SPECIAL THEME: COMPUTER GRAPHICS AND VISUALIZATION
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Graphics and Visualization: Breaking New Frontiers

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From the early graphical applications such as flight simulators, to today's stunning special effects in movies, computer graphics have had a significant impact upon the way computers have been used to represent and visualize the world. There are many big problems left to be solved, some of which are reflected in the following pages of this issue.

The two core issues in the past in computer graphics and visualization, have been Modelling, ie capturing and representing the geometry and topology of virtual objects, and Rendering, which is the process of producing a realistic image from such models. Although amazing advances have been made in both these domains, research is still extremely active as the quest for true realism, and not just photorealism, continues. Increasingly, extremely large 3D datasets or models are required and the level of accuracy, and hence the complexity, of such models is growing dramatically. The article by Francois Sillion and Cyril Soler discusses a new application of the radiosity rendering technique which allows accurate simulations of very large plant models. Another reason for this explosion in model size is the improvement of the devices for the rapid acquisition of 3D digital models eg the non-invasive scanning devices widely used in medical imaging and in industrial inspection, or the optical 3D scanning devices which can be used to acquire the surface properties of real objects. The contribution by Holly Rushmeier describes ongoing research into 3D scanning systems at IBM Watson Research.

Visualization might also seem a rather consolidated field. Many techniques have been proposed in the last ten years for managing different data (surfaces, volumes, scattered points, vector fields, etc). Users have access to a wide range of visualization modalities which allow sophisticated and differentiated insights of the data to be obtained. Consequently, visualization is a crucial communication and analysis tool in the design and simulation of many new products or systems. In the field of medicine, visualization has the potential to radically change the way that health is administered, and significant progress has been made to date. Andreas Koenig and Eduard Groeller from the Technical University of Vienna have contributed an overview of their group’s work in this important field. Even if visualization technology has reached a rather mature state, research in the field is still very active with the aim of: extending the potentialities of the visualization techniques, developing new approaches for interacting with and navigating the data, and improving efficiency. The search for more space- and time-efficient solutions is still a basic goal, because the impressive performance improvement of computing systems is counterbalanced by the increasing scale and complexity of the problems to be managed.

The advent of low-cost 3D graphics systems based on the PC architecture makes high-quality, real-time Interactive Graphics a ubiquitous and affordable resource. A powerful 3D graphics platform is now on the desk of anyone, from the scientist to the student. New games console hardware provides un-precented support for real-time animation and rendering at a relatively low cost, bringing cutting-edge 3D graphics into millions of homes around the world. Many of the advances in this area are based on the results of

pioneering graphics research. A big challenge in the future, is to capture this technology, and to use it for other purposes, such as desktop VR for education, art and entertainment. For this to happen, real-time graphical systems need to achieve levels of realistic image synthesis only achieved in the past with very computationally expensive rendering techniques such as path-tracing and radiosity. The animation of objects needs to be based on physical models, and entities in the world should be endowed with behaviours so that they can interact convincingly with the user. The performance/cost ratio may have improved considerably, but such computational power is still not possible on low-end platforms. Therefore, techniques which use multiresolution models, and levels of detail for all aspects of simulation, are becoming increasingly important.

New frontiers for visualization and interactive 3D graphics are opened by the rise of Virtual Reality environments (CAVEs, workbenches, data walls) which can greatly enhance the way that users analyze data or objects, or navigate a virtual world. Large tiled displays will be available at a low cost in the near future, and applications requiring cooperative analysis of data or navigation could benefit from these devices. Augmented reality allows graphical images to be superimposed on a real scene, either by projecting them onto real objects such as walls, or by viewing such virtual object with see-through glasses. An exciting future development will be the incorporation of real people into a virtual world, as in the blue-c project described by Markus Gross and Oliver Staadt in this issue.

Europe is a primary player in the domain of Graphics and Visualization. This is proved by the many research projects active on these topics in European laboratories, and ERCIM institutions support many of these research initiatives. The contributions collected for this Special Issue give only a partial view of the many research projects active in this domain. Nevertheless, the spectrum of applications and topics covered by the contributions is notably wide: basic modelling techniques (classical techniques, level of detail techniques, 3D scanning), rendering techniques (texture-based graphics, image-based modelling of BRDF), classical animation and non-photorealistic rendering, physically-based simulation, virtual reality and haptic interfaces, augmented reality, 3D medical imaging, molecular modelling, information visualization, visualization for simulation and training, and more. It is clear that this will remain a significant area of activity for ERCIM institutes well into the future, and we hope that you gain as much enjoyment from reading about these vibrant and exciting research activities as we have while coordinating this special issue.