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First Special Issue on "Computer Graphics and Geometric Modeling" (2008)
Selected Papers from CGGM'2007 Workshop

Editorial
IJCISIM Special Issue on "Computer Graphics and Geometric Modeling" Selected Papers from CGGM'2007 Workshop

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1 Introduction

It is my pleasure and a great honor to introduce this IJCISIM Special Issue on Computer Graphics and Geometric Modeling based on (but not confined to) the papers accepted for the *"Sixth International Workshop on Computer Graphics and Geometric Modeling - CGGM'2007"* held at the Graduate University of the Chinese Academy of Sciences, Beijing (China), May 27-30 2007. Although computer graphics and geometric modeling are two of the most dynamic and outstanding new areas in Computer Science, they barely appear as major themes in general computational science journals. This is not certainly the case for the *International Journal of Computer Information Systems and Industrial Management Applications, IJCISIM* journal; conversely, IJCISIM Editor-in-Chief, Prof. Khalid Saeed immediately recognized their importance and kindly accepted my proposal to edit a special issue devoted to selected papers from the CGGM'2007 workshop. I am very grateful to the IJCISIM staff, and especially to its Editor-in-Chief Prof. Khalid Saeed, for having given me the opportunity to collect some of the most recent developments in these fields and to publish them in this special issue.

Until recently, computer graphics was seen as a field whose requirements (expensive display devices, substantial computer resources, etc.) far exceeded those commonly available for computer scientists and researchers. Fortunately, in the last few years, the situation has changed dramatically: the field has greatly benefited from many spectacular developments in hardware and software leading to a drastic reduction in the hardware price/performance ratio and the appearance of powerful, high-level device-independent graphics packages and libraries. Nowadays, computer graphics is unanimously recognized as a major field in computer science with remarkable applications in a number of areas as diverse as science, engineering, medicine, business, education, advertising, entertainment, etc. In fact, almost every time we use a computer we are also using computer graphics since most computer programs, including the most popular operating systems, typically have a graphical user interface.

Another exciting computer science field is that of geometric modeling. Strictly speaking, it is defined as a collection of methods to describe geometric characteristics of an object [6]. However, its most comprehensive meaning (which is also assumed in this issue) often includes the representation of curves and surfaces by using computers, a field usually referred to as *Computer Aided Geometric Design (CAGD)*. Geometric modeling is a fundamental tool in many CAD/CAM settings, with outstanding applications in (among many others) the automotive, aerospace and shipbuilding industries, scientific simulations and visualization, computer animations, robotics, etc.

2 On the CGGM - Computer Graphics and Geometric Modeling Workshop

Seven years ago, some researchers decided to organize a series of international conferences (consisting of a set of workshops and technical sessions along with a general track) on all aspects of computational science. The first edition of this annual conference was held in San Francisco in 2001 under the name of International Conference on Computational Science, ICCS [1]. After the success of this conference, subsequent editions were held in Amsterdam (The Netherlands) in 2002, Saint Petersburg (Russia) and Melbourne (Australia) - a single event held at two different locations - in 2003, Krakow (Poland) in 2004, Atlanta (USA) in 2005, Reading (UK) in 2006 and Beijing (China) in 2007. The next edition will take place again in Krakow (Poland), June 23-25 2008 [5].

After participating in ICCS'2001, I realized that no special event devoted to either computer graphics or geometric modeling had been organized at that conference. Aiming to fill this gap, I proposed a special session on these topics to the ICCS'2002 organizers. Their enthusiastic reply encouraged me to organize the First International Workshop on Computer Graphics and Geometric Modeling, CGGM'2002 [2]. A total of 81 papers from 21 countries were submitted to the workshop and then reviewed by, at least, two referees each. As a result, 35 high quality papers were finally accepted and published by Springer-Verlag in its Lectures Notes in Computer Science series, vol. 2330.

This great success and the positive feedback of authors and participants motivated that CGGM became an annual

event on its own. Subsequent editions were held as follows: CGGM'2003 in Montreal (Canada), CGGM'2004 in Krakow (Poland), CGGM'2005 in Atlanta (USA), CGGM'2006 in Reading (UK) and CGGM'2007 in Beijing (China). All of them were published by Springer-Verlag, in its Lecture Notes in Computer Science series, volumes 2668, 3039, 3515, 3992 and 4488 with a total of 52, 24, 22, 22 and 20 contributions, respectively. In addition, one Special issue has been published in 2004 in the *Future Generation Computer Systems - FGCS* journal [4].

The *"Seventh International Workshop on Computer Graphics and Geometric Modeling, CGGM'2008"* will take place at the ICCS'2008 conference in Krakow (Poland), June 23-25 2008. For details about this seventh edition of the worshop, please refer to [3].

