



Researchers and Students at INI-GraphicsNet

Due to its international nature, the INI-GraphicsNet is obliged to a long tradition of exchanging researchers and students. Visitors in research and academia from all over the world have been hosted in INI-GraphicsNet institutes, which are adjoined to local universities and participate in university research, teaching and life. The Portuguese Centro de Computação Gráfica (CCG) is related to the University of Minho, CAMTech in Singapore to the Nanyang Technological University (NTU) and imedia, The ICPNM Academy in the US to RISD, the Rhode Island School of Design. The German institutes are adjoined to the Universität Rostock and the Technische Universität Darmstadt. Recently several new institutes joined the INI-GraphicsNet. VICOMTech in San Sebastian/Spain, NEMETech in Seoul/Korea and GraphiTech in Trento/Italy. And of course not to forget the new partnerships with the affiliated universities. These are the Universidad del País Vasco Euskal Herriko Unibertsitatea (University of the Basque Country), the Ewha Womans University in Korea and Università degli Studi di Trento in Italy. Student exchange programs between IGD and imedia in Providence or CAMTech in Singapore directly support the exchange of students between these institutes. This way it's very easy and much less bureaucratic for students to get financial support. But of course there are other possibilities to get funding for exchanges where non of these internal exchange programs apply. Several hints on how to find these scholarships can be found on the studINI Web Site (<http://www.inigraphics.net/students/studini/index.html>).

Of course the student exchange appointee will assist you too, if you have further questions. Another good starting point for a search for scholarships is <http://www.daad.de>.

Marie Curie Fellowships for example provide European placements for pre and post-doctoral researchers, usually up to the age of 35, and for experienced researchers. Last December the first calls for proposals under the 6th framework have been published. Individuals may have a look at http://europa.eu.int/comm/research/fp6/mariecurie-actions/action/fellow_en.html to find the actual proposals and the deadlines for applications. The time for the application for some of the programs ends at the 12th or 18th of February in 2004.

While Marie Curie Fellowships are targeting experienced researchers, there are other funding opportunities for internships. The Leonardo Da Vinci program for example supports exchanges for internships within Europe. Due to the increased number of INI-GraphicsNet institutions within the European community, this program seems to be very promising.

Don't hesitate to contact studini@igd.fraunhofer.de for information and for assistance with the application.

Additionally there are some new calls for application for PPP projects, programs for the exchange of persons in predefined projects. These programs are offered by the DAAD and are available for a special exchange country and typically a German project partner. More information on that subject you can find at (<http://www-zv.upb.de/~eb/neu%20eu%20web/ppp.htm>) (in German)

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ALUMNI

Addressing former staff
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The INI-Graphics- Alumni Forum

is a meeting-place and pool
for former staff members of
the INI-GraphicsNet. If you
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Dr. Wolfram Kresse
»Photometrically consistent radiosity simulation and image representation for virtual and augmented reality applications«

October 27th, 2003

Supervisors:

Prof. Dr.-Ing. José L. Encarnação

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Computer graphics strives to create realistic images, often using light simulation methods to compute illumination and shadows.

The result, however, often is nothing more than a nice image without any physical significance. Therefore, a physically correct simulation and the photometric and colorimetric consistency are essential to make design decisions based on simulated data.

But even when correct data is available, it may prove insufficient to actually evaluate and assess aspects such as readability or glare of car instruments, since the presentation of the computed data on various display systems results in different color and brightness for each display.

The concept of photometric and colorimetric consistency needs to be extended to the display step by calibrating all involved displays to ensure a 1:1 reproduction of the simulated data.

Another aspect lies in the emerging area of augmented reality. Here, photographs are augmented with virtual objects. These objects usually appear very artificial since the real illumination situation in the picture is not taken into account.

The real lighting situation needs to be reconstructed to illuminate the virtual objects accordingly and integrate them seamlessly and photometrically consistent into the real scenario.

This thesis investigates all related problems and finds efficient solutions which are developed and implemented:

Starting from the raw data of a CAD model or pixel values in a photograph, the data preparation and reconstruction steps are simplified significantly.

The radiosity system for light simulation developed here uses this input data for the simulation of complex scenes with efficient, structured mesh refinement and reliable visibility classification.

The simulated data can then be represented on different display types, which are calibrated with regard to color gamut, black value, gamma response and uniformity in intensity. To this end, a novel and automatic display calibration method is used which was developed in this thesis and which enables a consistent reproduction of physically correct data as well as identical display of uncalibrated information such as photographs or presentation slides.

The work of this thesis enables photometric and colorimetric consistency throughout the whole visualisation pipeline. It ensures quantitative correctness, and facilitates usability of the individual steps by automated control of both simulation and calibration, resulting in an encompassing consistency framework and a closed solution for the simulation and representation of diverse input data.



