

WSCG 2014

22nd WSCG International Conference on Computer Graphics, Visualization and Computer Vision 2014

<http://www.wscg.cz>

Primavera Hotel & Congress Center
Plzen, Czech Republic

June 2 – 5, 2014

ABSTRACTS

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Preliminary Conference Program

Keynote speakers

Manuel M.Oliveira, Universidade Federal do Rio Grande do Sul
Porto Alegre, Brazil

Tino Weinkauff, Max-Planck-Institut für Informatik
Saarbrücken, Germany

Conference Chair

Vaclav Skala, University of West Bohemia
Plzen, Czech Republic

Keynote talks

J03: Flow maps - Benefits, Problems, Future Research

Weinkauff, T.

Abstract:

The flow map has become a standard tool for the analysis and visualization of unsteady flows. In simple terms, it maps the start point of a particle integration to its end point. Flow maps are used to compute Finite Time Lyapunov Exponents (FTLE), Streak Line Vector Fields, or to speed up other methods in flow visualization. However, they are very costly in terms of both computation time and storage. In this talk, I will give an overview of the latest developments in flow visualization, review the theoretical and practical benefits of flow maps, discuss issues of accuracy and complexity, and pose open questions for future research in this area.

J05: Performing High-Dimensional Filtering in Low-Dimensional Spaces

Oliveira, M.M.

Abstract:

High-dimensional filtering is a key component for many graphics, image, and video processing applications. Edge-preserving filters (an important class of high-dimensional ones), for instance, are essential for tasks like global-illumination filtering, tone mapping, denoising, detail enhancement, and non-photorealistic effects, among many others. Edge-preserving filtering can be implemented as a convolution with a spatially-varying kernel in image space, or with a spatially-invariant kernel in high-dimensional space. Performing the operation either way is computationally expensive, preventing its use in interactive and real-time scenarios. The talk will present two recent techniques we have developed for efficiently performing edge-aware filtering. The first one is based on a domain transform that allows high-dimensional geodesic filtering to be performed in linear time as a sequence of 1-D filtering steps using a spatially-invariant kernel. The second technique works by sampling and filtering the input signal using a set of 2-D manifolds adapted to the original data. Its cost is linear in the number of pixels and in the dimensionality of the space in which the filter operates. These techniques are significantly faster than previous approaches, supporting high-dimensional filtering of images, videos, and global illumination effects in real time. In the talk, I will present several examples illustrating their use in graphics, image, and video processing applications.

Full papers – candidates for the Journal of WSCG

I11: City Sketching

Gain, J., Marais, P., Neeser, R.

Abstract:

Procedural methods offer an automated means of generating complex cityscapes, incorporating the placement of park areas and the layout of roads, plots and buildings. Unfortunately, existing interfaces to procedural city systems tend to either focus on a single aspect of city layout (such as the road network) ignoring interaction with other elements (such as building dimensions) or expect numeric input with little visual feedback, short of the completed city, which may take up to several minutes to generate. In this paper we present an interface to procedural city generation, which, through a combination of sketching and gestural input, enables users to specify different land usage (parkland, commercial, residential and industrial), and control the geometric attributes of roads, plots and buildings. Importantly, the inter-relationship of these elements is pre-visualized so that their impact on the final city layout can be predicted. Once generated, further editing, for instance shaping the city skyline or redrawing individual roads, is supported. In general, City Sketching provides a powerful and intuitive interface for designing complex urban layouts.

I41: Intelligent Prioritization and Filtering of Labels in Navigation Maps

Vaaranemi, M., Görlich, M., in der Au, A.

Abstract:

The description of objects in navigation maps by textual annotations provides a powerful means for orientation and visual data exploration. However, displaying labels for all features leads to a cluttered map with unreadable labels and occluded information. Therefore, the overall goal is to display the most important and filter out the less important labels. In this paper, we present a general approach for filtering labels. We use the navigation in automotive maps as an application to test our approach. This involves the creation of a priority metric for ranking labels in maps. Our flexible system allows runtime configuration of the priority. Moreover, we keep the temporal coherency of label filtering; hence, jittering of labels does not occur. The system is predictable, modular, and can easily be adapted to new applications. On medium-class hardware, our real-time system is capable of filtering on average 1000 labels within 8 ms. A concluding expert study validates our approach for navigation purposes. All candidates approve the resulting clear labeling layout.

I47: Detecting Dominant Motion Flows and People Counting in High Density Crowds

sultan daud khan, Giuseppe Vizzari, Stefania Bandini, Saleh Basalamah

Abstract:

Urbanisation is growingly generating crowding situations which generate potential issues for planning and public safety. This paper proposes new techniques of crowd analysis and precisely crowd flow segmentation and crowd counting framework for estimating the number of people in each flow segment. We use two foreground masks, one generated by Horn-Schunck optical flow, used by crowd flow segmentation, and another by Gaussian background subtraction, used by crowd counting framework. For crowd flow segmentation, we adopt K-means clustering algorithm which segments the crowd in different flows. After clustering, some small blobs can appear which are removed by blob absorption method. After blob absorption, crowd flow is segmented into different dominant flows. Finally, we estimate the number of people in each flow segment by using blob analysis and blob size optimization methods. Our experimental results demonstrate the effectiveness of the proposed method comparing to other state-of-the-art approaches and our proposed crowd counting framework estimates the number of people with about 90% accuracy.

I59: Efficient Procedural Generation of Forests

Kenwood, J., Gain, J., and Marais, P.

Abstract:

Forested landscapes are an important component of many large virtual environments in games and film. In order to reduce modelling time, procedural methods are often used. Unfortunately, procedural tree generation tends to be slow and resource-intensive for large forests. The main contribution of this paper is the development of an efficient procedural generation system for the creation of large forests. Our system uses L-systems, a grammar-based procedural technique, to generate each tree. We algorithmically modify L-system tree grammars to intelligently use an instance cache for tree branches. Our instancing approach not only makes efficient use of memory but also reduces the visual repetition artifacts which can arise due to the granularity of the instances. Instances can represent a range of structures, from a single branch to multiple branches or even an entire tree. Our system improves the speed and memory requirements for forest generation by 3--4 orders of magnitude over naive methods: we generate over 1,000,000 trees in 4.5 seconds, while using only 350MB of memory.

K47: Detecting Topologically Relevant Structures in Flows by Surface Integrals

Reich, W., Kasten, J., Scheuermann, G.

Abstract:

Gauss' theorem, which relates the flow through a surface to the vector field inside the surface, is an important tool in Flow Visualization. We exploit the fact that the theorem can be further refined on polygonal cells and construct a process that encodes the particle movement through the boundary facets of these cells using transition matrices. By pure power iteration of transition matrices, various topological features, such as separation and invariant sets, can be extracted without having to rely on the classical techniques, e.g., interpolation, differentiation and numerical streamline integration. We will apply our method to steady vector fields with a focus on three dimensions.

K67: A Visuomotor Coordination Model for Obstacle Recognition

Tomoyori Iwao, Hiroyuki Kubo, Akinobu Maejima, Shigeo Morishima

Abstract:

In this paper, we propose a novel method for animating CG characters that while walking or running pay heed to obstacles. Here, our primary contribution is to formulate a generic visuomotor coordination model for obstacle recognition with whole body movements. In addition, our model easily generates gaze shifts, which expresses the individuality of characters. Based on experimental evidence, we also incorporate the coordination of eye movements in response to obstacle recognition behavior via simple parameters related to the target position and individuality of the characters's gaze shifts. Our overall model can generate plausible visuomotor coordinated movements in various scenes by manipulating parameters of our proposed functions.

K73: Improved particle-based Ice Melting Simulation with SPH Air Model

Domaradzki, J., Martyn, T.

Abstract:

This paper presents an improved method for simulating melting of ice. The melting process is implemented as a result of the heat transfer between ice objects and fluids (water and air). Both the solids and the fluids, including air, are modeled as a set of particles with specified temperatures, which can vary locally during simulation. The proposed new particle-based air model allows one to consider in simulation the influence of the natural air convection on the ice melting process. Moreover, the model makes it possible to melt the ice object in a control-lable way by means of external heat sources. The motion of air and water, originally described by the Navier-Stokes equations for incompressible fluids, is computed using the Smoothed Particle Hydrodynamics (SPH) algorithm, which we modify to properly handle our particle-based air and its interactions with ice and water. Thanks to a GPU-based implementation, the proposed method allows us to run the simulation of ice melting at interactive speed on an average PC.

M07: Cross-domain image matching improved by visual attention

Melo, E., de Amo, S., Guliato, D.

Abstract:

A good accuracy in image retrieval across different visual domains, such as photos taken over different seasons or lighting conditions, paintings, drawings, hand-drawn sketches, still is a big challenge. This paper proposes the use of visual attention to estimate the relative importance of some regions in a given query image. Recently, researchers used different databases in specific domains to validate their hypothesis. In this paper, we are also proposing a database with multiple image domains, called UFU-DDD. We used the UFU-DDD database to demonstrate the performance and accuracy of the association of visual attention with orientation-based feature descriptors. The analysis of the results showed that our approach outperforms all the standard descriptors used in the experiments. Hopefully the UFU-DDD database may contribute for future research in the area of cross-domain for comparison of results.

M71: Acquiring Bidirectional Texture Functions for Large-Scale Material Samples

Steinhausen, H.C., den Brok, D., Hullin, M.B., Klein, R.

Abstract:

Most current acquisition setups for bidirectional texture functions (BTFs) are incapable of capturing large-scale material samples. We propose a method based on controlled texture synthesis to produce BTFs of appealing visual quality for such materials. Our approach uses as input data a complete measurement of a small fraction of the sample, together with few images of the large-scale structure controlling the synthesis process. We evaluate the applicability of our approach by reconstructing sparsified ground truth data and investigate the consequences of choosing different kinds and numbers of constraint images.

M73: Patch-based sparse reconstruction of material BTFs

den Brok, D., Steinhausen, H. C., Hullin, M., Klein, R.

Abstract:

We propose a simple and efficient method to reconstruct materials' bidirectional texture functions (BTFs) from angularly sparse measurements. The key observation is that materials of similar types exhibit both similar surface structure and reflectance properties. We exploit this by manually clustering an existing database of fully measured material BTFs and fitting a linear model to each of the clusters. The models are computed not on per-texel data but on small spatial BTF patches we call *apparent BTFs*. Sparse reconstruction can then be performed by solving a linear least-squares problem without any regularization, using a per-cluster sampling strategy derived from the models. We demonstrate that our method is capable of faithfully reconstructing fully resolved BTFs from sparse measurements for a wide range of materials.

Full papers – candidates for the Journal of WSCG to be selected from

G61: A Faster and Smarter Self-learning from Single Image for Image Upsampling

Khatri,N., Joshi,M.V.

Abstract:

Exploiting similarity of patches within multiple resolution versions of an image is often utilized to solve problems such as image upsampling, denoising, texture synthesis etc. Particularly, for image upsampling, recently, there has been a slew of algorithms exploiting patch repetitions within- and across- different scales of an image, along with some priors to preserve the scene structure of the reconstructed image. One such method, self-learning algorithm [1], uses only one image to achieve high magnification factors. But, as the image resolution increases, the number of patches in dictionary increases dramatically, and makes the reconstruction computationally prohibitive. In this paper, we propose a method that removes the redundancies inherent in large self-learned dictionaries and uses only a small percentage of these patches to quickly upsample the image without the use of any regularization methods or priors. We further prove that any non-dictionary low-variance (low details) patch can be represented as a linear combination of only low-variance patches from the dictionary. The same principle applies to highvariance (high details) patches. Images with high scaling factors can be obtained with this method without any regularization or prior information, which can be subjected to further regularization with necessary prior(s) to refine the reconstruction.

G67: Visual Analysis of Polarization Domains in Barium Titanate during Phase Transitions

Brix,T., Lindemann,F., Prassni,J.-S., Diepenbrock,S., Hinrichs,K.

Abstract:

In recent years, the characteristics of ferroelectric barium titanate (BaTiO₃) have been studied extensively in materials science. Barium titanate has been widely used for building transducers, capacitors and, as of late, for memory devices. In this context, a precise understanding of the formation of polarization domains during phase transitions within the material is especially important. Therefore, we propose an application that uses a combination of proven visualization techniques in order to aid physicists in the visual analysis of molecular dynamic simulations of BaTiO₃. A set of linked 2D and 3D views conveys an overview of the evolution of dipole moments over time by visualizing single time steps as well as combining multiple time steps in one single static image using flow radar glyphs. In addition, our system semi-automatically detects polarization domains, whose spatial relation can be interactively analyzed at different levels of detail on commodity hardware. The evolution of selected polarization domains over their lifetime can be observed by a combination of animated spatial and quantitative views.

