AFPA, Ecole des Mines de ParisTech and CNRS.

In this open framework of exchanges and collaborations, we intended to continue our collective work of writing a third, relatively complete and more interdisciplinary edition. To complete this third, larger edition, we set up an editorial committee of experts on virtual reality coming from different disciplines:

- Bruno Arnaldi, Professor and researcher at INRIA;
- Alain Berthoz, Professor at the Collège de France and member of the Académie des Sciences;
- Jean-Marie Burkhardt, reader at Paris V university;
- Sabine Coquillart, Project leader at INRIA;
- Philippe Fuchs, Professor at Ecole des Mines de ParisTech;
- Pascal Guitton, Professor and researcher at INRIA;
- Guillaume Moreau, Associate Professor at Ecole Centrale de Nantes;
- Jacques Tisseau, Director of ENIB at Brest;
- Jean-Louis Vercher, Professor at Aix-Marseille University.

The task of this editorial committee, headed by Philippe Fuchs, was to organise the contents, suggest authors and ensure coherence in the work. The members of the committee have ensured that the discourse is homogenous so that the book is accessible to readers of different disciplines and at the same time has an interdisciplinary content.

This collective work divided in four volumes was supervised by Philippe Fuchs and coordinated by Guillaume Moreau. Each volume was coordinated by two members of the committee.

The fifth volume "Les humains virtuels" (Virtual Humans) was written in 2009 to complete the treatise on virtual reality. The coordination of the fifth volume was entrusted to:

- Stéphane Donikian, Research scientist at INRIA, manager of the Bunraku team of IRISA.

The committee defined the objectives of the treatise, a manual meant for both designers and users of virtual reality. The aim of this treatise is to present them, in as complete a manner as possible, with the current state of the knowledge on virtual reality in the following domains: computer science, mechanics, optics, acoustics, physiology, psychology, ergonomics, ethics, etc. It aims to be the reference book of the domain and a design guide to help the reader in constructing his virtual reality project. Its second aim is to formalise original thought and to help in the conceptualisation of this discipline.

At the instigation of Pascal Guitton, the book was then partially translated into English and Chinese to offer a reference book to the non-French-speaking readers. It also enables to make the French research in this field known internationally.

We would first like to thank the coordinators, the members of the editorial committee, without whom the third edition would not have been possible and whose reputation helped us unite the French community from this domain to make this collective work a reality. We also thank all 101 authors who have written the 83 chapters of the treatise. We thank them for taking out time from their busy work schedules to write, generally collectively, the concise and pertinent chapters on their sector of research or activity. We know that it would not have been possible to fulfil the objective of creating a veritable treatise on virtual reality without their acceptance and enthusiasm. This treatise is supplemented with photographs and information provided by various companies; we thank them for their contribution.

We also thank the publisher, the Press of the Ecole des Mines and its manager Ms Silvia Dekorsy, who helped us in completing this third edition and patiently devoted the time required to read, correct and improve more than 2000 pages of this voluminous book.

The treatise on virtual reality is the result of an ambitious and federal editorial project. We hope that you, the readers of this treatise, will like it, because we have enjoyed writing it with the other authors and conveying our ideas.

Philippe Fuchs, Guillaume Moreau and Pascal Guitton

About the editors

Virtual Reality and Augmented Reality Team of Mines ParisTech

Mines ParisTech VR & AR Team's research main topic (leader: P. Fuchs) is the theoretical approach of Virtual Reality and the industrial VR & AR applications. The team's expertise focuses on human behavioural interfacing with virtual worlds. Our objective is to provide the industry with methodology and rationales for the use of virtual reality in their business. Our main partners are automotive manufacturers and suppliers (Renault, Peugeot, Valeo, Visteon), French railway company (SNCF), health centers, etc.

In partnership with automotive manufacturers and suppliers, we took part in a project whose aim is to simulate the interior of a car in order to study the design and ergonomy of the driver's interfaces.

Our scientific work focuses on:

- Research about theoretical approach of Virtual Reality with our Immersion and Interaction methodology: the "3I^2 model";
- Improving stereoscopic vision and reducing user fatigue in stereoscopic displays through the processing of spatial frequencies using wavelets. The approach is validated through comparison tasks between virtual models and corresponding real objects;
- Modifying product design directly inside the immersive environment. This consists in efficiently coupling the potentialities of CAO and RV, particularly with the exchange of CAO models and RV models, via the 3DXML standard;
- Improving behavioural interfaces for user experiences in a virtual store for marketing experiments, with the objective to make consumer behavior studies in the virtual store;
- With the PERF-RV2 platform, we have been studying, with car manufacturers, the optimization of the configurations of force feedback interfaces for the total immersion of a body. An application has been developed for the optimization of the configuration of a cable interface;
- Training in virtual environment. This is interesting because the activities can be executed without danger and with different difficulty levels. Such applications were proposed in collaboration with the SNCF, the French railway company.

