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Special Issue on Partial Differential Equations in Computer Graphics and Vision

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Differential equations is an essential tool for describing the nature of the physical universe and naturally also an essential part of models for computer graphics and vision. Some examples are: light rays, which follow the shortest path, and are conveniently described using the Euler-Lagrange (differential) Equations. The pinhole camera is an often used approximation for imaging, but more complicated solutions are often found in raytracing models. Another example is the motion of rigid, fluid, and gaseous phenomena at speeds much slower than sound. These follow Newton's three laws of mechanics, and Newton's second law, force is equal to mass times acceleration, is a partial differential equation for position. A final example is sampling. Many models rely on sampling which in raw form often has unpleasing artifacts. Smoothing is often introduced to improve the visual results, and such methods are often tailored to the geometrical structure of a scene and formulated as a linear or non-linear diffusion processes. Besides natural phenomena, partial differential equations appear as solutions to numerous man-made systems, where physical laws are imposed on artificial systems, and who's solutions have interesting properties such as tracking people in a video sequence or morphing one image into another.

A differential equation is a continuous concept, and since computers are not well suited for continuous mathematics, differential equations are almost always approximated by a numerical scheme. In graphics and vision finite differences is the dominating technique. Leonhard Euler (1707–1783) was one of the first to use finite differences for solving differential equations, but the landmark paper by Courant, Friedrichs, and Levy's paper "Über die partiellen differenzengleichungen der mathematischen physic" from 1928 was the starting point of the modern numerical methods for solving partial differential equations. Many have followed since, and in this issue we honor partial differential equations in computer graphics and vision. Following a workshop at the Department of Computer Science, University of Copenhagen on the topic of this special issue, in September 2006 researchers were encourage to submit novel and high quality works, where partial differential equations played a special role in the solution of computer graphics and vision problems. We would like to thank all those who made this special issue possible: The authors for submitting and later revising their works, the reviewers for making their high quality reviews, and the publication office of ELCVIA for their patience with us all.

Partial differential equations are central for smooth models and play a central role in the solution of many of today's computer vision and graphics problems. I'm happy to conclude that with this issue, we have contributed to furthering the use and understanding of this tool for computer graphics and vision.

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