G83: Improving Information Perception of Graphical Displays: an Experimental Study on the Display of Column Graphs

Falschlunger, L., Eisl, C., Losbichler, H., Greil, A.

Abstract:

Due to the fact that the quality of decisions is linked to the availability of information and to the ability of the human brain to process this in an effective and efficient way, its selection and representation are of major importance in business communication. Graphs and tables are widely used to transform raw data into a more understandable format, but there are not any empirically tested guidelines that consider the cognition and perception abilities of humans. This paper therefore explores how specific visual designs applied to column graphs influence effectiveness and efficiency by applying a technique that makes the process of perception transparent: the technology of eye tracking. The tested design elements show significant results and allow the deduction of the following design guidelines for column graphs: do not use a 3D view for depicting two dimensional data, do not use non-zero or broken axes, do show label values, do not use horizontal gridlines or the label axis when showing label values and do align the label values depending on the available space (either horizontally or vertically).

H07: Locally Adaptive Products for Genuine Spherical Harmonic Lighting

Lee,J.H., Kim,M.H.

Abstract:

Precomputed radiance transfer techniques have been broadly used for supporting complex illumination effects on diffuse and glossy objects. Although working with the wavelet domain is efficient in handling all-frequency illumination, the spherical harmonics domain is more convenient for interactively changing lights and views on the fly due to the rotational invariant nature of the spherical harmonic domain. For interactive lighting, however, the number of coefficients must be limited and the high orders of coefficients have to be eliminated. Therefore spherical harmonic lighting has been preferred and practiced only for interactive soft-diffuse lighting. In this paper, we propose a simple but practical filtering solution using locally adaptive products of high-order harmonic coefficients within the genuine spherical harmonic lighting framework. Our approach works out on the fly in two-fold. We first conduct multi-level filtering on vertices in order to determine regions of interests, where the high orders of harmonics are necessary for high frequency lighting. The initially determined regions of interests are then refined through filling in the incomplete regions by traveling the neighboring vertices. Even not relying on graphics hardware, the proposed method allows to compute high order products of spherical harmonic lighting for both diffuse and specular lighting.

H23: Point Sensitivity for Radial Visualization under Dimensional Anchor Motion

Russell,A., Kamayou,F., Marceau,R., Daniels,K., Grinstein,G.

Abstract:

This paper extends prior work with normalized radial visualizations (NRVs) that includes the RadViz mapping onto the two-dimensional unit disk. Here we examine point sensitivity under varying assumptions about dimensional anchor motion. First, we describe the role of the barycenter of the dimensional anchors as the position where records map to under a NRV when all of their dimensional values are equal. Next, we explore the intuition that data records whose standard deviation across the dimensions is small map close to the barycenter under a NRV; such data records have low mobility. When the dimensional anchors are arranged uniformly on the RadViz circle, our distance formulation provides a preprocessing test that is sufficient for concluding that a record will lay within a circle of radius $1/2$ around the barycenter. This test is independent of the ordering of the dimensional anchors on the circle. Then, for RadViz we employ a robotic motion planning analogy which utilizes the Minkowski sum to show that when some of the dimensional anchors' positions are free to move on the unit circle, then a data record maps inside an annulus, whose center, inner and outer radii are computable. Extending the motion planning analogy, we are able to determine a DA configuration which places a data record image point at a chosen position. To illustrate this, the Weave visualization system has been enhanced to include interactive point sensitivity features.

H73: Analytic Isosurface Rendering and Maximum Intensity Projection on the GPU

Jozsa,P., Toth,M.J., Csebfalvi,B.

Abstract:

It is well known that isosurfaces implicitly represented by volumetric data can be analytically rendered if a trilinear interpolation is assumed to be applied for the continuous reconstruction. However, to the best of our knowledge, it has not been investigated yet how this approach can be efficiently implemented on current GPUs and how much the analytic intersection point calculations slow down the rendering process compared to the traditional discrete approximation. In this paper, we propose a GPU friendly first-hit ray-casting algorithm that (1) minimizes the number of texture fetches, (2) significantly simplifies the arithmetic operations, and (3) avoids error accumulation during the ray traversal. We show that our analytic isosurface rendering optimized for the GPU is even faster than an equidistant discrete sampling, if the sampling frequency is set such that a comparable image quality is obtained. This is true even if the empty blocks of voxels are not processed along the rays. Therefore, the analytic approach can completely replace the traditional first-hit ray-casting implementations. Additionally, we show that the core of our algorithm can also be used for analytic Maximum Intensity Projection (MIP).

I07: Hexagonal Image Quilting for Texture Synthesis

Kuri, D., Root, E, Theisel, H.

Abstract:

The synthesis of textures of arbitrary size from smaller samples is a much-noticed problem in the field of computer graphics. While the proposed solutions deliver very good results for regular and near-regular textures, the synthesis of irregular textures is in need of improvement. In this paper the well-known Image Quilting algorithm is analyzed and its idea is enhanced by replacing the square shape of the patches by a hexagonal shape. In addition, rotation and mirroring of patches are introduced. A penalty map is used to enforce even usage of source data and transformations to make feature repetition less noticeable and improve synthesis from multiple source images. This leads to considerably better results for complex textures like wood, smoke or water waves.

I17: Scalable rendering for very large meshes

Chajdas, M. G., Reitingner, M., Westermann, R.

Abstract:

In this paper, we present a novel approach for rendering of very large polygonal meshes consisting of several hundred million triangles. Our technique uses the rasterizer exclusively to allow for high-quality, anti-aliased rendering and takes advantage of a compact, voxel-based level-of-detail simplification. We show how our approach unifies streaming, occlusion culling, and level-of-detail into a single rasterization based pipeline. We also demonstrate how our level-of-detail simplification can be quickly computed, even for the most complex polygonal meshes.

I31: Single-phase trapped air simulation in water flow

Oh, S., Jeong, I.K.

Abstract:

We introduce a novel practical single-phase particle simulation for trapped air bubbles in a turbulent water flow. Our model for a trapped air bubble is a low-density rigid body with a spherical shape, and our bubble interacts with water and other rigid bodies in a fully two-way manner. Our bubble is created at a trapped air pocket computed from the water volume. Stable and realistic bubble interactions are achieved using an impulse-based boundary force with non-positive coefficients of restitution. Subgrid-scale bubbles are also created to add more details using precomputed bubble data and an oscillating bubble mesh is used in rendering stage instead of a spherical shape for a soft look of the bubble surface. Our method can be easily implemented by extending an existing rigid body interaction of fluid solver, and it is fast compared to two-phase simulation because we do not simulate the air part.

I53: Reliable and Unobtrusive Inter-Device Collaboration by Continuous Interaction

Kajan,R., Szentandrás,I., Herout,A.,Pavelková,A.

Abstract:

Currently, there is a lack of support for seamless task migration among devices - starting a task on one device and continuing it on another, without the need of manual application state inspection and data transfer. We are solving this problem by employing our framework for application state acquisition coupled with user interface based on an intuitive

metaphor: video recording. Our solution utilizes a combination of natural features based detection and marker tracking in order to reliably establish the homography between the screen and the observation of the mobile device's camera. This allows us to employ a fast and precise continuous interaction even on low-end mobile devices. In every moment, user is given relevant task and content-migration options for selected application. The experimental results show that our solution provides reliable task migration at interactive frame rates.

J13: Median mixture model for background - foreground segmentation in video sequences

Graszka,P.

Abstract:

The purpose of this paper is to present a novel approach to the Gaussian mixture background modeling model (GMM) that we call the median mixture model (MMM). The proposed method is based on the same principles as the GMM, but all of the background model parameters are estimated in a much more efficient way resulting in accelerating the algorithm by about 25% without deteriorating the modeling results. The second part of this paper describes a method of uniting three MMMs where three different sets of input data undergo modeling in order to achieve even better results. This approach called the united median mixtures is more robust to random noise as well as unwanted shadows and reflections. Both algorithms are thoroughly tested and compared against the Gaussian mixture model, taking into consideration robustness to noise, shadows and reflections.

J31: Efficient Hand-Over Motion Reconstruction

Mousas, C., Newbury, P., Anagnostopoulos, C.N.

Abstract:

In this paper, a hand-over motion reconstruction methodology is presented. First to be examined in the proposed approach is the way in which the system computes the optimal markerset for a given dataset of hand motion sequences. In a second step before the motion reconstruction process and given the reduced number of markers, the system estimates the remaining markers by computing a simple distance metric. Having the complete number of markers, including both the input and the computed markers, the system reconstructs the motion of the character's fingers. The reconstruction process is formulated in a maximum a posteriori framework, which is responsible for approximating a valid pose of the character's hand, in which the mixture of factor analysis (MFA) clustering techniques was used for the prior learning process. The results show that high quality motions of the character's hand can be reconstructed with the methodology presented.

J59: Character Transfer: Example-based individuality retargeting for facial animations

Kato, T., Saito, S., Kawai, M., Iwao, T., Maejima, A., Morishima, S.,

Abstract:

A key disadvantage of blendshape animation is the labor-intensive task of sculpting blendshapes with individual expressions for each character. In this paper, we propose a novel system Character Transfer, that automatically sculpts blendshapes with individual expressions by extracting them from training examples; this extraction creates a mapping that drives the sculpting process. Comparing our approach with the naive method of transferring facial expressions from other characters, Character Transfer effectively sculpted blendshapes without the need to create such unnecessary blendshapes for other characters. Although Character Transfer is applicable, the number of training examples is limited based on region segmentations of the face and the blending of the mappings.

J89: A Multi-threaded Multi-context GPU Methodology for Real-time Terrain Rendering

Yusuf,A., Mostafa,M., Elarif,T.

Abstract:

Real-time rendering of large terrains has several important applications. Hence, many methods have been devised to solve this problem. The main challenge for such methods is to deal with a large terrain dataset and maintain interactive frame rates. In this paper, we propose a level-of-detail (LOD) based multi-threaded multi-context method that works on two separate activities. Each activity is assigned to its own CPU thread and GPU context. The LOD hierarchy is constructed on the GPU context of the errors activity and stored as a 2D texture map. This texture map is used by the blocks rendering activity via its CPU thread to initiate the rendering process by sending different terrain blocks as translation and scaling parameters to its GPU context, which uses a reusable single shared vertex and index buffer to render the required block based on the passed parameters and the height-field texture. The results show that the proposed method achieves high interactive frame rates at guaranteed very small screen-space errors.

K11: GPU-based Adaptive Surface Reconstruction for Real-time SPH Fluids

Shuchen Du, Takashi Kanai

Abstract:

We propose a GPU-based adaptive surface reconstruction algorithm for Smoothed-Particle Hydrodynamics (SPH) fluids. The adaptive surface is reconstructed from 3-level grids as proposed by \cite{Akinci13}. The novel part of our algorithm is a pattern based approach for crack filling, which is recognised as the most challenging part of building adaptive surfaces. Unlike prior CPU-based approaches as \cite{Shu95, Shekhar96, Westermann99, Akinci13} that detect and fill cracks according to some criteria during program running that were slow and unrobust, we analyse and define all the possible crack patterns in advance and later, during program running, the cracks are detected and filled according to the patterns, which is robust, GPU-friendly and easy to implement. As the results shown, our algorithm can get a similar surface mesh to the corresponding uniform one with significantly reduced computation time and memory cost.

K13: Accurate thickness computing of a B-Rep model on the GPU

Lemasson, G., Shariat, B., Zara, F., Iehl, J.C., Baudet, V.

Abstract:

We present a technique that calculates the thickness of a B-Rep model. This calculation is performed directly on trimmed NURBS and not on a triangular approximation. We determine the thickness by computing the radius of maximal spheres contained within the B-Rep model, in parallel on GPU. The results are presented by a color-coded thickness map. A detailed study of our results demonstrates a very important gain in stability and computation time compared to others approaches.

K31: Image-based 3D Modelling in Archaeology: Application and Evaluation

Bernardes, P., Magalhães, F., Ribeiro, J., Madeira, J., Martins, M.

Abstract:

Image-based 3D modelling tools and techniques can be used to support some stages of the archaeological process. Two application examples, for two sites of the Roman Era, are presented, illustrating the usage and usefulness of such tools for the archaeological survey. For a quadrangular pool in the Milreu Roman Villa (Faro, Portugal), the 3D models resulting from the application of two different image-based modelling tools, using the same initial set of digital photos, are compared regarding time spent and model accuracy. For the Fonte do Idolo in Bracara Augusta (Braga, Portugal), the result of a traditional survey is compared both with a laser-based survey and an image-based survey.

K43: Improved Estimation of Tissue Noise Power Spectra in CT Data

Walek, P., Jan, J., Ourednicek, P., Skotakova, J., Jira, I.