Wolfram Kresse celebrates his graduation

Color Normalization for the Robust Recognition of Video Sequences

*Study thesis by: Alexandre Bouffier
Supervisor: Stephan Volmer*

In this work two new procedures for the correction of color information, called color normalization procedures, are proposed and evaluated in the context of the automatic recognition of video sequences. In the transmission chain from the original sequence to its reproduction on the screen, lots of different influences can lead to changes in the color information of the image. Since algorithms for the determination of visual correspondences usually work on basis of the color information of the image, the color correctness represents a critical factor concerning the recognition accuracy. Purpose of the presented procedures is to correct such changes in the color information and to minimize their negative effect on the recognition reliability.

The first procedure – called Color Gamut Sphering – is a heuristic color normalization. It works without any prior information on the content of the video sequence, and is based on a projection of the color distribution in the RGB color space on a subspace, in which the dependency on small brightness and saturation distortions becomes negligible.

The second procedure – called Channel Color Profile – is an optimized color normalization that supposes the knowledge of both the original spot – the so-called master – and the broadcaster. It corrects the distorted versions of the videos specifically in terms of common image transformations. Two learning steps are therefore necessary, first to characterize the standard color transformations and second to model each channel's specific distortion in terms of these color transformations.

The efficiency of the proposed methods has been evaluated in comparison with well-known color correction algorithms.

Suspense Models for the Narrative Extension of a Virtual Narrator

*Diploma thesis by: Martin Dietz
Supervisors: Thomas Rieger, Norbert Braun*

An existing story engine, which was implemented in Prolog, was to be connected to a virtual character. This virtual character was supposed to tell the interactive story generated by the story engine using expressions and gestures which plausibly accentuated the story.

The story engine generates its interactive stories according to a structure developed by Vladimir Propp at the beginning of the 20th century. This structure splits up the story into segments which can be identified by their function for the whole story. These segments build up every story in the same order, so this structure can be used both for mapping emotions to the scenes by giving the content of the scene, and for assigning accentuation values by giving the position in the suspense arc and its reference to the narrative conflict of that scene.

The story engine was further extended to include the calculation of the relevance of a scene and the implementation of a test of the attainability of specific scenes.

A communication structure was built based on JADE. In this communication structure, systems requests to the story engine and calculations are performed by three main components via an interface agent which communicates with the Prolog interpreter. The results are sent to a second interface agent, which calls the routines of the graphical representation of the virtual character. These routines convert the text into a speech file, choose expressions and gestures from a database and finally perform the scene.

At the end of the project, an evaluation was carried out with test users which showed an improvement in the act of narrating

Analysis and Conception of an Authoring Environment for MR Applications

*Diploma thesis by: Thorsten Frei
Supervisors: Daniel F. Abawi, Paul Grimm*

The goal of this work was to analyze the development of MR applications and to create a concept for an MR authoring environment which would make it possible to generate better MR applications more easily. On the basis of the analysis, a concept was created for an authoring environment for mixed reality content. This concept was based primarily on the

focal points of the development process, the user groups and the areas of application. These individual focal points gave rise to special requirements which were integrated in the concept. The concept was rounded out by the demands that the basic technologies placed on the authoring environment. A prototype MR editor was then implemented. The first parts of the concept were implemented in this editor. However, the concept as a whole was too extensive to be fully realized within the allotted time. The functions of this minimum prototype were limited to the assignment of pre-defined objects to markers and the shifting of objects from one marker to another. The user guidance was accomplished solely by means of keyboard shortcuts. On the basis of this prototype without a graphical interface, the possibility of realizing a full-fledged authoring environment in the form of an MR editor was demonstrated. A evaluation of the work was subsequently carried out. This evaluation examined the analysis that was carried out, the concept that was developed and the realization possibilities that were demonstrated.

Parallel Particle Visualization

*Diploma thesis by: Martin Zwatschek
Supervisors: Sascha Schneider,
W.-D. Groch*

In the context of this diploma thesis, a module for parallel particle visualization was developed. It was integrated into a visualization environment for three-dimensional flow fields named HereVR(r), which was developed at the Fraunhofer Institute. The main aspects of HereVR(r) are its massively parallel data processing capability and the modular design concept.

The particle visualization is based on pre-calculated flow fields (vector fields) in regular grids and uses non-physical particles. The particles are emitted into the scene via so-called injectors which can be arranged on an emitter object in several configurations. This emitter object can be moved freely in the scene to provide a flexible and intuitive way of placing the particles.

