Katharina KRÖSL

Computational Design of Smart Lighting Systems for Visually Impaired People, using VR and AR Simulations

My dissertation research is set in a multidisciplinary field, spanning over the areas of architecture, specifically lighting design and building information modeling, to virtual reality (VR) and perception. 1.3 billion people worldwide are affected by vision impairments, according to the World Health Organization. However, vision impairments are hardly ever considered when we design our cities, buildings, emergency signposting, or lighting systems.

My research aims to provide the necessary methodology and tools for architects and designers to evaluate their designs for accessibility and develop lighting systems that can enhance the perception of people with vision impairments. With my research, I want to develop realistic, medically based simulations of eye diseases in VR and AR, which allow calibrating vision impairments to the same level for different users. This enables us to conduct user studies with participants with normal sight and graphically simulated vision impairments, to determine the effects of these impairments on perception, and to investigate lighting concepts under impaired vision conditions.

Maria LARA MIRO — Transformations Applied for Design

This work brings together two relevant aspects: the rigor of mathematical work and artistic creativity in architecture. It is an exploration of the possibilities and techniques of what is known as parametric design, since the specialized software Rhinoceros and its Grasshopper plug-in have been used in the transformations carried out, that have as a result the creation of components within this plug-in, which are now available. At the same time, this work tries to serve as a source of inspiration for future architectural projects and a bridge between the architect and mathematics. This exploration is carried out through circular quadrilateral that originate both flat and curve faces generated by the control of geometric transformations of discrete or smooth curves under some restrictions, so that the results are not random but adapt to the set goal. Mathematics applied to Architecture is an important pillar in the world of design, since the more knowledge the architect has of one of the fundamental sciences that architecture uses, the more possibilities it will have to develop innovative and creative projects.

Kurt LEIMER — Sit & Relax: Interactive Design of Body-Supporting Surfaces

We propose a novel method for interactive design of well-fitting body-supporting surfaces that is driven by the pressure distribution on the body's surface. Our main contribution is an interactive modeling system that utilizes captured body poses and computes an importance field that is proportional to the pressure distribution on the body for a given pose. This distribution indicates where the body should be supported in order to easily hold a particular pose, which is one of the measures of comfortable sitting.

Using our approximation, we propose the entire workflow for interactive design of smooth surfaces which serve as seats, or generally, as body supporting furniture for comfortable sitting. Finally, we also provide a design tool for Rhino/Grasshopper that allows for interactive creation of single designs or entire multi-person sitting scenarios. Our method aims at interactive design in order to help designers to create appropriate surfaces digitally without additional empirical design passes.

Iana PODKOSOVA — Walkable Multi-User VR

I will present an overview on my thesis that focuses on walkable multi-user VR. During the thesis, different combinations of sharing physical and virtual space in walkable multi-user scenarios were outlined. Then, ImmersiveDeck was developed. ImmersiveDeck is a large-scale multi-user VR platform that provides a technological foundation for further experiments presented in the thesis. Using ImmersiveDeck, I conducted four user experiments. Two of them investigate the use of colocated non-shared VR scenarios, while the further two are focused on shared VR scenarios in different situations of physical colocation.

DC:{CD}

Final Workshop

28. 1. 2019 Kontaktraum (Neues EI, Gusshausstr. 27-29, Stiege I, 6.Stock) 9:00 - 19:00

8:30	*arrival*	
9:00	OPENING	Michael DRMOTA, Dean of the Faculty of Mathematics and Geoinformation Michael WIMMER, Director of GCD Peter FERSCHIN, Coordinator DCCD
9:30	Katharina KRÖSL	Computational Design of Smart Lighting Systems for Visually Impaired People, using VR and AR Simulations
10:00	Maria LARA MIRO	Transformations applied for design
10:30	Kurt LEIMER	Sit & Relax: Interactive Design of Body-Supporting Surfaces
11:00	*Coffee break*	
11:30	Iana PODKOSOVA	Walkable Multi-User VR
12:00	Markus SCHÜTZ	Interactive Exploration of 3D Point-Clouds
12:30	*Lunch*	
14:00	Goran SIBENIK	Data Management Framework Supporting Synchronous Data Exchange between Architectural and Structural Analysis Models
14:30	Vitezslav STEMBERA	How to Calculate the Collapse of Shell Structures Efficiently
15:00	*Coffee break*	
15:30	Arvin RASOULZAHDEH	Variational Path Optimization of Linear Pentapods with a Simple Singularity Variety
16:00	Anja WUTTE	The Grammar of Late Period Funerary Monuments at Thebes
16:30	*cleaning up and leaving*	*for social event* *U1 to Praterstern and 2 stops with S-Bahn: Handelskai/MilleniumCity*
17:00	social event *BOWLING*	*„Oceanpark Wien"*; reserved 5-7pm; the group may stay longer https://www.oceanparkwien.at

Kontaktraum (Neues EI, Gusshausstr. 27-29, Stiege I, 6.Stock) http://gcd.tuwien.ac.at/?page_id=83

Markus SCHÜTZ

Interactive Exploration of 3D Point-Clouds

This PhD thesis deals with the interactive exploration and manipulation of 3D environments that consist of point-based models, rather than the traditionally used triangle-based models. These point-based models are captured by scanning systems such as laser scanners or photogrammetry, and consist of millions to hundreds of billions of colored points. Sub-topics of this thesis include the rendering of large unstructured point clouds without the need to generate level of detail structures in advance, but also the rendering of large point clouds with a continuous level of detail to eliminate noticeable popping artifacts that are prevalent in state-of-the-art discrete level of detail approaches. Additionally, a live coding OpenGL and VR framework, which allows developers to modify the whole rendering engine at runtime inside VR, was developed during this thesis to help reach these goals in a more efficient manner.