Abstract:

Evaluation and measuring of image quality in X-ray computed tomographic (CT) data gained importance with recent appearance of modern algorithms for iterative reconstruction of CT data which, thanks to ability to dramatically reduce applied radiation dose declaratively without loss of image quality, are expected to replace the conventionally used filtered back projection (FBP) algorithm. Quality of iteratively reconstructed data in terms of image noise is routinely evaluated in images of homogeneous phantoms or in small regions of interest in real patient data. Character of the noise, whose characteristics are dependent on imaged scene, require measuring in the whole volume of real patient data and moreover in diverse tissues separately. This paper presents generalization of a one dimensional noise power spectra estimation which enables its calculation from separate tissues. Firstly, basic tissues must be segmented and the resulting segmentation masks are used for the noise power spectra estimation. The estimation carried out with help of the binary segmentation masks is, due to convolutional property of the Fourier transform, burdened by error due to spectral leakage. A binary segmentation mask may be seen as a two-dimensional windowing function with steep borders. Our method for reduction of the error is based on replacement of binary segmentation masks by designed two-dimensional spatially adaptive windowing functions with better spectral properties. Design of the spatially adaptive windows is based on distance maps and optimized skeletonization calculated using the maximal discs approach. The magnitude of the segmentation introduced error can be experimentally measured using a simulated noise with known power spectrum, which is compared with the noise power spectrum estimated in frame of the segmented tissue (i.e. affected by the spectral leakage). Finally, it is shown that the proposed two-dimensional spatially adaptive windowing functions are able to significantly improve precision of the noise power spectra estimation in diverse tissues.

K71: A Physically-based Simulation of a Caenorhabditis elegans

Andoni Mujika, Alessandro de Mauro, Gautier Robin, Gorka Epelde, David Oyarzun

Abstract:

This paper shows the three-dimensional physical model created to simulate the locomotion of the *Caenorhabditis elegans*. The *C. elegans* is a very deep studied nematode as it is considered one of the simplest nervous systems in nature, made of 302 neurons and about 8000 connections. To the date, there is no system that can faithfully reproduce the rich behavioral repertoire of this tiny worm in terms of neural activity and locomotion. The *Si Elegans* project aims to develop the first hardware-based computing framework that will accurately mimic a *C. elegans* worm in real time. It will enable complex and realistic behavior to emerge through interaction with a rich and dynamic simulation of a natural or laboratory environment. As a result, the locomotion of the worm will be rendered in a web-based platform. In this paper, we describe the approach followed for the physically-based modelling and simulation of *C. elegans* and the benefits of our approach compared to existing ones. The main contribution of our work is the utilization of biphasic springs in the structure that represents the worm in the virtual environment and a Finite Element Method based internal force field to simulate the internal pressure of the body.

M05: A Stable and Invariant Three-polar Surface Representation: Application to 3D Face Description

Jribi, M., Ghorbel, F

Abstract:

In this paper, we intend to introduce a new curved surface representation that we qualify by three-polar. It is constructed by the superposition of the three geodesic potentials generated from three reference points of the surface. By considering a pre-selected levels set of this superposition, invariant points are obtained. A comparative study between this representation and the unipolar one based on the level curves around one reference point is established in the sense of the stability under errors on the reference points positions. The three-polar representation is applied, finally, for 3D human faces description. Its accuracy is performed in the mean of the Hausdorff shape distance.

M23: Supervised Force Directed Algorithm for the Generation of Flow Maps

Alberto, D., Simoes, B., Raffaele D.

Abstract:

Flow maps in cartography are graphical representations that depict the movement of objects, such as people, goods or traffic network, from one location to another. The advantage of flow maps is that they reduce visual clutter by merging flow lines, that is, a visual description of some specific movement. Hence, many well-defined problems can be visually analysed in more effective way. In this paper, we present a new method for the automatic generation of flow maps.

This method is based on a theoretically grounded physical system to describe the motion and forces of attraction and repulsion between data points. Additionally, users have at their disposal features to supervise the evolution of layout. Finally, we evaluate the cost of our algorithm and we give a comparison with the existing implementations. Results have shown a good balance between computational complexity and the visual quality of the generated maps.

M83: Review and Comparative Study of Ray Traversal Algorithms on a Modern GPU Architecture

Santos, A.L., Teichrieb, V. and Lindoso, J.E.F.

Abstract:

In this paper we present a chronological review of five distinct data structures commonly found in literature and ray tracing systems: Bounding Volume Hierarchies (BVH), Octrees, Uniform Grids, KD-Trees, and Bounding Interval Hierarchies (BIH). This review is then followed by an extensive comparative study of six different ray traversal algorithms implemented on a modern GPU architecture, the NVIDIA CUDA platform, to point out pros and cons regarding performance and memory consumption of such structures. We show that, for most cases, a GPU KD-Tree ray traversal achieved better performance results, specially the one based on ropes. It surpasses or competes with the BVH, often used as primary structure on state-of-the-art ray tracers. A carefully well implemented ropes based KD-Tree CUDA traversal can improve performance on a 26-32\% approximate range. This suggests that, for critic real time applications, the ropes based KD-Tree traversal is a more adequate option on GPU. However, this structure consumes at least 2x more memory space than BVHs and BIHs. This disadvantage can be a limiting factor for rendering highly complex geometric scenes or on memory limited architectures.

M89: A lightweight approach for analyzing insect behavior on a mobile system

Marcovecchio,D., Delrieux,C., Werdin,J., Stefanazzi,N.

Abstract:

This paper describes the research, design, and development of a lighthweight system created in order to track multiple insects on just-recorded videos, and generate statistics using the obtained information. The system was created in order to replace the previous methods (manual monitoring that requires a lot of human assistance, or expensive specific instrumental) used in a laboratory to analyze insect behavior, and uses algorithms that are fast enough to allow it to run on a simple mobile phone. The final installation is simple and unexpensive, and allows the researchers to immediately obtain the data needed to evaluate their work. Typical segmentation and tracking problems (bad-quality frames, changes on the appearence of the tracked objects or the background scene, occlusion between an object and the scene or between multiple objects, or camera movement) were attacked. The tortuosity of the insect's path was calculated using our own algorithm to approximate the fractal dimension of the trails, and the result is a flexible system that allows researchers to record and immediately analyze the behavior of multiple insects in a laboratory.

Communication and short paper s

G73: The Shortest Path Finding between two points on a Polyhedral Surface

Popov, Eugene Vladimirovich; Popova, Tatyana Petrovna; Rotkov, Sergej Igorevich

Abstract:

The paper describes the approximate method of the shortest path finding between two points on a surface. This problem occurs when cutting pattern generating after the form of the fabric tensile surface is found. The shortest path finding is reduced to the problem of finding the geodesic line on the surface. However, the numerical problem solution of the fabric tensile structure form finding leads to the fact that final surface is represented by an arbitrary polyhedron. There is no an analytical problem solution of finding shortest paths in this case. The described method allows finding a shortest path on the surface of any regular polyhedron form.

G89: Wavelet Representation of Optical System Distortion

Zahradka,J., Barina,D., Zemcik,P.

Abstract:

A novel method for a representation of the optical system distortion using the discrete wavelet transform is proposed in this paper. Using the proposed approach, virtually any complex distortion can be represented only with a small number of wavelet coefficients. Moreover, one can represent the distortion up to the resolution of one pixel or even finer. The experiments shown in the paper suggest that the proposed wavelet interpolation reconstruct distorted data very realistically. The proposed method was evaluated on two scenes comprising a projector and irregular surfaces using dataset of images of various type.

G97: Distributed Triangle Mesh Processing

Cabiddu,D., Attene,M.

Abstract:

We propose a web-based system to remotely and distributedly process triangle meshes. Users can implement complex geometric procedures by composing simpler processing tools that, in their turn, can be provided by researchers who publish them as appropriate Web services. We defined an efficient geometric data transfer protocol in order to resolve the potential mesh delivery bottleneck caused by the transfer of large models to the various servers on typical long-distance connections with limited bandwidth. We have experimented our system on several large models and on diverse processing scenarios, and we have concluded that our transfer protocol significantly reduces the overall time needed to produce the result.

H03: Local Monte Carlo estimation methods in the solution of global illumination equation

Budak, V., Zheltov, V.

Abstract:

In this article we consider a local estimations of the Monte Carlo method for solving the equation of the global illumination. The local estimations allow to calculate directly the luminance at a predetermined point, in a given direction for an arbitrary law of reflection. Thus, there is no need to construct the map of the illumination. Thereby it is much more effective than direct modeling or method of finite element . The usage in lighting calculations of the object described by the spherical harmonics is also discussed in the article.

H13: Is Augmented Reality the Future Middleware for Improving Human Robot Interactions?

Eranda Lakshantha

Abstract:

With robots appearing frequently within our society, the cases will be higher where people with little or no practical experience in robotics would have to supervise robots. Future interfaces should make Human Robot Interactions (HRI) intuitive for such less-experienced users. A key requirement to have an intuitive interface is to improve the level of HRI performance. In this study we try to improve the HRI performance by developing a system namely, SHRIMP (Spatial Human Robot Interaction Marker Platform) based on Augmented Reality (AR) technology. We present SHRIMP as a new type of middleware for HRI, that can mediate high-level user intentions with robot-related action tasks. SHRIMP enables users to embed user intentions in the form of AR diagrams inside the robot's environment (as seen by the robot's camera view). These AR diagrams translate into action tasks for robots to follow in that environment. Furthermore, we report on the HRI performance induced by our SHRIMP framework when compared to an alternative more common robot control interface, a joystick controller.

H19: Image Matching using Circular Dynamic Time Warping

Faisal,S., Vijayakumar,B., Jagadish,N.

Abstract:

In this paper, we present a simple image matching method, that can be tuned to work according to the constraints of the computation environment or the domain context. It can be used in cases where a quick comparison estimate is required using just enough resources that can be spared. A novel technique, Circular Dynamic Time Warping (CDTW), developed by modifying the basic DTW method is used to obtain an optimum alignment of vector form feature representation before the comparison process. CDTW can be used to enhance the matching accuracy of any audio or visual search system. The feature descriptor that we have used in this work is based on pixel tile density measure. However, this can be replaced with any feature descriptor that can be represented in a vector form. The system initially splits the image into a customizable number of tiles. Features are extracted for each tile using density histogram based computation. CDTW vector realignment and matching is then performed on the image density matrices along each dimension. This process is iterated for increasing values of the tiling parameter until the expected results are obtained or until the threshold resource constraints are reached.

H29: Visual Exploration of Patterns in Multi-run Time-varying Multi-field Simulation Data Using Projected Views

Molchanov,V., Linsen,L.

Abstract:

Numerical simulations in the fields of science and engineering generate spatial data of time-varying phenomena that frequently depend on various simulation and input parameters. It is common to run hundreds of simulations to investigate the dependence of the modeled process on the choice of the parameters. We propose a comprehensive approach for the visual analysis of such multi-run data to detect patterns and outliers. We use dimensionality reduction algorithms to generate a visual representation that exhibits the distribution of the simulation results under varying parameter settings. Each field (or even multi-field) of every time step and every simulation run is represented as a point in a 2D space, where the 2D layout conveys similarity of the scalar fields. Points corresponding to consecutive time steps of one run are connected by line segments, such that each simulation run is represented as a polyline. Consequently, the multi-run data are visually encoded as a set of polylines. Variations of hue, saturation, opacity, and shape allow for distinguishing groups of simulations and depicting various characteristics of runs. The user can interactively change these settings, while further interaction mechanisms allow for selection, refinement, zooming, requesting textual information, and brushing and linking to coordinated (or embedded) views of physical and attribute space visualizations. We apply our approach to two common applications with significantly different data structure. The first application is a multi-run climate modeling simulation based on an Eulerian method over a 2D regular grid. The second application is a multi-run binary star evolution simulation based on a Lagrangian method (Smoothed Particle Hydrodynamics) with unstructured particles changing 3D positions over time. We demonstrate the contribution and impact of our visualization method for the interactive visual analysis of the multi-run data by identifying meaningful groups of simulations, detecting global patterns, and finding interesting outliers.

H37: Invariant Interest Point Detection Based on Variations of the Spinor Tensor

Hast,A., Marchetti,A.

Abstract:

Image features are obtained by using some kind of interest point detector, which often is based on a symmetric matrix such as the structure tensor or the Hessian matrix. These features need to be invariant to rotation and to some degree also to scaling in order to be useful for feature matching in applications such as image registration. Recently, the spinor tensor has been proposed for edge detection. It was investigated herein how it also can be used for feature matching and it will be proven that some simplifications, leading to variations of the response function based on the tensor, will improve its characteristics. The result is a set of different approaches that will be compared to the well known methods using the Hessian and the structure tensor. Most importantly the invariance when it comes to rotation and scaling will be compared.

