Product Engineering
Product Engineering

Tools and Methods Based on Virtual Reality

by

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PREFACE

This book contains an edited version of the lectures and selected contributions presented during the Advanced Summer Institute on “Product Engineering: Tools and Methods based on Virtual Reality” organized at Chania (Greece) in the period 30th May-6th June 2007. The Advanced Summer Institute (ASI) was organized in the framework of the European FP6 funded project “VEGA – Virtual Reality in Product Design and Robotics” and was devoted to the Product Engineering field, with particular attention to the aspects related to the Virtual Reality (VR) technologies, its use and added value in engineering.

The objective of the ASI was to create a meeting framework for leading scientists with PhD holders and advanced PhD students carrying out research in the field of Virtual Reality Technologies, Haptic systems, CAD and VR integration, Virtual Testing and Prototyping and Virtual Manufacturing. The aim was to create conditions for high level training through a series of 15 invited lectures presented by world reputed scientists, as well as to give possibilities for young researchers to present their achievements and to establish professional contacts. The ASI was seen also as an opportunity for academics, practitioners and consultants from Europe and elsewhere who are involved in the study, management, development and implementation of product engineering principles in the learning and teaching sectors, as well as professionals to come together and share ideas on projects and examples of best practice.

Out of the invited lectures, the ASI programme included a number of contributions from the other participants. In total, the event was attended by about 60 participants from 9 countries.

The topics covered areas of Product Engineering including new aspects related to the environmental issues, i.e.:

– Virtual Reality Technologies,
– Haptic Systems,
– Virtual Reality Aided Design,
– Virtual Testing and Prototyping,
– Virtual Manufacturing

As in the first ASI edition held in Romania in 2004, the topics have been chosen such as to bring together scientists from traditionally distinct
areas of research such as Virtual Reality and Product Engineering, in order to catalyze cross-fertilization and enable new ideas in an interdisciplinary framework.

The lectures included in the book have been presented as tutorials as well as state of the art papers in the respective areas, providing thus a good overview of the current work in the field. Therefore it addresses a wide range of readers, from students to professors, from industrial experts to the researchers.

The publication of this book has been possible thank to the kind support from the European Commission within the Fifth Framework Programme for research and scientific development support project “VEGA”. For this reason the ASI Directors express hereby their full gratitude. The support from the Transilvania University, “INTUITION” Network of Excellence and all the other partners in the project VEGA is also acknowledged.

Brașov and Athens,
August 2007.

Doru Talabă and Angelos Amditis
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INTRODUCTION

In the last years, Virtual Reality (VR) became a technology with mature developed devices that have been used in a series of successful demonstrations. Nowadays, a wide range of technologies is available on the market e.g. CAVE systems, reality theatres, power walls, holobenches, individual immersive systems, as well as mixed reality technologies, haptic devices and speech systems. Moreover, while the technical systems have improved and diversified, the price of the commercial versions continuously decreased, growing thus the system’s popularity among the users, in particular within the industrial sector.

At the same time, the Computer Aided tools for engineering purposes (so called CAX software) currently available on the market have dramatically improved and diversified covering practically the entire product life cycle applications. However, the interaction with the user within this software is made in most cases via the CRT/LCD display and mouse which are just 2D devices. While the geometric database is 3D since long time, including now extended information, attributes and knowledge, the interaction technology has not significantly changed since the years’80s.

Virtual and Augmented Reality are broadly considered as the next-generation of man-machine interface. During the last two decades the VR research community proposed various technical solutions and developed different interaction modalities. The following issues have been addressed and partially solved in different research projects: interaction and pointing anisotropy, ergonomic and user fatigue, bimanual input exploitation, multimodal input optimization, effective perception and feedback of the virtual model.

The Advanced Summer Institute on “Product Engineering: Tools and Methods based on Virtual Reality” focused on these topics with a particular attention paid to the aspects relevant for the usability and added value of Virtual Reality Technologies in Product Engineering. In this context, the book is structured on five chapters, covering the topics of Virtual Reality Technology, Haptic systems, Virtual Reality Aided Design, Virtual testing and Prototyping and Virtual Manufacturing.
Virtual Reality is the first topic of the book. Since 90’s these technologies significantly diversified and are now available in commercial versions at lower prices, affordable even for small and medium sized enterprises. This subject included three lectures and three selected contributions that offer a good overview of the available technologies as well as possible paths for integration in the context of multimodal interfaces.

Haptic Systems, as one of the most popular branches of VR, dealing with the force feedback based interaction, has been devoted a lot of research effort lately. This is the reason for which a separate section was reserved to this issue including two lectures and four selected contribution focusing mainly on the design and development of such interfaces.

Virtual Reality Aided Design represents the next step expected in the evolution of traditional CAD systems, the user interfaces of which are supposed to change dramatically. This chapter includes recent achievements in 3D integration that are likely to lead to new paradigms of conceptual design that are of crucial importance for the next generation of CAD systems. The industrial relevance of this topic is widely illustrated in the first lecture coming from the world of industry. At the same time new VR concepts, tools and methods for the interaction between the user and the CAD environment have been presented.

Virtual Testing and Prototyping are considered already as parts of Product Engineering. For the Advanced Summer Institute (ASI) and this book, the Virtual prototyping applications developed in the Industrial environment have been of particular interest. From the systematic and tutorial presentation of the Virtual Prototyping models to complex applications in multi-physics and real time simulation, a wide area was covered.

Virtual Manufacturing is another important field of the Product Engineering and was included in the book with two invited lectures and four selected contributions. Recent advances in this area are presented e.g. assembly planning and manufacturing tasks analysis.

New advances in VR – Product engineering integration are now on the way to produce changes in the entire product life cycle chain. Taking into account the state of the art and the contemporary needs, the above content is proposed under the title of the book “Product Engineering: Tools and Methods based on Virtual Reality”, which addresses a wide audience in the engineering profession as the development engineers and practitioners, researchers, managers, academic staff, PhD and master students.

Doru Talabă and Angelos Amditis