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OpenSG: A Scene Graph System for Flexible and Efficient Realtime Rendering for Virtual and Augmented Reality Applications
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This work covers the problems of scene graph systems. Currently used systems like Open Inventor or OpenGL Performer cover current and coming developments only partially. The work is concerned with three main parts: Extensibility, Parallelisation and Graphics Hardware Abstraction.

Extensibility is a central problem given the quickly changing requirements posed by new applications. To support it new mechanisms are developed that allow dynamically extending the system. This concerns object creation as well as manipulation of objects, which is done via a reflectivity concept. The active components of the system, the traversals, have also been embedded into a new, extensible concept.

Parallel processing is gaining importance due to the latest developments in processor and system architectures. In a VR application there are a number of independent tasks which can be executed in parallel and which access and manipulate the scene graph's data. To protect these from each other each task needs a private copy of the data. Using an appropriate synchronisation of accesses this division could be achieved using minimal memory overhead while allowing fast access and easy distribution of data between threads.

Graphics hardware abstraction is forced by the growing diversifi-



Dr. Dirk Reiners celebrates his graduation

cation in the graphics board market. At the same time algorithms to create real time displays are moving further and further away from the classic, simple approaches and switch to using multiple stages and/or passes to create the final image. To give an application a usable access to these features without burdening it with too many details an extensible method to encapsulate the OpenGL state has been developed, which together with a new structure called DrawTree is used to optimize and abstract the display tasks.

The central algorithms and methods developed in this work have been implemented in the free OpenSG system (www.opensg.org). It is used and enhanced by a number of universities and research institutes.

STUDY & DIPLOMA THESES

XML Topic Maps for the Management and Retrieval of Domain-specific Competencies in a Research Institute
Diploma thesis by: Christine Haller
Supervisors: Erik Meißner (ZGDV)

The objective of this work was the investigation of topic maps as described in ISO/IEC 13250 for supporting the administration, organization and search for domain-specific competencies of members within the INI-GraphicsNet.

Starting from the review process practiced in the INI-GraphicsNet, information structures were analyzed by gathering the available terms and their meaning as regards a search in the context of the review process. From this data, a formal model was defined. Subsequently, all determined topics and associations were transferred into the formal notation of a topic map (XTM 1.0). The classification of domains then formed the basis for the modeling of the structure of the domains, which is important for a semantics-based navigation and search. Furthermore, the organizational structure of the INI-GraphicsNet and context-sensitive cross-references were formally conceptualized.

All formal models were specified as valid topic map documents consisting of three abstraction levels:
level M0: abstract level (XTM elements)
level M1: conceptual model of the competence and organizational structure
level M2: exemplary input of data.
For presentation purposes in the intranet, XSLT scripts were developed which transform the competence topic map into HTML. Another diploma thesis (Alexander Diegelmann: Visualization of Topic Maps Using Scalable Vector Graphics) defined alternative XSLT scripts for transferring the developed topic map into SVG for graphical access.

The design and definition of the competence topic map showed that topic maps possess the potential to improve the review process. An optimization of the review process was achieved by improved and faster access to competence specifications, particularly through linking information resources and topics among themselves.

Intelligent Behavior Control and World Modeling for Virtual Humans in Virtual Environments

Diploma thesis by: Daniel Kullmann, Supervisors: David Zeltzer, (CRCG CBV); Torsten Fröhlich, (IGD A4)

Autonomous virtual humans must be able to solve problems in their virtual environment. Starting from an animation system that was developed in two other diploma theses, a system for autonomous virtual humans was developed. The basis of the system is a framework for the behavior control of the virtual human. It consists of three parts: a perception module that provides information about the virtual environment and user commands to the virtual human, a planning system for the creation of plans, and an action manager that is responsible for the execution of the plans. The planner is a simple, rule-based (reactive) planning system that can be extended with specialized planning algorithms. These planning algorithms solve complex problems that are too hard for the reactive planner. Two complex problems that were dealt with are path-finding and the grasping of objects. For path-finding, one needs a proper representation of the virtual environment which is then used to search for a path. The A* algorithm was used for the actual search in that representation; it was extended to take the height, width, step height and step length of the virtual human into account. Additionally, a connection had to be made between the path-finding module, the animation module and the arbitrary scene. This enables the virtual human to follow a found path. The architecture of the system integrates the perception system, the planning system with specialized planning algorithms, and the action manager with the visualization of the scene.

Automatic Recognition of Artificial Text in Video Streams

Diploma thesis by: Stefan Maier Supervisor: Dipl.-Ing. Stephan Volmer, M.Sc.

The efficient organization of video data within a database calls for information on the content of the video streams. Unlike stored documents, abstract binary video data do not provide information explicitly.

Therefore, additional content information, called annotations, is manual-

ly supplied at storage time and can be used to organize the video database. Because of the high costs and the great amount of time needed for manual content indexing, it is hardly possible to index the growing number of digital videos. Therefore, this mass of digitally stored video data required an automatic system able to create the annotations needed.

This diploma thesis describes a process for extracting information from video streams automatically. What is extracted is artificial text which was added in the post-production phase of the video and which generally represents a basic information source regarding the semantics and the content of a video stream. Therefore, this artificial text is very well-suited to the automatic annotation of the video content.