H41: Correspondence Chaining for Enhanced Dense 3D Reconstruction

Wasenmüller, O., Krolla, B., Michielin, F., Stricker, D.

Abstract:

Within the computer vision community, the reconstruction of rigid 3D objects is a well known task in current research. Many existing algorithms provide a dense 3D reconstruction of a rigid object from sequences of 2D images. Commonly, an iterative registration approach is applied for these images, relying on pairwise dense matches between images, which are then triangulated. To minimize redundant and imprecisely reconstructed 3D points, we present and evaluate a new approach, called Correspondence Chaining, to fuse existing dense two-view 3D reconstruction algorithms to a multi-view reconstruction, where each 3D point is estimated from multiple images. This leads to an enhanced precision and reduced redundancy. The algorithm is evaluated with three different representative datasets. With Correspondence Chaining the mean error of the reconstructed pointclouds related to ground truth data, acquired with a laser scanner, can be reduced by up to 40%, whereas the root mean square error is even reduced by up to 56%. The reconstructed 3D models contain much less 3D points, while keeping details like fine structures, the file size is reduced by up to 78% and the computation time of the involved parts is decreased by up to 42%.

H43: Interactive Guidance and Navigation for Facilitating Image-Based 3D Modeling

Liu, Damon Shing-Min Liu, Chang, Te-Li

Abstract:

Here we present an interactive guidance and navigation system that assists user in acquiring pictures for image based 3D modeling. To reconstruct an object's 3D model, user follows our instruction to take a set of images for an object in different angles, we calculate their relative viewing positions and sparse point cloud data using structure from motion technique. After we obtain sufficient number of images, we use Patch-based Multi-View Stereo (PMVS) [1] software to generate dense point cloud data. When displaying dense point cloud, we provide user an interface to eliminate those noise data points yielded from background construction or re-projection errors. Afterwards we reconstruct surface mesh as output. Our system provides informative message for failures while calculating camera poses and helps user how to resolve those problems. Furthermore, we assess the quality of camera poses reconstruction and generated point cloud to reveal the lack of angles for captured images and guide user to remedy those information.

H47: Kinect based 3D Scene Reconstruction

Zeller,N., Quint,F., Guan,L.

Abstract:

This paper presents a novel system for 3D scene reconstruction and obstacle detection for visually impaired people, which is based on Microsoft Kinect. From the depth image of Kinect a 3D point cloud is calculated. By using both, the depth image and the point cloud a RANSAC based plane segmentation algorithm is applied. After the segmentation the

planes are combined to objects based on their intersecting edges. For each object a cuboid shaped bounding box is calculated. This paper also presents accuracy analysis of the system, which show promising results. Besides, the paper gives an overview about already existing navigation aids for visually impaired people and the presented system is compared to a state of the art system.

H59: On Maximum Geometric Finger-Tip Recognition Distance Using Depth Sensors

Shekow,M., Oppermann,L.

Abstract:

Depth sensor data is commonly used as the basis for Natural User Interfaces (NUI). The recent availability of different camera systems at affordable prices has caused a significant uptake in the research community, e.g. for building hand-pose or gesture-based controls in various scenarios and with different algorithms. The limited resolution and noise of the utilized cameras naturally puts a constraint on the distance between camera and user at which a meaningful interaction can still be designed for. We therefore conducted extensive accuracy experiments to explore the maximum distance that allows for recognizing finger-tips of an average-sized hand using three popular depth cameras (SwissRanger SR4000, Microsoft Kinect for Windows and the Alpha Development Kit of the Kinect for Windows 2), two geometric algorithms and a manual image analysis. In our experiment, the palm faces the sensors with all five fingers extended. It is moved at distances of 0.5 to 3.5 meters from the sensor. Quantitative data is collected regarding the number of recognized finger-tips for each sensor, using two algorithms. For qualitative analysis, samples of the hand outline are also collected. The quantitative results proved to be inconclusive due to false positives or negatives caused by noise. In turn our qualitative analysis, achieved by inspecting the hand outline images manually, provides conclusive understanding of the depth data quality. We find that recognition works reliably up to 1.5 m (SR4000, Kinect) and 2.4 m (Kinect 2). These insights are generally applicable for designing NUIs that rely on depth sensor data.

H61: 3D Morphing for Triangle Meshes

Tianwei Xing, Yipin Yang, Yao Yu, Yu Zhou, Xianglei Xing, Sidan Du

Abstract:

We introduce a 3D morphing method which generates a merged model given a series of triangle meshes. Our morphing, based on a set of parameters between the source and target shapes, can show the process of the transformation from the source to the target smoothly. We choose a model as our reference mesh, and obtain corresponding unified models from other models which may have different number of vertices or facets. Given these unified models, parameters between any two meshes can be computed integrally or separately for each rigid part. Different forms of combination of the parameters can generate different merged models. To address the collapsed situation happened occasionally, shape and pose morphing are separated for some parts in our work. By merging different parts of different models, we can get a merged shape, e.g. an animal with the horse head and the cat body. As an application of our 3D morphing method, quantifying the difference between any two models can be done efficiently, represented by the distance between any two sets of low-dimensional parameters reduced from the initial parameters using Principal Component Analysis (PCA). Character replacement and model driven are another two applications. Characters in two-dimensional images are used to guide our morphing work and depth image sequence is used to drive our merged model to show the same pose as the character in the sequence respectively.

H67: Visualization of Traffic Flow Simulations Based on

Vergeest, J.S.M.

Abstract:

Microscopic car-following models are widely used to generate traffic flow simulations. In some cases visualization on macroscopic scales (both spatial and temporal) are required to provide relevant feedback to researchers. Recent studies have indicated that the life time of highway traffic jams is severally influenced by temporary deviations of the driving style of individual motorists. The most influential parameters are the longitudinal acceleration and the headway distance produced by car drivers soon after leaving a congestion situation. To study the effects of acceleration profiles on the life times of congestions it is crucial to generate traffic flow simulations which can be viewed at highly varying spatial and temporal scales. The influence of adaptive cruise control (ACC), for example, is one of the factors that can be forecasted using traffic flow simulations. In this paper we present typical results of such simulations and suitable graphical presentations, which support the traffic flow research.

H71: Evaluation of Fuzzy Rough Set Feature Selection for Content Based Image Retrieval System with Noisy Images

Shahabi Lotfabadi,M., Shiratuddin,M.F., Wong,K.W.

Abstract:

In this paper Fuzzy Rough Set is used for feature selection in the Content Based Image Retrieval system. Noisy query images are fed to this Content Based Image Retrieval system and the results are compared with four other feature selection methods. The four other feature selection methods are Genetic Algorithm, Information Gain, OneR and Principle Component Analysis. The main objective of this paper is to evaluate the rules which are extracted from fuzzy rough set and determine whether these rules which are used for training the Support Vector Machine can deal with noisy query images as well as the original queried images. To evaluate the Fuzzy Rough set feature selection, we use 10 sematic group images from COREL database which we have purposely placed some defect by adding Gaussian, Poisson and Salt and Pepper noises of different magnitudes. As a result, the proposed method performed better in term of accuracies in most of the different types of noise when compared to the other four feature selection methods.

H79: Recursive Procedural Tonal Art Maps

Szécsi,L., Szirányi,M.

Abstract:

This paper presents a real-time procedural texturing algorithm for hatching parametrized surfaces. We expand on the concept of Tonal Art Maps to define recursive procedural tonal art maps that can service any required level-of-detail,

allowing to zoom in on surfaces indefinitely. We explore the mathematical requirements arising for hatching placement and propose algorithms for the generation of the procedural models and for real-time texturing.

I02: Navigation Parameters Correction Technique Using Multiple View Geometry Methods

Sablina,V.A., Novikov,A.I., Nikiforov,M.B., Loginov,A.A.

Abstract:

The problem of determining precisely the current location coordinates and orientation of an aircraft in the space is formulated and considered in this paper. The review of the existing approaches to the navigation tasks solutions in the aviation is done. The advantages of the contour analysis and the multiple view geometry mathematical apparatus application are revealed. The general navigation parameters correction technique on the basis of the multispectral computer vision system images analysis is suggested. For the main stages of the suggested technique the used approaches are described and the experimental results of the investigations are obtained, viz. the object detection and comparison, the geometric interconnection finding between the images for the subsequent navigation parameters correction. The obtained results also can be used for the real and the synthesized images superimposition problem solution in multispectral computer vision systems. The experiments show that using multiple view geometry methods in combination with contour analysis methods is promising for the aircraft navigation parameters correction problem solution in the real time.

I03: Texture Classification with the PQ Kernel

Ionescu, R.T., Popescu, A.L., Popescu, M.

Abstract:

Computer vision researchers have developed various learning methods based on the bag of words model for image related tasks, including image categorization, image retrieval and texture classification. In this model, images are represented as histograms of visual words or textons from a vocabulary that is obtained by clustering local image descriptors. Next, a classifier is trained on the data. Most often, the learning method is a kernel-based one. Various kernels can be plugged in to the kernel method. Popular choices, besides the linear kernel, are the intersection, the Hellinger’s, the χ2 and the Jensen-Shannon kernels. Recent object recognition results indicate that the novel PQ kernel seems to improve the accuracy over most of the state of the art kernels. The PQ kernel is inspired from a set of rank correlation statistics specific for ordinal data, that are based on counting concordant and discordant pairs among two variables. This paper describes an efficient algorithm to compute the PQ kernel in $O(n \log n)$ time, based on merge sort. The algorithm leverages the use of the PQ kernel for large vocabularies. Texture classification experiments are conducted to compare the PQ kernel with other state of the art kernels on two benchmark data sets of texture images. The PQ kernel has the best accuracy on both data sets. In terms of time, the PQ kernel becomes comparable with the state of the art Jensen-Shannon kernel. In conclusion, the PQ kernel can be used to obtain a better pairwise similarity between histograms, which, in turn, improves the texture classification accuracy.

I19: Parking Spaces Modelling for Inter Spaces Occlusion Handling

Masmoudi,I., Wali,A., Alimi,A.

Abstract:

Intelligent systems for vacant parking spaces detection present an important solution to facilitate finding an available place for the drivers. Many real world challenges can face these vision based systems like weather conditions and luminance variation. In this paper, we are interested in the problem of inter spaces occlusion, where one or more place of a parking can be hidden by another parked vehicle. In order to overcome this problem we propose a new on-street surface based model for parking model extraction and we perform vehicle tracking in order to detect the events of "Entering" and "Leaving" of a car to a parking place.

I23: Mesh Partitioning for Parallel Garment Simulation

Hutter,M., Knuth,M., Kuijper,A.

Abstract:

We present a method for partitioning meshes that allows a simple and efficient parallel implementation of different simulation methods. It is based on a generalization of the concept of independent sets from graph theory to sets of simulation elements. The general description makes it versatile and flexibly applicable in existing simulation systems. Every simulation method that formerly worked by sequentially processing a set of simulation elements can now be parallelized by partitioning the underlying set, without affecting the behavior of the simulated model.

I29: Calibration of RGB Camera with Velodyne LiDAR

Velas,M., Spanel,M., Materna,Z., Herout,A.

Abstract:

Calibration of the LiDAR sensor with RGB camera finds its usage in many application fields from enhancing image classification to the environment perception and mapping. This paper presents a pipeline for mutual pose and orientation estimation of the mentioned sensors using a coarse to fine approach. Previously published methods use multiple views of a known chessboard marker for computing the calibration parameters, or they are limited to the calibration of the sensors with a small mutual displacement only. Our approach presents a novel 3D marker for coarse calibration which can be robustly detected in both the camera image and the LiDAR scan. It also requires only a single pair of camera-LiDAR frames for estimating large sensors displacement. Consequent refinement step searches for more accurate calibration in small subspace of calibration parameters. The paper also presents a novel way for evaluation of the calibration precision using projection error.

I61: Set of Texture Descriptors for Music Genre Classification

Nanni, L., Costa, Y., and Brahnam, S.

Abstract:

This paper presents a comparison among different texture descriptors and ensembles of descriptors for music genre classification. The features are extracted from the spectrogram calculated starting from the audio signal. The best

results are obtained by extracting features from subwindows taken from the entire spectrogram by Mel scale zoning. To assess the performance of our method, two different databases are used: the Latin Music Database (LMD) and the ISMIR 2004 database. The best descriptors proposed in this work greatly outperform previous results using texture descriptors on both databases: we obtain 86.1% accuracy with LMD and 82.9% accuracy with ISMIR 2004. Our descriptors and the MATLAB code for all experiments reported in this paper will be available at <https://www.dei.unipd.it/node/2357>.