3 Special Issue Contents

The 6 contributed papers in this special issue have been selected to provide IJCISIM readers with an overview on some of the most interesting problems involved in computer graphics and geometric modeling. The different topics and questions analyzed in these papers reflect clearly the diversity of interests, methods and techniques involved.

The first paper, by *J. Flórez, M. Sbert, M.A. Sainz* and *J. Vehí* concerns the problem of aliasing for ray traced surfaces. Ray tracing is a classical illumination technique able to produce high-quality, photo-realistic images. While this method aims at reproducing the real process of vision that happens in nature, some *artifacts* typically appear in our computer-generated images. Such artifacts, usually referred to as *aliasing*, occur because of computers' inability to perform floating point operation robustly. The design of good, reliable algorithms to remove (at least partially) those artifacts, usually known as *antialiasing* techniques, has been a major field of research in computer graphics for many years.

In their paper, Flórez *et al.* introduce a new antialiasing technique for ray tracing of implicit surfaces. The method relies on the interval arithmetic and requires a function to evaluate a beam of rays instead of individual rays. The proposed strategy is adaptive: the method analyzes the coherence of those sets of neighboring rays in a pixel to detect variations over the hit surface. If such variations are not small enough, the area of the pixel is subdivided and the process is started over the new sub pixels. The subdivision continues until the variations over the surface are small. The paper reports better visualization results than those obtained with traditional interval ray tracing methods (see, for instance, Figures 6, 7 and 8 in that paper).

The simulation of natural phenomena has been one of the most classical - and challenging - problems in computer graphics. Natural phenomena cannot be represented accurately by using only smooth surfaces or solid modeling primitives. Their intricate nature soon captured the attention of the computer graphics community. Nowadays, a number of research groups are trying to simulate those phenomena by applying more and more complicated theoretical models in order to obtain realistic replicas of their behavior.

In this context, the second paper, by *N. Lee, N. Baek* and *K.W. Ryu* presents a new real-time method to generate synthetic images of ocean waves. Their approach is based on a precise ocean wave model in oceanography, the Texel, Marsen and Arsloe (TMA) model. In their contribution, the authors implemented this method for computer animation purposes, obtaining a rate of more than 50 frames per second on an Intel Core 2 Duo 2.4 GHz personal computer. The proposed technique uses several parameters such as depth of sea, fetch length and wind speed, so that different ocean waves under different conditions can readily be generated.

The third paper by *E. Roanes-Lozano* and *E. Roanes-Macías* is of a more geometrical basis. In particular, the authors report some results in geometry plane whose truthfulness is strongly dependent on the base field considered. They examine a simple example of a geometric theorem whose geometric configuration can be easily constructed by rule-and-compass. Amazingly, such a theorem is always true in the real case while is "almost always" false in the complex case. For their discussion the authors use computer algebra and computer geometry systems. Their results show clearly that a careful approach should be taken with regards to checking geometric theorems by computer. As shown in the paper, even for apparently simple cases that can be constructed by unsophisticated geometric tools (i.e. rule and compass), the results might "behave" in a completely different way, depending on the base field considered.

Point-based methods are becoming more and more important in computer graphics during the last few years. The rapid development of powerful technology for point acquisition (notably 3D laser scanning devices) and the fact that point-based models are simple to understand and easy to store yet very efficient and highly flexible have changed the way those models are regarded by computer graphics researchers and practitioners.

In their paper *Z. Su, X. Zhou, X. Liu, F. Liu* and *X. Shi* propose a novel physically-based modeling method for point-sampled surfaces based on the mass-spring system. First, the original point-sampled surface is simplified by using a Delaunay-based simplification algorithm. Since no explicit connectivity information is known for the refined point-sampled surface, traditional mass-spring system approach can not be applied directly. To address this problem, tangent planes and projection are applied. Then the mass-spring system for the refined point-sampled surface is generated locally. Finally, the deformed point-sampled surface is obtained by transferring the deformation of the simplified point-sampled surface. Some interesting examples of deformed point-based surfaces are given. They illustrate the possibilities of the proposed method. The reader is suggested to take a look at Figures 6 and 7. The guest editor thanks the authors for their proposal of a CGGM'2007 logo,

as displayed in Figure 8 of their paper.

The paper by *A. Cobo, A. Gálvez, J. Puig-Pey, A. Iglesias* and *J. Espinola* concerns the problem of surface reconstruction. This problem appears very often in applied domains, such as the construction of car bodies, ship hulls, airplane fuselages, and other free-form objects. A typical example comes from the so-called *Reverse Engineering* where free-form curves and surfaces (usually obtained either from optical or from tactile scanning) are extracted from clouds of data points.