Various implemented particle tracing methods (streamlines, pathlines, timelines, streaklines) support the observation of static and time-dependent flow fields. By choosing different particle shapes (pixels, streamlets, billboards, objects) and/or textures, a variety of effects can be realized. An implemented 'factory' design pattern allows one to add additional particle shapes easily. Furthermore, it is possible to steer and control the visualization interactively.

All parameters (particle shape, color and number, tracing method, path integration algorithm, emitter position and alignment etc.) can be changed and adjusted at run-time through a graphical user interface to affect the visualization immediately.

Following the concept of the underlying parallel visualization environment, the particle visualization module is capable of the parallelized calculation of the particle traces. Therefore, it can use multi-processor machines to their full capacity. The load-balancing process of the CPUs is handled automatically.

Segmentation of 3D MRI Volume Data Sets

Diploma thesis by: Mathias Seitel
Supervisors: H. Gläser

Purpose

This work addresses the design and implementation of an application for segmenting medical volume data. The software to be implemented (MIP-Medical Imaging Platform) is designed as a platform for developing and testing general medical image processing applications. A typical area of application is the segmentation and analysis of time series of three-dimensional nuclear magnetic resonance images of the human heart with regard to various cardiological characteristics. Primary product requirements are determined on the basis of the observations gained from examining this specific application.

Methods and Tools

The planning and design of the application are carried out in accordance with common principles of software engineering. After specifying the product requirements, an object-oriented analysis model is developed. This model is refined to form the system design which is finally implemented in C++.

Several software libraries are employed: the ITK toolkit (Insight Segmentation & Registration Toolkit) provides a wide range of image processing functionality. Visualization is addressed using VTK (Visualization Toolkit). The wxWindows framework is used to implement the graphical user interface.

Results

In order to ensure easy extensibility for new areas of application, various approaches for efficiently organizing and managing image data are examined. Since a multitude of image types are

commonly used in medical image processing, these alternatives are particularly tested for the type of flexibility they provide. The approach which emerges from this process is reflected in the whole application, which can be controlled entirely by means of type-independent interfaces. This applies not only to the management of arbitrary image types, but also to the handling of different image processing procedures. The use of object-oriented design patterns helps to realize this approach in a convenient way.

Image processing usually comprises the consecutive filtering of image data. For this purpose, filter chains are established, where the output of one filter serves as the input of its successor. While ITK already basically provides this functionality, it is extended in order to enable the consistent processing of series of images. Filters are encapsulated in classes and can be parameterized via a common, type-independent interface. Two segmentation methods-Region Growing Connected Threshold and Geodesic Active Contours-are implemented and applied to authentic medical data.

The graphical user interface is designed to satisfy the developer's rather than the physician's needs and thus provides full control over image processing activities. Dialogs for configuring filters and controlling the data flow are generated automatically, as all information required for this can be retrieved by querying consistent interfaces of the respective class hierarchy.

Conclusion

The designed software is intended to serve as a foundation for developing and examining a wide range of applications in medical image processing. This purpose is promoted by consistent data flow handling and the provided image type flexibility. Commonly used features like visualization and file handling, as well as the graphical user interface, have been implemented with regard to possible future extensions.

Whiteboard functionality for mobile conference systems

Diploma thesis by: Björn, Schnabel
Supervisor: Pedro Santos

This paper describes the requirements of a whiteboard module for mobile conference systems. In the chapter entitled »State of the Technology«, a selection of common whiteboard modules in commercial and non-commercial applications is presented. Subsequent to this, the requirements of a whiteboard module to

be used for the purposes foreseen in this paper are established. The chapter entitled »Fundamentals« deals with the basic technologies necessary for implementation. The development of a whiteboard module for mobile conference systems is described in the following chapter. This is followed by a sample application, as well as a discussion of the results, which determines whether the requirements have been fulfilled. Finally, there is an overview of future enhancements.

Realisation of a bluetooth-beacon for the localisation of mobile end devices

Diploma thesis by: Klaus Drechsler
Supervisor: Dipl.-Inform. Matthias Grimm

One of the major tasks of Mobile Computing consists of recognizing the context of the user. Context Aware Services, thus services which are offered to the user in dependence of its current environment, can only so be carried out. The environment of a user is described by many attributes to which the current location also belongs. To the most important beginnings of the local indoor recognition belongs the use of infrared beacons. These send a usually static signal, which can be interpreted by the receiver as identification of a location. A substantial disadvantage of these beacons is however the characteristic that the recognition of the signal presupposes visual contact between end device and beacon. In the last years the radio based bluetooth technology gains more in importance and is increasingly found in mobile end devices. Thus it lies close to use this technology for local indoor recognition in order to avoid thereby the disadvantages of the infrared beacons. The goal of this thesis was the realization of a bluetooth based beacon as embedded system, which mobile end devices can use for local indoor recognition. Beside the hardware design an important part of the work consisted of implementing a minimum bluetooth protocol stack which gets along with the scarce resources of the microcontroller. In addition a concept for the mode of operation of the beacon had to be found, since Bluetooth works connection oriented and a broadcast is not possible. This problem was solved by implementation of a pseudo broadcast, with which to each found end device successively a connection is established, in order to transfer localized information. In tests this method functions very reliably. A further part of this thesis applied the conceptual design of a