I83: Consistent Pose Uncertainty Estimation for Spherical Cameras

Krolla, B., Gava, C., Pagani, A., Stricker, D.

Abstract:

In this work, we discuss and evaluate the reliability of first order uncertainty propagation in context of spherical Structure from Motion, concluding that they are not valid without restrictions, but depend on the choice of the objective function. We furthermore show that the choice of the widely used geodesic error as objective function for a reprojection error optimization leads to disproportional pose uncertainty results of spherical cameras. This work identifies and outlines alternative objective functions to bypass those obstacles by deducing Jacobian matrices according to the chosen objective functions with subsequent conduction of first order uncertainty propagation. We evaluate the performance of the different objective functions in different optimization scenarios and show that best results for uncertainty propagation are obtained using the Euclidean distance to measure deviations of image points on the spherical image.

I97: Mass-spring parameters definition in 2D for simulation

Trouvain, G., Gagnol, V., Duc, E., Sancho, J.F.

Abstract:

In computer graphics and in industrial context, Mass-Spring model is used to obtain fast and visual results in physical simulations. A disadvantage of the method is to obtain accurate result on account of the different parameters of a Mass-Spring Model. Different works and results are carried out to define Mass-Spring parameters in other domains such as in cloth animation or in soft tissue modeling. However the Mass-Spring model is not used in some context where a real-time computation can be useful as in tire manufacturing industry for example. In this paper, a method is presented to define the geometric configuration of a Mass-Spring system and the tuning of the mass, stiffness and damper parameters according to physical material behaviours. Different load cases are studied and used to conduct a sensitivity study on the network spring parameters. Then, results are compared to FEM model of same cases in order to evaluate the precision of the proposed approach.

J07: A GPU-Based Level of Detail System for the Real-Time Simulation and Rendering of Large-Scale Granular Terrain

Leach, C., Marais, P.

Abstract:

We describe a system that is able to efficiently render large-scale particle-based granular terrains in real-time. This is achieved by integrating a particle-based granular terrain simulation with a heightfield-based terrain system, effectively creating a level of detail system. By quickly converting areas of terrain from the heightfield-based representation to the particle-based representation around dynamic objects which collide with the terrain, we are able to create the appearance of a large-scale particle-based granular terrain, whilst maintaining real-time frame rates.

J17: MULTI-RESOLUTION SMOOTHING OF NURBS CURVES BASED ON NON-UNIFORM B-SPLINE WAVELETS

Aimin Li, Farong Kou, Qinyu Niu and Haibo Tian

Abstract:

As a rule, an energy method is widely adopted for b-spline curve smoothing, but this method has the disadvantages such as massive calculation, computation complexity and low efficiency. Compared with the energy method, multi-resolution smoothing approaches nicely overcome these obstacles. Presently, some researches have been conducted on multi-resolution smoothing, but these efforts mainly aimed at uniform or quasi-uniform b-spline curves. Uniform and quasi-uniform b-spline curves are just exceptional cases of NURBS curves. Multi-resolution smoothing for these types of curves mostly depend on uniform b-spline wavelets, so this smoothing method can't be directly applied to NURBS curves. In this paper, firstly, new non-uniform b-spline wavelets are created based on discrete b-spline basis functions in the light of the particularities of NURBS curves, the wavelet reconstruction and decomposition algorithms are provided. The wavelets, obviously, have greater flexibility and applicability than uniform b-spline wavelets because of its distance-independence of neighbor nodes in knot vectors. Then, it presents the multi-resolution smoothing method for NURBS curves based on the newly built wavelets. Lastly, an example is presented to confirm effectiveness of this multi-resolution smoothing method. Furthermore, the method can also be applied to NURBS surfaces if extended properly.

J19: Feature Extraction and Localisation using Scale-Invariant Feature Transform on 2.5D Image

Pui, S.T., Minoi, J.L., Terrin, L., Oliveira, J.F., Gillies, D.F

Abstract:

The standard starting point for the extraction of information from raw facial data is the identification of key anatomical landmarks. Extracting identified landmarks from raw face data is usually done manually by trained and experienced scientists or clinicians. The manual landmarking on face surfaces is a laborious process. Hence, we aim to develop methods to automate as much as possible the process of landmarking facial features. These extracted geometric features are useful in several applications such as craniofacial anthropometry landmarking for orthognatic surgery, face recognition and face analysis. In this paper, we present and discuss an automatic landmarking method on face data using 2.5-dimensional (2.5D) range images. We applied the Scale-invariant Feature Transform (SIFT) method to extract feature vectors and the Otsu's method to obtain a general threshold for landmark localization. We have

also developed an interactive tool to ease the visualisation of the overall landmarking process. The interactive visualization tool has a function which allows users to manipulate the threshold values for further analysis, thus enabling one to extract a generalized threshold value that best detects and extracts important keypoints or/and regions of facial features. This paper describes our own implementation of the SIFT and Otsu's algorithms, presents the results of the landmarks, and highlight future work.

J29: A methodological approach to BIM design

Barbato, D.

Abstract:

More and more often the design engineers are in the necessity to realize planning graphic arts loads of information in a very short time: on the one hand the clients' request, on the other hand the decision-makers forced, therefore, to considerable conceptual and executive efforts. The increase of the representative quality and the time and price reduction are just a few of the 'enemies' against which the stakeholders in the construction industry are compelled to fight. The three-dimensional models, conceptual and photo-realistic render, videos, etc., represent a part of the infographics representations available and required by the market. Pursuant to the sectorialization of the specific professional skills, the Building Information Modeling, if properly implemented, deploys itself as 'ally' to face the interdisciplinary inefficiencies in building projects and to reduce the planning time without affecting its quality. It must pay attention to the evolution of the information and data's exchange and management techniques that constitute a complex project. With this contribution we are going to analyze the level of interoperability between three BIM software ArchiCAD 16 by Graphisoft, Revit Architecture 2013 and Robot Structural Analysis both by Autodesk confirming the compatibility of data exchange and, if necessary, how to proceed in the case of loss of information in the transition from one software to another. In particular the Graphisoft program will be used for the architectural modeling, Revit Architecture as control software of the BIM management project and finally Robot Structural Analysis for the structural analysis of the frames in the realized building.

J37: Exploiting Spatial and Temporal Redundancy to Accelerate GPU Rendering

Lawlor, O., Genetti, J.

Abstract:

Just as image data compression is designed to save space while preserving the essence of an image, we present a "rendering time compression" technique designed to save rendering time while maintaining acceptable image quality. We predict when and where it is safe to take less than one sample per output pixel, and exploit temporal and spatial redundancy to predict pixel colors in the resulting gaps, both of which can be performed at framerate in realtime on a modern GPU. As a lossy compression method, we present experimental data on the rendering time versus image quality tradeoff for several example renderers.

J41: GROUP ANALYSIS BASED ON MULTILEVEL BAYESIAN FOR FMRI DATA

Feng Yang, Kuang Fu, Ai Zhou

Abstract:

This paper suggests one method to process fMRI time series based on Bayesian inference for group analysis. The method is based on Bayesian inference to divide group into multilevel by session, subject and group levels. And it compares covariance to select prior to reinforce posterior probability in group analysis. And also it combines classical statistics, i.e., t-statistics to obtain voxel activation at subject level as prior for Bayesian inference at group level. It effectively solved computation expensive and complexity. And it shows robust on Bayesian inference for group analysis.

J43: A Simple Method for Generating of Facial Barcodes

Matveev, Yu., Kukharev, G., Shchegoleva, N.

Abstract:

In the paper a simple method for generating of standard type linear barcodes from facial images is proposed. The method is based on the use of difference gradients of image brightness, averaging gradients on a limited number of intervals, quantization of results in a range of decimal numbers from 0 to 9 and table conversion into the final barcode. The proposed solution is computationally low-cost and not requires the use of specialized software on image processing that allows generating of facial barcodes in mobile systems. Results of tests on the Faces94 database and database of composite faces at different ages showed that the proposed method is a new solution for use in the real-world practice and ensures the stability of generated barcodes in changes of scale, pose and mirroring of a facial image, and also changes of a facial expression and shadows on faces from local lighting.

J47: GPU-based discrepancy check for 3D fabrication

Wu, F., Dellinger, A.

Abstract:

A GPU-based visualization approach is presented to show the discrepancies between the 3D model and the fabrication of that model. To show the differences, a 3D scanner is constructed to scan the fabrication for comparison with the 3D model. To compare the detailed differences, a high resolution camera with a projector is used. To demonstrate its application, a sculpting assistance system is implemented. The system can capture the three-dimensional model iteratively and provide information by rendering different colors on the surface to show the topological and geometric differences between the final target model and the current model. Then the user can see how to modify the current model to best approximate the final target model. The topological difference is obtained by rendering on the screen the 3D data from both the final target model and the current model. The user can manipulate and observe their differences. The local geometry is compared in the GPU and rendered on the real scene. Users can easily see the geometry directly on the fabrication. To keep a fixed relationship between the 3D model and the fabrication, a reference image is tracked at the bottom stage to recover the related transformation.

J67: Geometrical Analysis Based Text Localization Method

Tehsin, S., Masood, A.

Abstract:

Textual information embedded in multimedia can provide a vital tool for indexing and retrieval. Text extraction process has many inherent problems due to the variation in font sizes, color, backgrounds and resolutions. Localization of detected text is the most challenging phase. Text extraction results are highly dependent upon this phase. This paper focuses on the text detection and localization because of their very fundamental importance. A text detection and localization methodology along with the geometrical analysis of text objects is presented.

J83: A Cave Based 3D Immersive Interactive City With Gesture Interface

Ziyang Zhang, Tim McInerney, Ning Zhang, Ling Guan

Abstract:

3D city models have greatly changed the way we interactive with geographic information. However both the visualization and interaction are limited on conventional 2D displays. This paper presents a system that visualizes 3D cities and allows gesture interaction in the fully immersive Cave Automatic Virtual Environment (CAVE). The proposed system enables navigation, selection, and object manipulation, which will be basic functions in applications such as urban planning, virtual tourism, etc. We propose the use of pattern recognition methods for gesture recognition as new type of interactions in a Virtual Reality (VR) environment. In this work, we apply the Hidden Markov Model, to facilitate real time dynamic gesture recognition, and achieve good recognition result. We also propose a novel selection method for selecting multiple objects in VR. User study shows preference of the proposed system both for its realistic immersive visualization and natural gesture interface.

K02: Manipulation of Motion Capture Animation by Characteristics

De Martino, J. M., Angare, L. M. G.

Abstract:

Three-dimensional animation is an area in vast expansion due to continuous research that has enabled an increasing number of animators, artists and technicians access to softwares that provide powerful tools with an intuitive interface. In this paper we present a new methodology by which artists can manipulate existing animation segments using intuitive characteristics instead of manually changing keyframes' values and interpolations. To achieve this goal, motion capture is used to create a database in which different characteristics are performed within a movement, these characteristics are mapped as transformations of animation curves that can be used to change a large set of keyframes in order to imbue such characteristic into the segment. To test our methodology, we used as a proof of concept a character performing a walk, represented by 59 joints and 172 DOF, and a set of 12 physical and emotional characteristics. Using our methodology we imbued a neutral walk with these desired characteristics and evaluated the results with a survey comparing our imbued animations with direct motion capture movements. With this methodology, one can decrease drastically the time needed to tweak large sets of keyframes, imbuing a desired characteristic in a fashion more closely related to the artistic universe of animators than the mathematical representations of angles, translations and interpolations in an animation curve commonly used in animation softwares.

K17: Accelerated SQLite Database using GPUs

Hordemann,G., Lee,J.K., Smith,A.H.

Abstract:

This paper introduces the development of a new GPU-based database to accelerate data retrieval. The main goal is to explore new ways of handling complex data types and managing data and workloads in massively parallel databases. This paper presents three novel innovations to create an efficient virtual database engine that executes the majority of database operations directly on the GPU. The GPU database executes a subset of SQLite's SELECT queries, which are typically the most computationally expensive operations in a transactional database. This database engine extends existing research by exploring methods of table caching on the GPU, handling irregular and complex data types, and executing multiple table joins and managing the resulting workload on the GPU. The GPU database discussed in this paper is implemented on a consumer grade GPU to demonstrate the high-performance computing benefits of relatively inexpensive hardware. Advances are compared both to existing CPU standards and to alternate implementations of the GPU database.

K19: SAMI: Saliency based Metrics of Identification

Gossemaume,J.,Kpalma,K.,Ronsin,J.