In that paper, given a cloud of 3D data points, the authors' goal is to construct a smooth surface that approximates the cloud of data points as much as possible, in the sense of least-squares. Of course, many methods have been reported in the literature to solve this problem. Among them, those based on heuristic approaches are gaining increasing attention during the last few years because of their ability to handle optimization problems with a great number of unknown variables. In that paper, two heuristic techniques, namely genetic algorithms (GA) and particle swarm optimization (PSO) are combined with the classical least-squares approximation scheme to fit 3D data points by means of free-form parametric curves and surfaces. Some examples for the case of Bézier curves and surfaces are provided. They show that the proposed methods perform well (with PSO outperforming GA for the examples discussed) for the parameterization problem, i.e. obtaining a suitable parameterization of the data points.

The last paper by *C. Otero, C. Manchado* and *R. Arias* focuses on a very interesting problem in Civil Engineering: the visual impact that a new work can produce on the environment. It is obvious that any new civil work will alter the surrounding areas while yielding a new visual appearance when viewed from the distance. However, not all points are similarly affected by the new construction. This idea leads to the concept of "visual quality" to account for specific points or areas where the "quality" of the landscape view is optimal, according to some prescribed criteria. In their paper, the authors seek for the most representative scenes of the alteration caused by the new work. The ultimate goal is to determine a collection of pairs (Camera Point, Target Point), satisfying the criteria of maximum impact on the landscape and maximum potential interest for the observer. Such pairs are described as solutions such that it is guaranteed that one looks at an area with maximum landscape impact (the target point) from a point where the amount of potential observers might be the highest (camera point).

In their paper, the authors describe a new tool called MOYSES, aimed at computing scenes that simulate the intrusion at points where the visual impact of a new work is maximum. The combination of this computer tool with commercial software for rendering purposes yields a satisfactory description of the solution in both a numerical and graphical way. The reader is kindly invited to take a look at Figure 8 of that paper to realize about the good performance of the proposed solution.

Acknowledgments

To conclude, I wish to thank the authors, including those whose papers were not accepted for this special issue, for their high-quality contributions and their great cooperation in preparing this volume. I also thank the referees (see the CGGM'2008 International Program Committee and CGGM'2008 International Reviewer Board in Tables 1 and 2 respectively) for their hard work in reviewing the papers and making constructive comments and suggestions, which have substantially contributed to improving all the papers. They undoubtely did a great job!

Once again, I would like to express my sincere acknowledgement to the IJCISIM Editor-in-Chief, Prof. Prof. Khalid Saeed, for having offered me the great opportunity to present this issue. Special recognition is also due to the IJCISIM staff for their support and assistance during the editing process. Last, but certainly not least, I wish thank the readers for their interest in this issue and for supporting IJCISIM. Many thanks to all of them!

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[3] *http://personales.unican.es/iglesias/CGGM2008/* (CGGM'2008 web page)

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About the Guest Editor

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ANDRES IGLESIAS is currently the chair of the Department of Applied Mathematics and Computational Sciences of the University of Cantabria (Spain). Since Nov. 2005, he is also the Post-graduate studies coordinator at his department, whose Ph.D. Program has got the *"Mention of Quality"* of the Spanish Ministry of Education for the best Ph.D. programs in the country. He has been a Visiting Researcher at the Department of Computer Science of the University of Tsukuba (Tsukuba, Japan), Wessex Institute of Technology (Southampton, UK) and International Center of Theoretical Physics (Trieste, Italy). He holds a B.Sc. degree in Mathematics (1992) and a Ph.D. in Applied Mathematics (1995). He has been the chairman and organizer of 24 international conferences in the fields of computer graphics, geometric modeling and symbolic computation, such as the CGGM (2002-08), TSCG (2003-08) and CASA (2003-08) annual conference series and co-chair of ICMS'2006, VRSAL'2008 and ICCIT'2008. In addition, he has served as a program committee and/or steering committee member of 71 international conferences such as 3IA, CGA, CAGDAG, CGIV, CIT, CyberWorlds, FCGN, GMAG, GMAI, GMVAG, Graphicon, GRAPP, ICCS, ICCSA, ICICS, ICCIT, ICM, ICMS, IMS, ISVD, MMM, VIP and WSCG. He has been reviewer of 75 international conferences and 18 international journals. He is currently Associate Editor of the journals *"Transactions on Computational Science", "Int. Journal of Computer Graphics and CAD/CAM", "Int. Journal of Computational Science", "International Journal of Computer Information Systems and Industrial Management Applications"* and *"International Journal of Biometrics"*, member of the Editorial Board of the journals *"Journal of Convergence Information Technology"* and *"Int. Journal of Digital Content Technology and its Applications"* and member of the International Reviewing Board of the journals *"Int. Journal of Information Technology and Web Engineering"* and *"Int. Journal of Computational Intelligence Research"*. He has been guest editor of some special issues of international journals about computer graphics and symbolic computation. He is the author of over 100 international papers and author/editor of five books in Springer-Verlag, Elsevier Science, IEEE Computer Society Press and Thomson-Paraninfo Publishers. For more information, see:

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