List of authors

Claude Andriot, CEA – LIST, France, www-list.cea.fr/, E-mail: claude.andriot@cea.fr

Dominique Bechmann, LSIIT, UMR 7005 CNRS-ULP Strasbourg, France, http://dpt-info.u-strasbg.fr, E-mail: bechmann@dpt-info.u-strasbg.fr

Mohamed Benali, CEA – LIST, France, www-list.cea.fr/, E-mail: mohamed.khoudja@cea.fr

Jean-Marie Burkhardt, LEI, Paris Descartes University, France, www.psycho.univ-paris5.fr/lei, E-mail: jean-marie.burkhardt@univ-paris5.fr

Sabine Coquillart, INRIA Rhône Alpes, France, http://www.inria.fr, E-mail: Sabine.Coquillart@inria.fr

Lionel Dominjon, CLARTE, France, www.clarte.asso.fr, E-mail: dominjon@ingenierium.com

Philippe Fuchs, Ecole des Mines, ParisTech, Paris, France, E-mail: philippe.fuchs@mines-paristech.fr

Florian Gosselin, CEA – LIST, France, www-list.cea.fr, E-mail: florian.gosselin@cea.fr

Jérôme Grosjean, LSIIT, UMR 7005 CNRS-ULP Strasbourg, France, http://dpt-info.u-strasbg.fr, E-mail: grosjean@dpt-info.u-strasbg.fr

Pascal Guitton, INRIA, University of Bordeaux I, Bordeaux, France, E-mail: guitton@labri.fr

Martin Hachet, LABRI, INRIA, France, www.labri.fr, E-mail: hachet@labri.fr

Moustapha Hafez, CEA – LIST, France, www-list.cea.fr/, E-mail: moustapha.hafez@cea.fr

Abderrahmane Kheddar, LIRMM, CNRS, France, www.lirmm.fr, E-mail: kheddar@ieee.org

Domitile Lourdeaux, Heudiasyc – UTC, France, www.hds.utc.fr, E-mail: domitile@hds.utc.fr

Hervé Mathieu, INRIA Rhône Alpes, France, www.inrialpes.fr, E-mail: herve.mathieu@inrialpes.fr

Daniel Mestre, CNRS, Méditerranée University, Marseille, France, www.laps.univ-mrs.fr, E-mail: daniel.mestre@univmed.fr

Philippe Meseure, SIC, University of Poitiers, France, www.sic.sp2mi.univ-poitiers.fr, E-mail: meseure@sic.sp2mi.univ-poitiers.fr

Guillaume Moreau, Ecole Centrale de Nantes, CERMA, Nantes, France, E-mail: guillaume.moreau@ec-nantes.fr

Jean-Paul Papin, E-mail: j.papin@wanadoo.fr

Mathias Paulin, IRIT, Toulouse, France, www.irit.fr, E-mail: Mathias.Paulin@irit.fr

Bernard Péroche, LIRIS, Claude Bernard University, UMR 5205 du CNRS, France, E-mail: bperoche@liris.cnrs.fr, liris.cnrs.fr

Ludovic Sterngerber, LSIIT, UMR 7005 CNRS-ULP Strasbourg, France, http://dpt-info.u-strasbg.fr, E-mail: ludovic.sterngerber@dpt-info.u-strasbg.fr

Jean-Louis Vercher, CNRS, Méditerranée University, Marseille, France, http://www.laps.univ-mrs.fr, E-mail: jean-louis. vercher@univmed.fr

The French Association for Virtual Reality and Mixed Reality

Founded by researchers and experienced professionals from the industry, the French Association for Virtual Reality and Mixed Reality (AFRV) wishes to unite the French community of academics and professionals on the theme of virtual reality. Its purpose is to:

- Promote and encourage the development of virtual reality, mixed reality and 3D interaction in all their aspects: teaching, research, studies, developments and applications;
- Build a channel of communication between those interested in this domain;
- Make this community known to French, European and international institutions.

The association is formed by members, who can be either individuals or legal entities. The members are divided into different colleges depending on their legal and/or occupational status. These colleges are:

- College 1: Individuals working in the field of virtual reality: teachers, researchers, engineers, developers and students;
- College 2: Teaching and research institutions: Universities, National Centres, Schools, Institutes, Laboratories, etc.
- College 3: Private organisations in the industrial, commercial or other sectors.

A board of directors is responsible for the organisation of the association and its activities.

AFRV days are organised each year to evaluate the latest research works and discuss the current and future professional applications.

The members receive a newsletter titled "Rêveries", informing them about events related to virtual reality and mixed reality, job offers, advances in research and new products. It also serves as a platform for exchanging ideas. The association has also created a website. A blog for discussions and information is accessible on this website. To become a member visit our website **www.afrv.fr**

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