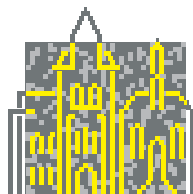


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Hierarchical Methods in Computer Graphics

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Summary

Over the last decade hierarchical methods, multiresolution representations and wavelets have become an exceedingly powerful and flexible tool for computations and data reduction within computer graphics. Their power lies in the fact that they only require a small number of coefficients to represent general functions and large data sets accurately. This allows compression and efficient computations. They offer theoretical characterization of smoothness and coherence, insights into the structure of functions, and operators, and practical numerical tools which often lead to asymptotically faster computational algorithms. Examples of their use in computer graphics include geometric modeling, mesh simplification, multiresolution surface viewing with automatic level of detail control, image and video editing, compression, global illumination computations, volume visualization, and animation.

There is strong evidence that hierarchical methods will become a core technique in computer graphics in the future. The seminar was a follow-up to a Dagstuhl-Seminar with the same title which we have organized in 1998. The development since then confirms this impression.

The idea of this Dagstuhl Seminar was to provide again a forum for the leading researchers in this area to present their ideas and to bring together applications and basic research in order to exchange the requirements of systems, interfaces, and efficient algorithmic solutions to be developed.

Another goal of the seminar was to provide an opportunity for discussing ideas and work in progress. International conferences with their densely packed schedules usually leave little room for this sort of scientific exchange. There is a requirement of events like Dagstuhl Seminars. This was demonstrated by the number of participants from different European countries and abroad.

Scientific Highlights

The majority of the presentations of the seminar can be assigned to one of five main topics: high-quality interactive graphics, data acquisition for realistic rendering and image-based modeling rendering, parametrization of meshes, adaptive/dynamic/deformable meshes, and processing/rendering of point data.

High-quality interactive graphics can be achieved in different ways. One aspect is to get the necessary throughput of data by algorithms adapted to the capabilities of graphics processing units, PC processors, and parallel processing. One contribution of the seminar to this aspect concerned the possibility of interactive ray tracing which has been a grand challenge over the past twenty years, but now seems close to a solution. Interactive rendering of point sets has been another issue. Similar to ray tracing, a huge amount of operations have to be performed. As demonstrated at the seminar, hierarchization is a helpful approach to cope with this problem.

In order to achieve the necessary speed, the algorithms are usually implemented close to hardware, similar to assembler programming, using sophisticated instructions sets of e.g.

graphical processing units (gpus). From the view of software production, this development is not satisfactory. One contribution concerned a language for gpu-programming, called Sh, which might be a tool for more efficient implementation.

Another approach to achieve interactivity is to develop simplified or adapted models of simulation for image generation which still yield visually satisfying results. Several examples have been presented at the seminar. An interesting question might be how to bring all those specialized approaches together.

The presentations to next topic of the seminar, data acquisition for realistic rendering and image-based modeling rendering, has shown the necessity, but also the achievement, of cooperation between the fields of computer graphics and image processing/computer vision. Themes of the presentations have been wavelet-based lightfield compression, wavelet environment matting, accurate light source acquisition and rendering, free view-point video and 3D TV, scanning large-scale articulations and learning and application of class-specific information for facial modeling and animation. Hierarchization, in particular by wavelets of different sort, helps to overcome the problem of the huge amount of data that has to be processed and stored.

The third topic, parametrization of meshes, is a central issue of mesh processing. New contributions concerning improved parametrizations have been presented, over the sphere, as well as for parametrization of meshes of arbitrary genus.

The fourth topic, adaptive, dynamic and deformable meshes, is less settled than the topic of static meshes. Themes of particular interesting presentations on the algorithmic level have been interactive animation of objects represented by surface meshes and collision detection for deformable objects. An interesting talk on an application which demonstrates the power of the methods treated in the seminar concerned a geometric data base for gen expression.

The fifth topic, modeling and rendering of point data, currently finds intensive interest in the research community. It was represented in the seminar by two contributions which reported on recent important advances. The contributions were entitled "Hierarchical Splatting of Point Data" and "Multiscale Modeling of Point Sample Geometry"

To each of those topics, both senior and young researchers have given presentations. It could be observed that most of the young researchers had already achieved an exceptional level in their specific topic of research. The wide variety of applications of hierarchization in computer graphics presented at the seminar offered the opportunity to them to recognize possibilities of application of their methods to applications somewhat besides their main interest. Many questions and discussions after the talks have shown that the opportunity has been used.

Nearly around three quarters of the about 50 participants came from European countries, two third of them from Germany. Most of the participants from abroad came from the USA (8), others from Canada (2) and Brazil (1). The seminar was successful in strengthening the contacts, in particular, to the American researchers. But also several discussions on possible future joint research projects on all levels (world-wide, European, nation-wide) could be observed outside the regular program of the seminar.

Participants

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