Abstract:

ABSTRACT

We propose original metrics for estimation of detection and identification of an object in an image. SAMI, (Saliency based Metrics of Identification), allows to compare the performance of detection and identification of a given Region Of Interest (ROI) within a test image. The metrics give a saliency score and a structural score, for the detection evaluation and the identification evaluation, respectively, for this ROI. The identification evaluation requires the ground truth edges of the test image. SAMI has initially been conceived to estimate the performance of SCOTT, a Synthesis COncement Two-level Texture algorithm. However, a direct derived application of such metrics could be the evaluation of saliency algorithms for object segmentation: given the ground truth area of a salient object in the ROI, the best segmentation would be the one with the highest SAMI saliency score in this ROI. Another possible application could be the use of SAMI inside a saliency algorithm, to compute a dense modified saliency map, in which each pixel has the SAMI score corresponding to its neighborhood. Such a resulting map would be more robust to saliency noise from small spots.

K29: 3D Visualization of UCG Process

Iwaszenko S., Nurzyńska K.

Abstract:

This paper presents the aspects of 3D graphics utilization in the visualization of underground coal gasification (UCG) process. Data gathered during the process as well as achieved by the mathematical modelling describe a three

dimensional structure of the georeactor where the process takes place. Proper visualization of this information is crucial for better understanding of the process and further possibilities of its development and practical usage. Therefore, a dedicated software tool was developed to support the visualization of the data. This program enables visualization of the data in user friendly environment which supports the monitoring of process during each stage. It is developed with application of XNA technology in C#.NET. The system overview with possible applications are presented.

K37: A web-based occlusion culling method applied to real 3D cities considering terrain information

Robles-Ortega, M.D., Ortega L.M. Feito F.R.

Abstract:

A complete and realistic urban model is too complex to be stored in any type of client device, especially in tablets or smartphones. Nevertheless, from a pedestrian point of view, only a small portion of an urban scene is visible. This feature makes efficient the use of occlusion culling techniques working on the server-side since the client only visualizes the portion of visible scene during the walkthrough process. However, in steep cities the buildings are not the only occluders, but also the street slope. In this paper we propose an exact occlusion culling method for 2.5D urban scenes considering DEM information. Our approach uses the polar diagram as plane tessellation and the Digital Elevation Model of the city. We combine our method with a Level of Detail technique to reduce the scene geometry, which makes the approach appropriate to be used in a client-server system. The application has been tested using the cadastral 2D GIS of Jaén.

K59: Pose Estimation of Small Articulated Animals with Multiple View Images

Hwang,S., Young, C.

Abstract:

Study of robot that mimics the behavior of small animals such as lizards and arthropods has been actively carried out. However, research on systematic analysis of the gait behavior of small animals is not easy to find. Motion analysis of most living creatures is using the optical motion capture system. However, it is inapplicable to small animals because of it is difficult to attach optical makers. To solve this problem, the markerless motion capture is being researched, but many researches about markerless motion capture performed with human subjects. Therefore, to apply markerless motion capture system for insects which have many legs and high degree of freedom, the additional researches are needed. The purpose of the study is to develop a system to estimate continuous pose of small articulated animals using three-dimensional skeleton model of the animal from multi-view video sequence. It includes extraction of extremity and root of each leg and calculation of joint kinematics using FABRIK(Forward And Backward Reaching Inverse Kinematics) algorithm with extracted extremity and root. The method developed in this study will contribute to better understand gait behavior of the small articulated animals.

K79: Physics-based modelling and animation of saccadic eye movement

Papapavlou,C., Moustakas,K.

Abstract:

In this paper we present a new approach in producing realistic saccade eye movement animations by incorporating anatomical details of the oculomotor system into the dynamics of the eye model. Unlike abstract models of the eye motor behaviour, we make use of a biomedical framework to effectively model the eye globe along with the three extraocular muscle pairs in efficient detail, that the application of the corresponding muscle activation signals, naturally results in realistic motions. That way, we avoid the need of explicitly providing trajectory information, and therefore simplify the process of eye animation. Regarding the calculations of the muscle activation signals needed to drive the animation in a way that imitates a real human eye, we are based on existing knowledge about the way that the nervous system utilizes the extraocular muscles during saccades.

L07: Semi-automatic Segmentation of Prostate by Directional Search for Edge Boundaries

Kortelainen, J.M., Antila, K., Schmitt, A., Mougenot, C., Ehnholm, G., Chopra, R.

Abstract:

Semi-automatic segmentation of prostate boundary is presented for the pre-operational images of the MRI-guided ultrasonic thermal therapy of prostate cancer. The specific deformable surface method is based on firstly fitting ellipsoid on the given manual landmark points, then modifying the shape of the initialization surface mesh by masking out regions of separately segmented bladder and rectum, and finally adapting the surface mesh by searching image for the edge boundaries in direction of the surface normal. The segmentation is using both T2-weighted planning MR-image, which shows sufficient contrast on the prostate boundary, and the smoothed T1-weighted preparation MR-image, for guiding the search direction. Dice similarity coefficient (DSC) between the semi-automatic segmentation and the manual reference was in the average 0.89 for a group of N=5 patients having MRI guided ultrasound thermal treatment. The robustness of the surface fitting method was tested by simulating 30 randomized initialization sets of landmark points for each patient, and the resulted standard deviation of DSC was 0.01.

L29: Three Dimensional Blood Vessel Modeling Method Considering IVUS Catheter Insertion

Son,J., Choi,Y.,Lee,W.S.,Kim,S.W.

Abstract:

In this paper, we proposed a new 3D blood vessel modeling method for FSI(Fluid-Structure Interaction) analysis. Because of characteristics of medical images, a 3D blood vessel model including intima and adventitia cannot be reconstructed using a single medical image. For obtain detail intima and adventitia information, many researchers use IVUS(Intravascular Ultrasound) image and for calculate position and orientation of IVUS images, X-ray angiogram images are used. Therefore, by combining these medical images, 3D blood vessel model can be generated. However, when IVUS image is taken, a catheter attached miniaturized ultrasound device is inserted into blood vessel, so the

shape of blood vessel is deformed. Accordingly, the 3D blood vessel model combining IVUS and X-ray angiogram images is in deformed state by IVUS catheter. For solve this problem, in this study, we proposed novel method for 3D blood vessel model including undeformed intima and adventitia by IVUS catheter.

L31: Sequence-based Human Appearance Matching Across Multiple Cameras

Beihua Zhang, Xiongcai Cai and Arcot Sowmya

Abstract:

We present a sequence matching algorithm based on selected feature point pairs and a sequence matching measure across multi-cameras. In initial frame-based similarity measurement, we cluster the feature point candidate pairs based on photometric similarity and pairwise geometric constraints. Then, we use a similarity measure to obtain a frame-based similarity score. In the sequence matching measurement, we obtain the stable and accurate sequence of human frames based on Model-adaptive Mean-Shift Tracking method. For improving the accuracy of human matching, we choose the best view of the human face for sequence-based matching, then obtain a sequence-based similarity score based on the Hausdorff distance. Experiments demonstrate that our method is robust to deformation, even for large pose changes, and applicable to overlapping and non-overlapping multiple camera systems.

L37: Head Pose Estimation Based on 2D and 3D for Driving Assistance Systems

Peláez, G., García, F., Armingol, J. Escalera, A.

Abstract:

A solution for driver monitoring and event detection based on 3D information from a range imaging camera is presented: The system combines 2D and 3D algorithms to provide head pose estimation and regions of interest identification. Starting with the captured cloud of 3D points from the sensor and the detection of a face in the 2D projection of it, the points that correspond to the head are determined and extracted for further analysis. Later the head pose estimation with 3 degrees of freedom (Euler angles) is estimated using ICP algorithm. As a final step, the important regions of the face are identified and used for further experimentation, e.g. gaze orientation, behavior analysis and more. The resulting application is a complete 3D driver monitoring application, based on low cost sensor; it is described how to combine both 2D and 3D computer vision algorithms for future human factors research enabling the possibility to study specific factors like driver drowsiness, gaze orientation or the head pose estimation itself. The experimental results shown are compared with ground-truth head movements obtained using an IMU

L47: A Diving Simulator for Organizing Dives in Real Conditions

Aristidou, K., Michael, D.

Abstract:

We present a complete diving simulator that can be used for organizing dives in real conditions. Our simulator comprises of three main components: (a) integration of a diving computation algorithm that allows divers to compute the available time they have in water to avoid drowning and divers sickness, (b) accurate visualization of a real wreck site in Mediterranean sea, Zenobia Cyprus, one of the most well-known wrecks worldwide and (c) visualization of marine life based on the real types of species that are gathering near the wreck. The simulator can be used by divers to organize their dives in advance at the specific wreck and moreover can be used as a tool to promote diving tourism. The diving computation part of the simulator has been validated according to International Diving Training Organization's data proving its accuracy and correctness, while the complete system has been evaluated by expert users (divers) denoting the importance of the specific simulator.

L53: 3D Registration of Multi-modal Data Using Surface Fitting

Amine Mahiddine, Djamal Merad, Pierre Drap, Jean-marc Boï

Abstract:

The registration of two 3D point clouds is an essential step in many applications. The objective of our work is to estimate the best geometric transformation to merge two point clouds obtained from different sensors. In this paper, we present a new approach for feature extraction which is distinguished by the nature of the extracted signature of each point. The descriptor we propose is invariant to rotation and overcomes the problem of multi-resolution. To validate our approach, we have tested on synthetic data and we have applied to heterogeneous real data.

L83: Innovative Solutions for Immersive 3D Visualization Laboratory

Lebiedz', J., Mazikowski, A.

Abstract:

The paper presents results of the work concerning the technical specification of Immersive 3D Visualization Laboratory to be opened in late summer 2014 at the Faculty of Electronics, Telecommunications and Informatics at Gdańsk University of Technology in Poland. The person immersed in VR space will be placed in a transparent sphere with a diameter of over 10 feet, supported on rollers and equipped with a motion tracking system. Walking motion of the person will inflict the revolution of the sphere and trigger changes in the computer generated images on screens surrounding the sphere (CAVE with six walls) thus creating an illusion of motion. The projection system will be equipped with a 3D visualization capability and supplemented with a spatial sound generation system. The analysis prior to the specification was based on extended studies including literature and site visits to selected installations in Europe as well as consulting with companies which are leading European manufacturers and 3D systems integrators.

L97: Reconstruction & Interaction with 3D Simplified Bone Models

Pulido, R., Paulano, F., Jiménez, Juan J.

Abstract:

Visualization and interaction with 3D bone models reconstructed from medical images are fundamental for bio-medical applications. They are useful for surgeons in order to diagnose and plan surgical operations. Although traditional reconstruction techniques based on iso-surfacing are mainly used for visualization, it is desirable to obtain labelled models without outliers in order to improve the interaction. This paper presents the integration of digital image processing and computer graphic techniques to enable not only the reconstruction of simplified 3D bone models, but

also the interaction with them. To that end, the segmentation of CT images is performed in order to obtain the different bone regions and to label them. This approach is divided into three main parts: segmentation, reconstruction and interaction. The goal of the segmentation is to extract closed contours and to generate labelled regions which represent the bone structures to be reconstructed. Then, three-dimensional bone models are obtained from these regions by isosurfacing. Finally, a detailed collision detection can be calculated between the 3D models in the scene in order to provide visual aid when the user is interacting with the them. This interaction includes the calculation of distances, nearest points and overlapping triangles. Moreover, an immersive experience is provided by integrating the Leonar3Do stereo system.

M03: User-based Visual-interactive Similarity Definition for Mixed Data Objects - Concept and First Implementation

Bernard, J., Sessler, D., Ruppert, T., Davey, J., Kuijper, A., Kohlhammer, J.

Abstract:

The definition of similarity between data objects plays a key role in many analytical systems. The process of similarity definition comprises several challenges as three main problems occur: different stakeholders, mixed data, and changing requirements. Firstly, in many applications the developers of the analytical system (data scientists) model the similarity, while the users (domain experts) have distinct (mental) similarity notions. Secondly, the definition of similarity for mixed data types is challenging. Thirdly, many systems use static similarity models that cannot adapt to changing data or user needs. We present a concept for the visual-interactive definition of similarity for mixed data objects emphasizing 15 crucial steps for the development of appropriate systems. For each step different design considerations and implementation variants are presented, revealing a tremendous design space. Moreover, we present a first implementation of our concept, enabling domain experts to express mental similarity notions through a visual-interactive system. An additional system mode enables data scientists to monitor this similarity-based expert feedback and thereby to validate our implementation. The provided implementation tackles the different stakeholders problem, the mixed data problem, and the changing requirements problem. We show the applicability of our implementation in a case study where a mental similarity notion is transferred into a functional similarity model.

M11: Personal Health Data: Visualization Modalities and Their Perceived Values

Fens, P., Funk, M.