The text recognition system that was developed consists of an analysis part in which the displayed artificial text is localized by a segmentation step and a frequency analysis of the video frames, and a processing part in which the text areas that have been located are converted by OCR software into alphanumeric characters. These extracted characters finally can be added to the video streams as annotations.

Development of Security Protocols and New Approaches to Application Service Providing for Mobile Devices

Diploma thesis by: Stefan Schwalm Supervisors: Jalali-Sohi Mehrdad

In Application Service Providing (ASP), framework security is one of the most important issues. Current approaches for implementing such frameworks take advantage of elaborate protection mechanisms such as signatures, public and private key encryption and smart cards.

Because these technologies are demanding in terms of processing power, many of them are not, or are only partly, applicable to mobile clients and their limited capacities. This means that new methods must be found for guaranteeing an acceptable degree of security if such devices are to be used within ASP frameworks.

In the approach suggested in this report, a secret DES key shared between the client and the server is hidden inside the Java classes to be executed on the mobile client. Using this key, the client and server can

establish a secure communication channel without the need for utilizing expensive protocols like SSL. The protocol used is HTTP; security is guaranteed by signing and encrypting the transferred data with the shared secret key. Obfuscation is applied to obscure the application logic of the client code, thus making it tamper-resistant and protecting the hidden secret key.

By these means, two leasing models for an application or service are implemented, one based on access frequency and one based on the period of time an application can be used. Depending on the leasing model, either the number of valid accesses or the expiration date is checked by a short HTTP request to the server every time the application is invoked. Only applications with a valid license are allowed to be executed. In addition to this, in the period-of-time model, the expiration date is continuously checked against the system clock at runtime.

The methods introduced seem particularly suited to small applications aimed at mobile phones, such as games, or location-based services which have a limited lifetime and are not expensive or valuable enough to put much effort into reverse engineering.

In order to proof the proposed concept, a prototypical implementation based on Java was developed.

Visualization of the Development of the Sahara Through a Virtual Reality Exhibit for a Public Exhibition.

Diploma thesis by: Thomas Guthier Supervisors: Torsten Fröhlich, Ulrich Joger, Frank Klees

The landscape of the present-day area of the Sahara has substantially changed in the last 20,000 years. Areas which today are empty of human habitation were earlier populated. This work occupies itself with the representation of a three-dimensional model of the Sahara over the course of this time. The different conditions of the area (free water, flora and fauna) are animated in real time. The user has the ability to move continuously through both landscape and time and to explore the respective realities. The »public exhibition« application area necessitates that the scientific content is arranged in a generally comprehensible form. The simple ease of use and robustness of

the system were therefore important. Essentially, the work covers three main points:

1. Terrain rendering

An interactive representation of the landscape at maximum resolution is not possible due to the number of polygons necessary (over 8 million). The level of detail was therefore rendered using the »ROAMing« algorithm. In order to avoid artifacts being lost in the representation of the ground structure, the procedure was enhanced with so-called »Color-ROAMing«.

2. Object simulation

Plants existed only at certain times and in certain places. Still, the various types follow a life-cycle characteristic. A procedure was developed to determine the existence of objects and to simulate their development. It is therefore possible for the observer to explore both the landscape at any point in time, as well as any continuous changes over time.

3. Representation of complex scenarios

In order to represent complex scenarios, such as passing animal herds, a possibility was found to integrate high-quality existing video material into the scene. The resulting material is scaled and is represented using virtual binoculars.

Rights Clearinghouse for Selling Software

Diploma thesis by: Thorsten Pohl

Supervisors: Mehrdad Jalali-Sohi

The goal of this diploma thesis was the development of a rights clearinghouse for the FILIGRANE system. FILIGRANÉ (FlexIbLe IPR for Software AGent ReliANcE) is a framework which realizes a Web architecture and protocols for the secure exchange of the mobile code on the Internet. The FILIGRANE rights clearinghouse acts as a central authority that controls the licensing of a software manufacturer to a provider, and the further licensing of the software to another provider or to end users, so that no illegal license agreements are made. Furthermore, the FILIGRANE rights clearinghouse realizes a monitoring Web interface for sales based on the concluded contracts. Software manufacturers and providers can use the rights clearinghouse to access their content and structurally prepared information on the contracts and sales.

Development of Automated Movement Control for a Geographically Distributed Audio-visual Telepresence System

Diploma thesis by: Groß, Jochen

Supervisors: Krafzig, Urs (IGD A9)

A telepresence system called BiBiH 1 has been developed at the »Fraunhofer Institut für graphische Datenverarbeitung« in Darmstadt. This system includes a dummy head; software applications to grab, send and display audio and video-data; and hardware to visualize the data.

In this diploma thesis, a concept for the intelligent electromechanical control of a dummy head was developed. The user gets the opportunity to control the remote telepresence system with a head-tracker over the network. The line of vision of the dummy head is set mechanically by servomotors. A change in the line of vision has a direct effect on the grabbed video and audio data.

The software parts needed for the control of the servomotors were programmed and implemented in C++. The servo's moves are mostly equivalent to the user's moves, because only the latest tracking data is used and the data that has not yet been processed is rejected. In this way, nearly smooth movement of the dummy head can be assured.

Moreover, the construction of a new dummy head began in this work. Cameras have already been put into a new head. Also, a link for the necessary DOFs (degrees of freedom) has been designed and constructed.