Goran SIBENIK

Data Management Framework Supporting Synchronous Data Exchange between Architectural and Structural Analysis Models

The research first reviews existing software tools, standards and data exchange processes, where the inconsistencies and deficits in the existing data exchange process were identified. Next, it proposes a new approach for synchronous data handling in the AEC process. Thereby a data-handling framework based on domain-specific classification and interpretation proposal was created that supports synchronous interdisciplinary exchange. The data is available on a central storage (server), and the domain specific tool communicates real-time with the data model. The proposed central data handling framework is generic for all AEC industry domains. However, the proposed classification and interpretation system is developed for the exchange between architecture and structural engineering domains.

The innovative contribution of the proposed framework is a domain-specific classification proposal for information structuring on the central data storage (MongoDB), domain-specific interpretation proposal and finally synchronised data handling framework involving proposed classification and interpretation; different from the IFC standard which is built upon integrated classification system (not domain-specific), not supporting domain-specific interpretations and data handling being based on sequential file-based framework. Automating the central storage-based interpretation processes is a crucial feature of a new framework allowing communication between various domain specific models within central storage.

Vitezslav STEMBERA

How to Calculate the Collapse of Shell Structures Efficiently

The prediction of the collapse load (limit load) of a structure made of a material exhibiting elastic plastic behavior is very often of practical interest. The standard approach to obtain such collapse loads is based on iterative calculation schemes using the classical nonlinear finite element method.

However, as an alternative approach the so-called finite-element-based limit analysis (FELA) can be applied. This approach is based on limit theorems, first formulated by A.A.Gvozdev in 1938. Thereby, the collapse load is obtained as the minimum of a certain optimization problem, either considering kinematically compatible velocity fields (upper bound approach) or statically admissible stress fields (lower bound approach) within the structure, at the time instant of collapse. Thus, the whole load history doesn't need to be taken into account, resulting in a much more stable and efficient approach compared to the standard scheme based on classical finite element formulations. The two significant disadvantages of the FELA method, which are the assumption of geometrical linearity and ideal plasticity, can be overcome by the so-called sequential finite element limit analysis (SFELA), as, e.g., shown in [1]. Thereby, the FELA method is called repeatedly, where the geometry and the plastic strain is updated after each iteration.

In this work, four topics have been investigated. First, the iterative calculation schemes using the classical nonlinear finite element method has been implemented and compared with the FELA method in terms of efficiency and robustness. Second, one new and several well-known finite elements from classical FE formulations have been implemented into an upper bound approach for shell structures. To the material a von Mises type strength criterion for shell elements (Ilyushin criterion) has been assigned. By means of different benchmark examples, the performance of these elements has been evaluated. Third, different adaptive meshing strategies have been explored and mutually compared in term of the convergence rate improvement. Fourth, the SFELA method has been implemented and its advantages has been demonstrated on the steel frame collapse benchmark test.

[1] D. Kong, C. M. Martin, B. W. Byrne, Modelling large plastic deformations of cohesive soils using sequential limit analysis, Int. J. Numer. Anal. Meth. Geomech., Vol.41, 2017, pp. 1781–1806.

Arvin RASOULZAHDEH

Variational Path Optimization of Linear Pentapods with a Simple Singularity Variety

The configuration space of a linear pentapod is described by points $(u, v, w, p_x, p_y, p_z) \in \mathbb{R}^6$ under the $\Gamma : u^2 + v^2 + w^2 = 1$ constraint, where (u, v, w) describes the orientation of linear pentapod while $(p_x; p_y; p_z)$ stands as its position. The set of all singular configurations will be $\Gamma \cap \Sigma$, where Σ is a 5-dimensional variety in $\mathbb{R}^6$. Neglecting the constraint Γ is equivalent to relaxing the motion group from the Euclidean one to the group of equiform motions (also known as similarity transformations). It can be shown that omitting this constraint simplifies the computations and will let us derive an architecture-depended analytic formula for pedal points on the singularity variety. Furthermore the actual length of the linear platform will be obtained through similarity transformations and hence paving the way for the optimization of the singularity-free paths. In this talk, we investigate the optimization of the singularity-free paths between two non-singular configurations in $\mathbb{R}^6$ in such a way that these curves would have the maximum possible distance from the singularity variety, Σ, while preserving the minimum possible length and their smoothness. This act is done through the optimization of the energy and bending energy variations along with the distance to the variety.

Anja WUTTE

The Grammar of Late Period Funerary Monuments at Thebes

The described project examines architecture of ancient Egypt, using interdisciplinary methods from architecture, computer science and Egyptology to analyze tradition and evolution of geometry and architecture of Late Period private funerary monuments of Thebes. The primary purpose is to evolve and present information and theories about the development of the building concepts combining archaeological sources, architectural science and computational reconstructions.

Relatively little attention has yet been given to new technologies and methods to examine design principles and building parameters of ancient Egyptian architecture. Therefore, the main goal of this project is to develop architectural analysis methods to examine under which conditions similarities and variations of a building type produced, which is of primary importance to the creation of a typology. For this purpose, Late Period private funerary monuments of Thebes were analyzed and compared. The analyses include semi-automatic methods to study circulation and accessibility paths, natural lighting paths, proportions and decoration concepts of the funerary monuments. Furthermore, a 3-dimensional visualization of the collected data allows to identify spatial qualities of room components and comparative analyses.

The deriving parameters of the building elements can be considered as design or shape rules and define a procedural modeling system of the buildings' design characteristics to enable new perspectives on design concepts of these funerary monuments.