Abstract:

In this paper we focus on universal human values as defined by Schwartz [Schw92] in the context of visualizing personal health data. Can data visualizations convey human values? We have explored various modalities of presenting health data and found that personal health visualizations indeed can convey values. This is currently work in progress, an initial step towards value-based design in the area of data visualization of personal health data.

M13: Minimum Residual Methods for Cloth Simulation

Francu, M.

Abstract:

This paper presents a new method of simulating cloth based on the position based dynamics paradigm. We are replacing the widely used iterative relaxation techniques (Jacobi and Gauss-Seidel) with conjugate gradient like methods (Minimum Residual and Conjugate Residuals) and show that they have better convergence and stability properties. They are also easier to parallelize and can be optimized to less accurate but faster versions well suited for real-time and GPU implementation.

M19: Recognising Tables Using Multiple Spatial Relationships Between Table Cells

Mohamed Alkalai

Abstract:

While much work has been done on table recognition this research has been primarily concerned with tables in ordinary text. However, tables containing mathematical structures can differ quite significantly from ordinary text tables and therefore specialist treatment is often necessary. In fact, it is even difficult to clearly distinguish table recognition in mathematics from layout analysis of mathematical formulae. This blurring is often leading to a number of possible, equally valid interpretations. However, a reliable understanding of the layout of a formula is often a necessary prerequisite to further semantic interpretation. In this paper, a new construction of table representation method is introduced which, attempts to overcome the unsolved issues mentioned in several published works. This encompasses the lack of sufficient work that deals with tables with misaligned cells. I utilise multi spatial relationships between cells to recognise tabular components. Experimental evaluation on two different datasets shows a promising results.

N05: Multi Scale Color Coding of Derived Curvature and Torsion Fields on a Multi-Block Curvilinear Grid

Brener, N., Harhad, F., Karki, B., Bengler, W., Acharya, S., Ritter, M., Iyengar, S.

Abstract:

We present a method to compute and visualize the curvature and torsion scalar fields derived from a vector field defined on a multi-block curvilinear grid. In order to compute the curvature and torsion fields, we define a uniform Cartesian grid of points in the volume occupied by the curvilinear grid and interpolate from the curvilinear grid to the Cartesian grid to get the vector field at the Cartesian grid points. We can then use finite difference formulas to numerically compute the derivatives needed in the curvature and torsion formulas. Once the curvature and torsion have been computed at the Cartesian grid points, we employ a multi scale color coding technique to visualize these scalar fields in orthoslices of the Cartesian grid. This multi scale technique allows one to observe the entire range of values of the scalar field, including small, medium and large values. In contrast, if uniform color coding is used to visualize curvature and torsion fields, it sometimes shows most of the values in a single predominant color, which makes it impossible to distinguish between the small, medium and large values. As an example of this multi-scale

technique, we displayed the curvature and torsion fields in a computational fluid dynamics (CFD) simulation of an industrial stirred tank and used these images to identify regions of low, medium and high fluid mixing in the tank.

M61: Histogram of Structure Tensors: Application to Pattern Clustering

Walha, R., Drira, F., Lebourgeois, F., Garcia, C., Alimi, A.M.

Abstract:

Pattern clustering is an important data analysis process useful in a wide spectrum of computer vision applications. In addition to choosing the appropriate clustering methods, particular attention should be paid to the choice of the features describing patterns in order to improve the clustering performance. This paper presents a novel feature descriptor, referred as Histogram of Structure Tensors (HoST), allowing to capture the local information of an image. The basic idea is that a local pattern could be described by the distribution of the structure tensors orientations and shapes. The proposed HoST descriptor has two major advantages. On the first hand, it captures the dominant orientations in a local spatial region taking into account of the local shape of the edges structure. In fact, it is based on the structure tensor that represents a very interesting concept for characterizing the local shape. On the other hand, the use of the histogram concept makes the proposed descriptor so effective and useful when a reduced feature representation is required. In this paper, the proposed HoST descriptor is addressed to the pattern clustering task. An extensive experimental validation demonstrates its performance when compared to other existing feature descriptors such as Local Binary Patterns and Histogram of Oriented Gradients. In addition, the proposed descriptor succeeds in improving the performance of clustering based resolution enhancement approaches.

N03: Preliminary User Tests Evaluation on PRISMA-MAR, a Data Visualization MAR Tool Applied in Academic Context

Costa, M., Carneiro, N., Santos, C., Furtado, L., Meiguins, A., Meiguins, B.

Abstract:

This paper presents the user tests for the PRISMA-MAR application, a mobile augmented reality app with face recognition support for students' evaluations and comparison. The tests were conducted with a combined approach of usability tests and controlled experiments based on user tasks, focusing in the kinds of interactions classified by (Spence, 2007). The tests were performed with 16 people who have a profile close to the profile of scholar teachers; due to the target users of the PRISMA-MAR are scholar teachers. The tests described in this paper are the first step in the usability evaluation of this application. The results showed that users who had already used the ios environment before the test, had better times in all tests.

Poster papers

G71: A Programme to Determine the Exact Interior of any Connected Digital Picture

Fabris,A.E. , Ramos Batista,V.

Abstract:

Region filling is one of the most important and fundamental operations in computer graphics and image processing. Many filling algorithms and their implementations are based on the Euclidean geometry, which are then translated into computational models moving carelessly from the continuous to the finite discrete space of the computer. The consequences of this approach is that most implementations fail when tested for challenging degenerate and nearly degenerate regions. We present a correct integer-only procedure that works for all connected digital pictures. It finds all possible interior points, which are then displayed and stored in a locating matrix. Namely, we present a filling and locating procedure that can be used in computer graphics and image processing applications.

H17: Ocean wave simulation by the mix of FFT and Perlin Noise

Tian,L.

Abstract:

For the application of ocean wave, a new height-field simulation method is proposed by the mix of FFT and Perlin Noise, and OpenSceneGraph (OSG) and VC++ 2008 are used to simulate realistic ocean wave. The method takes wind effects into consideration, and uses Philips model and Gauss random numbers to produce ocean wave spectrum, which is then transformed to wave height-field by FFT. Perlin Noise is overlaid to disturb the wave height to generate a vivid and random sea surface. Simulation results show the effectiveness of the proposed method.

H31: POSTER: Visualizing multi-channel networks

Antemijczuk, P., Magiera,M., Lehmann, S., Cuttone, A., Larsen, J.

Abstract:

In this paper, we propose a visualization to illustrate social interactions,built from multiple distinct channels of communication. The visualization displays a summary of dense personal information in a compact graphical notation. The starting point is an abstract drawing of a spider's web. Below, we describe the meaning of each data dimension along with the background and motivation for their inclusion. Finally, we present feedback provided by the users (31 individuals) of the visualization.

H53: A Low-Cost IR Imaging System for Hand Vein Biometrics Parameters Extraction

Sarah Benziane and Asmaa Merouane

Abstract:

This paper presents a new approach to authenticate individuals using hand vein images. The proposed method is fully automated and employs palm dorsal hand vein images acquired from a low cost, near infrared contactless imaging; the aim of our work. In order to evaluate the system performance, a prototype was designed and a dataset of 34 persons from different ages above 20 and different gender, in each step 10 images per person was acquired at different intervals, 5 images for left hand and 5 images for right hand. The vein detection process consists of an easy to implement a device that takes a snapshot of the subject's veins under a source of infrared radiation at a specific wavelength. The system is able to detect veins but not arteries due to the specific absorption of infrared radiation in blood vessels. Almost any part of the body could be analyzed in order to extract an image of the vascular pattern but the hand and the fingers are preferred.

H83: Method of Discrete Wavelet Analysis of Edges on the Random Background

Bezuglov D.A., Bezuglov Yu.D., Shvidchenko S.A.

Abstract:

In this work was solved the question of working out of methods of automated analysis of measurement results for edge detection of fragments in images on the basis of background noise with the use of wavelet-transformations. The results of mathematical simulation are given. Assessed the effectiveness of the proposed algorithms compared with the known. Using of suggested methods and algorithms can increase peak signal-to-noise ratio and reduce the middle quadrant deviation of mistake. Suggested methods and algorithms can be used in creation the systems for working out digital image signals in industry while creating autonomous robots, in conditions of observation, which complicate registration process, when there is no a priori information about background noise.

I05: Polynomiography with Non-standard Iterations

Gdawiec, K., Kotarski, W., Lisowska, A.

Abstract:

In the paper visualizations of some modifications based on the Newton's root finding of complex polynomials are presented. Instead of the standard Picard iteration several different iterative processes described in the literature, that we call as non-standard ones, are used. Following Kalantari such visualizations are called polynomiographs. Polynomiographs are interesting from scientific, educational and artistic points of view. By the usage of different kinds of iterations we obtain quite new, comparing to the standard Picard iteration, polynomiographs that look aesthetically pleasing. As examples we present some polynomiographs for complex polynomial equation $z^3 - 1 = 0$. Polynomiographs graphically present dynamical behaviour of different iterative processes. But we are not interested in it. We are focused on polynomiographs from the artistic point of view. We believe that the new polynomiographs can be interesting as a source of aesthetic patterns created automatically. They also can be used to increase functionality of the existing polynomiography software.

I13: Humanized Game Design Based on Augmented Reality

Su,Y.H, Li,Sh.,Zhan,Y.S

Abstract:

Augmented Reality (AR) is an important branch of virtual reality technology and a focus of recent research. Now, the primary research of AR is focus on how to improve the accuracy of identification and reduce the dependency to markers. Successful cases are scarce on how to play the special advantage of augmented reality, combine it with mobile devices and generate practical value. We start from the actuality of AR technology characteristics, achieved the first blind game system which based on mobile platform Android. This system is not only regard game's emotion design as starting point and pay close attention to the vulnerable groups, especially the blind community, but also provide them the opportunities that compete with average person. Besides, it offers a diversification choice of game against for blind users by set different difficulty level and game player modes. Finally, the user experience indicates that the system not only could combine AR and the innovation of game design together, but also could help vulnerable group achieve flexible user experience and operation.

I67: GPU Implementation of 3D Grid and Proximity Clouds for Ray Tracing

Ryan Thomas and Sudhanshu Kumar Semwal

Abstract:

Bounding Volume Hierarchies (BVHs) and k-d trees have been used to create interactive ray tracing. Ray tracing dynamic scenes using nVidia's OptiX has already provided thirty to sixty frames per second or better. Object hierarchy methods such as k-d trees are used for these implementations. But the above mentioned approaches are based on partitioning the object space and may not be suitable for ray tracing 3D volume data as volume data does not have any objects to build the object hierarchies on. In this paper, we implement space partitioning methods, such as grid method and the proximity clouds (PCs), on multiple GPUs. Our motivation is to investigate the use of such methods for medical applications, because there is direct one to one correspondence between 3D voxels used in space partitioning methods and 3D voxels in the volume data. In the past, proximity Clouds have worked well on static scenes, but object movement forces recalculation of the scene and some preprocessing cost. This paper investigates parallelizing these techniques on the GPU to determine the feasibility of dynamic scenes using them. Our scenes are made of spheres instead of volume data because at this time we do not know of any technique that can generate dynamically changing volume data. Interestingly, Proximity Clouds (PCs), which typically has large gains in rendering times compared to the 3D Grid method, emerges only slightly better than the 3D Grid method for dynamic scenes, because both the processing and rendering costs are now added for dynamic scenes with spheres. The means that the 3D grid method, due to its simpler preprocessing, may be the best choice for ray tracing the dynamic volume data on multiple GPU.

I71: POSTER: Spatter Tracking in Laser- and Manual Arc Welding with Sensor-level Pre-processing

Lahdenoja, O., Sääntti, T., Laiho, M., Poikonen, J.

Abstract:

This paper presents methods for automated visual tracking of spatters in laser- and manual arc welding. Imaging of the welding process is challenging due to extreme conditions of high radiated light intensity variation. The formation and the number of spatters ejected in the welding process are dependent on the parameters of the welding process, and can potentially be used to tune the process towards better quality (either on-line or off-line). In our case, the spatter segmentation is based either on moment analysis or Hough transform, which are applied on pre-processed image sequences captured by a high-speed smart camera. Part of the segmentation process (adaptive image capture and edge extraction) is performed on the camera, while the other parts of the algorithm are performed off-line in Matlab. However, our intention is to move the computation towards the camera or an attached FPGA.

I73: Fast and Robust Tessellation-Based Silhouette Shadows

Milet,T.,Kobrtsek,J.,Zeměík,P.,Peèiva,J.