distance estimation between transmitters and receivers on basis of the signal strength. A model is presented, which describes the signal propagation mathematically and referred to problems and their possible solutions. For example a radio signal reaches the receiver due to reflections usually by means of several ways. Now if the strength of the signal is measured, then the result depends substantially on which way the measured signal put back. However, it cannot be determined which signal one measured and therefore one must count on inaccuracies during the distance computation, which can be improved only algorithmically. Additionally this thesis describes safety problems, which can occur to bluetooth in general and to the bluetooth based beacon. Among other things the delusion attack is described, which has the goal to bring a receiver in disorder as the aggressor installs beacons, which send wrong localized information. To prevent this attack a solution will be described, with which the beacons will be » pre-authenticated« over a safe channel. With each contact with a beacon a Challenge-Response-Protocol is then used in order to convince the end device of the authenticity of the following localized information.

Study of the ARToolKits for collaborative augmented reality

*Diploma thesis by: Florent Laot
Supervisor: Reiner Wichert*

With the technique of Augmented Reality virtual objects can be overlaid over the real world with help of tracking algorithms and can be displayed in some eye glasses. This is a new exciting method of Human-Computer-Interaction. A very common tool to overlay the virtual Images over the real world is ARToolKit, a software library from the HITLab Washington for Augmented Reality applications. In this work access methods for manipulation of VRML objects with help of the ARToolKit have been investigated and analysed. After careful consideration of the ARToolKit for aptitude for Collaborative Augmented

Reality the ARToolKit was enlarged with these methods for manipulation of VRML objects over a Java interface, the new JARTK. Afterwards it was compared and evaluated for Collaborative AR with the AR system of ARVIKA. Therefore a 3D-Tetris game for multiple users was used as test application on the respective AR platform.

Over a central component, the Context Manager all information needed by the components of the system can be conveyed beyond their life span and is compared by way of a Push Mechanism in real time in order to direct their further procedure depending on the incoming information.

The result of the evaluation period is that both systems can be used for multiple marker applications like the AR-Tetris game. The ARToolKit is the more efficient mono marker AR-System. Unfortunately it loses a lot of its advantages as multi marker system, since the ARVIKA AR-System is in a better position to differ markers. Therefore the ARToolKit needs bigger markers to be as effective in a multi marker system as the ARVIKA AR-System. The ARToolKit has a very fast initialising phase and a smaller minimum angle camera to marker from only 5°, but have to cut back in a slower execution as result of the more stable algorithm. It is in fact a powerful, but not complete AR software library, because it can't differ very good between the markers. With help of the JARTK wrapper the ARToolKit is now able to communicate with the ARVIKA ContextManager and the collaborative component.

Efficient Animation of Virtual Clothing

*Diploma thesis by: Sebastian Gantzert
Supervisors: Arnulph Fuhrmann,
Volker Luckas*

One aim in simulating cloth is to reproduce the motion of cloth as realistic as possible with minimal effort. In physically-based modeling the state of cloth is numerically changed by integrating the equation of motion. Because of the high stiffness of the underlying differential equation implicit integration methods prove to be superior to explicit integration methods. The most expensive step in (semi-)implicit integration is about solving a linear system. In most simulation systems this solution is computed by the relative efficient conjugate gradients algorithm. The core of this work is the introduction of multigrid methods into the area of textile simulation that lower the computational costs of solving precisely this linear system. The faster convergence is obtained by heavily reducing the number of expensive cg-iterations on the finest grid. Therefore multigrid methods include calculations on many grids on different discretisation levels inside the

solution process. After a general introduction to multigrid methods efficient algorithms for the work with multiple grids in the area of textile simulation are presented. This includes the construction of coars grids and corresponding operators to change between these as well as the embedding into a complex simulation system. The decrease of computational costs is proven by comparing performance of the standard cg-method and the newly invented multigrid method.

The experiments were done based on a rectangular discretized model of cloth connected by cubic springs that is embedded in an environment with gravity and air drag. By using a cubic spring model instead of the commonly used linear spring model the highly nonlinear load-deflection behaviour of cloth could be better approximated and more stable and visually more pleasant simulations according to that model could be observed.