Abstract:

This paper presents a new simple, fast and robust approach in computation of per-sample precise shadows. The method uses tessellation shaders for computation of silhouettes on arbitrary triangle soup. We were able to reach robustness by our previously published algorithm using deterministic shadow volume computation. We also propose a new simplification of the silhouette computation by introducing reference edge testing. Our new method was compared with other methods and evaluated on multiple hardware platforms and different scenes, providing better performance than current state-of-the art algorithms. Finally, conclusions are drawn and the future work is outlined.

I79: A method of micro facial expression recognition based on dense facial motion data

Akagi, Y., Kawasaki, H.,

Abstract:

In this paper, we propose a method for recognizing a micro expression which is a small motion appearing on a face by using the high density and high frame-rate 3D reconstruction method. Some studies report that the micro expressions are caused by the change of mental state. If we can recognize the micro expressions, this information could be useful for machines to understand the mental state of a human. With advancements of 3D reconstruction methods, methods have been proposed to reconstruct dynamic objects such as motions of a human's body in high accuracy with high frame rate. Based on the data obtained from the high quality shape reconstruction method, the proposed method recognizes the micro expressions. To detect a part of the face where the micro-expressions are appeared, we propose an experimental estimation of the part. We also report a recognition rate of the change of the mental state using the experimental system.

I89: Human-Computer Interaction Using Robust Gesture Recognition

Endler, M., Lobachev, O., Guthe, M.

Abstract:

We present a detector cascade for robust real-time tracking of hand movements on consumer-level hardware. We adapt existing detectors to our setting: Haar, CAMSHIFT, shape detector, skin detector. We use all these detectors at once. A unified interface to all the detectors was introduced to facilitate our approach. Our software is available as an open-source application. Our main contributions are: first, utilization of bootstrapping: Haar bootstraps itself, then its results are used to bootstrap the other filters; second, the usage of temporal filtering for more robust detection and to remove outliers; third, we adapted the detectors for more robust hand detection. The resulting system produces very robust results in real time. We evaluate both the robustness and the real-time capability.

J61: Semiotic Aspects of Computer Visualization Theory

Vladimir L. Averbukh

Abstract:

The purpose of this paper is to discuss the Semiotic approach to forming of Theory of Computer Visualization. Such theory (or rather theories) should be the foundation of design, development, and evaluations of specialized visualization systems. The semiotic analysis of visualization is defined. The paper contains the scheme of the semiotics analysis during designing of visualization systems. The semiotic analysis helps in design and development of the real visualization systems. Also such conceptions as Computer Metaphor, Metaphor Action, Metaphor Formula are defined and discussed.

J79: POSTER: Adaptive Projection Displays: a low cost system for public interactivity

Dundas, J., Wagner, M.

Abstract:

Interactive digital public displays that track viewer's position are currently inaccessible to the average consumer. Many tracking systems available on the market are prohibitively expensive and are out of scope for small business owners to purchase. This research tests various consumer level tracking technologies to ascertain whether a system can be developed in a low cost and accessible manner. Microsoft's Kinect in tandem with Unity3D offers a system that is straightforward to use and allows for ease of implementation. The resulting technique can be quickly carried out to create an interactive digital public display.

J97: Mobile Graphics Game with Peer-to-Peer Android based Collaborative System

Timothy W. Poley and Sudhanshu K. Semwal

Abstract:

Smart phones combine graphics interaction with mobility and provide an opportunity for collaborative social interaction in small groups. They also provide an opportunity to implement virtual games with multiple participants nearby because smart phones can be used as an input and an output device. This paper presents an Android application called Droid Hold'em. Droid Hold'em utilizes a peer-to-peer architecture combined with voice recognition software to create an interactive system. The application implements the popular version of poker known as Texas Hold'em that is a common game played at social gatherings. This android application allows participants to interact in the social environment without any additional assistance needed to participate in the group activity. The implementation consists of two phases. The first is the development of a peer-to-peer communications API (Application Programming Interface) that can be used and reused by any application that wishes to utilize peer-to-peer communication. The second is to develop the Droid Hold'em game itself, which will utilize a tablet to serve in place of a poker table, and phones as game interfaces for each individual player. Because of the voice recognition and voice feedback used in our system, smart devices may have universal appeal, and may also be useful for Blind and the Visually Impaired (B/VI) community to engage on equal footing with their sighted peers.

L41: The application of face recognition methods for processes automation in an intelligent meeting room

Ronzhin Al.L.

Abstract:

Proactive information-control services provision based on human behavior and situation analysis is the main idea of intelligent space concept. Biometric identification technology is one of such services, it is based on face recognition methods, and application of these methods provides the automation of meetings processes. This paper presents method of automatic registration and identification based on face recognition of meeting participants, which has been implemented on the basis of the SPIRAS intelligent meeting room. This method provides unobtrusive recognition and photographing of participants faces. Application of the developed method makes it possible to reduce the work of secretaries and videographers; it also allows participants to concentrate on the discussed issues at the expense of automated control of sensory equipment. For the experimental evaluation of the developed method participants photographs were accumulated only from a high resolution camera. As a result, the number of accumulated photos was more than 52,000 for 36 participants. During the experiments three face recognition methods LBPH, MON-PCA and MON-LDA were compared. The experimental results showed that method LBPH has the highest recognition accuracy 79,3%, but the MON-PCA method has the lowest percentage of the false positives 1,3%, which is an important aspect in the participants identification.

L61: POSTER: Connect-S: a physical visualization through tangible interaction

Giang, K., Funk, M.

Abstract:

In our current society, open data streams are more and more available through the Internet. This data can have an increasing impact on everyday life. Its full potential can, however, only be reached through better integration and new interfaces. The goal of this project is to explore the possibilities of repurposing public information in a developing area of a large city in the Netherlands. Can we create a tangible interaction with use of physical visualization of these data streams? A series of prototypes have been made to develop a physical visualization through the method of research through design. Users were involved in expert panels and interviews to fine-tune and create a final prototype, Connect-S. The concept shows the opportunities of using physical visualization in connection with physical interaction for browsing and navigation.

L73: The study of features of expert signature for left ventricle on ultrasound images

Zyuzin, V., Porshnev, S., Bobkova, A.

Abstract:

The article presents the study result of signature of left ventricle (LV) contours which are built by experts. The result is a part of a task of automatic contouring area of LV on an ultrasound frames with apical four-chamber view. Signature is LV contour curve, built in polar coordinates. The study was found the optimal point in the center of the LV base. The resulting signature is approximated by three polynomials second and third degree: right side, left side and top. The result of such approximation has been qualitatively and quantitatively better than the whole curve.

M02: POSTER: Real time vehicle detection and tracking on multiple lanes

Kovačević, K., Ivanjko, E., Gold, H.

Abstract:

Development of computing power and cheap video cameras enabled today's traffic management systems to include more cameras and computer vision applications for transportation system monitoring and control. Combined with image processing algorithms cameras are used as sensors to measure road traffic parameters like flow, origin-destination matrices, classify vehicles, etc. In this paper development of a system capable to measure traffic flow and estimate vehicle trajectories on multiple lanes using one static camera is described. Vehicles are detected as moving objects using foreground and background image segmentation. Adjacent pixels in the moving objects image are grouped together and a weight factor based on cluster area, cluster overlapping area and distance between multiple clusters is computed to enable multiple moving object tracking. To ensure real-time capabilities, image processing algorithm parallelization is applied. Described system is tested using real traffic video footage obtained from Croatian highways.

M41: Neural Gas based 3D Normal Mesh Compression

Shymaa Elleithy

Abstract:

The essential need for an efficient geometry mesh compression technique becomes more and more crucial because of the recent widespread of processing and transmitting the 3D model in various areas such as computer graphics, animations and visualization. This paper proposes a neural gas based progressive compression technique for 3D geometry normal meshes. The introduced technique is based on multi-resolution decomposition which is obtained by the wavelet transform and then it quantizes the coefficients by the neural gas algorithm as a vector quantizer which improves the visual quality of the reconstructed geometry mesh. Our experiments show that the proposed technique outperforms the state-of-the-art techniques in terms of the visual quality of compressed meshes.

M53: VisNow - a Modular, Extensible Visual Analysis Platform

Nowinski, K.S., Borucki, B.

Abstract:

A new, dataflow driven, modular visual data analysis platform with extensive data processing and visualization capabilities is presented. VisNow is written in Java, easily extendable to incorporate new modules and module libraries. Dataflow networks built with the help of interactive network editor can be wrapped into stand-alone application for the end users.

M67: A new way of Rich Image Representation (VectorPixels)

Simons Alain

Abstract:

These are Preliminary Results: Generating images on computer systems has been done with the same technology for several decades now. Bitmap or pixel technology is used for the representation of rich color images. Simple graphics like line drawings and logos usually use vector graphics. As known both have their disadvantages and advantages. In recent years a lot of research has been done to combine the advantages of both techniques in a comprehensive solution. However all these research started from one of these two technologies as base, so new technologies were built on top of existing technologies. There was no development from scratch and that's exactly what this paper wants to propose, an algorithm to invent the pixel again. By always applying new developments on existing technologies generating images became a mix of various techniques and a rather complex matter. A latest contribution to this, for instance, is the use of Diffusion Curves. As said before, all research has been fixed on improving existing pixel or vector based graphics. With the use of VectorPixel (VP) the concept of a pixel will be redefined. In contrast with a pixel (Picture Element) a VectorPixel will be defined by a mathematical description and resolution independent. Instead of using a classical grid, which is resolution dependent, to position a VectorPixel a reference point will be defined and the position of other VectorPixels will refer to that reference point. Classical pixels make use of a grid which is resolution

depended. VectorPixels instead can for example overlap each other to present a smooth curve. When the image is enlarged VectorPixels are also increased proportionately.

M97: Optical method of determining parameter for calculation of the braided aramid torsion shear modulus

Larin M.S., Perechesova A.D., Kalapyshina I.I.

Abstract:

The suspension of the magnetosensitive element of torsion magnetometer, which is a part of the geophysical complex GI-MTS-1 (SPbF IZMIRAN), obtained by means of device are made of three microfilaments of aramid yarn with a diameter of 0.016 mm. Object of study is an elastic torsion bar in a form of braid. Purpose of work – describe the preparatory phase for the experimental determination of the aramid torsion physical-mechanical characteristics. This paper proposes the optical-calculating method of the physical-mechanical characteristics evaluating of the helical elements of the Helically Anisotropic Rod. This method is based on experimental data from tensile testing of microfilament aramid yarns. The data for this study will be received by the high-speed camera CamRecord CR450x3 Optronis.

WSCG 2014 PRELIMINARY Conference Schedule

Registration Monday, June 2 17:30 - 20:30

Conference office is open during breaks, only

Tuesday, June 3, 2014

8:00-10:00	30'	10:30-12:00	10'	12:10	13:00-15:00	30'	15:30-16:30	16:30-17:30	
Session A Room A	Break	Session C Room A	Welcome	Lunch Break	Session E Room A	Break & Posters A	Keynote talk	Session G Room A	Late Registr.
Session B Room B		Session D Room B			Session F Room B			Session H Room B	

Wednesday, June 4, 2014

8:00-10:00	30'	10:30-12:00	20'	12:20	13:30-15:30	30'	15:30-16:30	16:00-17:30	18:59*
Session K Room A	Break & Posters B	Session M Room A	Common Photo	Lunch Break	Session O Room A	Break & Posters C	Keynote talk	Session Q Room A	DINNER
Session L Room B		Session N Room B			Session P Room B			Session R Room B	

Thursday, June 5, 2014

8:00-10:00	30'	10:30-12:20	12:20	13:30-15:00	30'	15:30-16:30	16:00-17:00	17:00
Session S Room A	Break & Posters D	Session U Room A	Lunch Break	Session W Room A	Break & Posters E	Session Y1 Room A	Session Y2 Room A	Closing Session
Session T Room B		Session V Room B		Session X Room B		Session Z1 Room B	Session Z2 Room B	

*** Expected**

**** NOT ORGANIZED – JOIN US AND PASS THE CITY CENTER**

Conference Dinner: Wednesday, June 4 – buy a ticket [at a symbolic price 10 EUR] at the registration – offer limited.
Place and time to be announced.

We recommend to buy 24 hour/1 day ticket for public transport

We recommend visiting (not organized tours):

- Explore Plzen City <http://web.zcu.cz/plzen/>
- ZOO and Botanical Garden
<http://www.zooplzen.cz/> (45 mins.)
- Purkmister Brewery
<http://www.purkmistr.cz/> (10 mins. by trolleybus)

- Techmania Science Center <http://www.techmania.cz>
(recommended ½ day visit)
- Stara Sladovna – Medieval Pub – city center (40 mins.)
<http://www.staraslادovna.cz/video/slad2.mp4>
- Pilsner Urquell Brewery and Brewery Museum -
<http://www.prazdrojvisit.cz/en/> (30 mins.)