INVITATION

ISRAEL SIGGRAPH PROFESSIONAL CHAPTER MEETING

May 22, 2009
9:00 – 13:00

Efi Arazi Building, Room C109
Interdisciplinary Center
(IDC) Herzliya

Chapter Chair: Zachi Karni

HP LABS

IDC HERZLIYA | Efi Arazi School of Computer Science

Program:

- **8:30 – 9:00**
  Gathering & Refreshments
- **9:00 – 9:30**
  Variational Harmonic Maps for Space Deformation
  Ofir Weber, Technion
- **9:30 – 10:00**
  Edge-Avoiding Wavelets and their Applications
  Raanan Fattal, Hebrew University
- **10:00 – 10:30**
  FlexiStickers - Photogrammetric Texture Mapping using Casual Images
  Yochay Tzur, Technion
- **10:30 – 11:00**
  Vessels-cut: a graph based approach for carotid arteries segmentation
  Moti Freiman, Hebrew University
- **11:00 – 11:30**
  Coffee Break
- **11:30 – 12:00**
  Coordinates for Instant Image Cloning
  Zeev Farbman and Gil Hoffer
  Hebrew and Tel-Aviv University
- **12:00 – 12:30**
  iWires An Analyze-and-Edit Approach to Shape Manipulation
  Ran Gal, Tel-Aviv University
- **12:30 – 13:00**
  Multi-operator Media Retargeting
  Michael Rubinstein, IDC

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Variational Harmonic Maps for Space Deformation

Ofir Weber, Technion

A space deformation is a mapping from a source region to a target region within Euclidean space, which best satisfies some user-specified constraints. It can be used to deform shapes embedded in the ambient space and represented in various forms – polygon meshes, point clouds or volumetric data. For a space deformation method to be useful, it should possess some natural properties: e.g. detail preservation, smoothness and intuitive control. A harmonic map from a domain $\Omega \subset R^d$ to R^d is a mapping whose d components are harmonic functions. Harmonic mappings are smooth and regular, and if their components are coupled in some special way, the mapping can be detail-preserving, making it a natural choice for space deformation applications. The challenge is to find a harmonic mapping of the domain, which will satisfy constraints specified by the user, yet also be detail-preserving, and intuitive to control. We generate harmonic mappings as a linear combination of a set of harmonic basis functions, which have a closed-form expression when the source region boundary is piecewise linear. This is done by defining energy functional of the mapping, and minimizing it within the linear span of these basis functions. The resulting mapping is harmonic, and a natural "As-Rigid-As-Possible" deformation of the source region. Unlike other space deformation methods, our approach does not require an explicit discretization of the domain. It is shown to be much more efficient, yet generate comparable deformations to state-of-the-art methods. We describe an optimization algorithm to minimize the deformation energy, which is robust, provably convergent, and easy to implement.

Joint work with Mirela Ben-Chen and Craig Gotsman

Edge-Avoiding Wavelets and their Applications

Raanan Fattal, Hebrew University

We propose a new family of second-generation wavelets constructed using a robust data-prediction lifting scheme. The support of these new wavelets is constructed based on the edge content of the image and avoids having pixels from both sides of an edge. Multi-resolution analysis, based on these new edge-avoiding wavelets, shows a better decorrelation of the data compared to common linear translation-invariant multi-resolution analyses. The reduced inter-scale correlation allows us to avoid halo artifacts in band-independent multi-scale processing without taking any special precautions. We thus achieve nonlinear data-dependent multi-scale edge-preserving image filtering and processing at computation times which are linear in the number of image pixels. The new wavelets encode, in their shape, the smoothness information of the image at every scale. We use this to derive a new edge-aware interpolation scheme that achieves results, previously computed by an inhomogeneous Laplace equation, through an explicit computation. We thus avoid the difficulties in solving large and poorly-conditioned systems of equations. We demonstrate the effectiveness of the new wavelet basis for various computational photography applications such as multi-scale dynamic-range compression, edge-preserving smoothing and detail enhancement, and image colorization.

FlexiStickers
Photogrammetric Texture Mapping using Casual Images

Yochay Tzur, Technion

Texture mapping has been a fundamental problem in computer graphics from its early days. As online image databases have become increasingly accessible, the ability to texture 3D models using casual images has gained more importance. This will facilitate, for example, the task of texturing bland models of an animal using any of the hundreds of images of this animal found on the Internet, or enabling a naive user to create personal avatars using the user's own images.

In this talk we will present a novel approach for performing texture mapping using casual images, which manages to account for the 3D geometry of the photographed object. Our method overcomes the limitation of both the constrained-parameterization approach, which does not account for the photography effects, and the photogrammetric approach, which cannot handle arbitrary images. The key idea of our algorithm is to formulate the mapping estimation as a Moving-Least-Squares problem for recovering local camera parameters at each vertex. The algorithm is realized in a FlexiStickers application, which enables fast interactive texture mapping using a small number of constraints.

Joint work with Ayellet Tal

Vessels-cut: a graph based approach for carotid arteries segmentation

Moti Freiman, Hebrew University

We present a nearly automatic graph-based segmentation method for patient specific modeling of the aortic arch and carotid arteries from CTA scans for interventional radiology simulation. The method starts with morphological-based segmentation of the aorta and the construction of a prior intensity probability distribution function for arteries. The carotid arteries are then segmented with a graph min-cut method based on a new edge weights function that adaptively couples the voxel intensity, the intensity prior, and geometric vesselness shape prior. Finally, the same graph-cut optimization framework is used to interactively remove a few vein segments and to fill minor vessel discontinuities due to large intensity variations. Our method accurately segments the aortic arch, the left and right subclavian arteries, and the common, internal, and external carotids and their secondary vessels. It does not require any user initialization, parameters adjustments, and is relatively fast (150– 470 secs). Experimental results on 30 carotid arteries from 15 CTAs from two medical centres to manually segmented by expert radiologist yield a mean symmetric surface distance of 0.79mm (std=0.25mm). The interactive refinement required about 10 seed points and took less than 120 secs for each case.

Joint work with Leo Joskowicz

Coordinates for Instant Image Cloning

Zeev Farbman and Gil Hoffer, Hebrew and Tel-Aviv Universities

Seamless cloning of a source image patch into a target image is an important and useful image editing operation, which has received considerable research attention in recent years. This operation is typically carried out by solving a Poisson equation with Dirichlet boundary conditions, which smoothly interpolates the discrepancies between the boundary of the source patch and the target across the entire cloned area. In this paper we introduce an alternative, coordinate-based approach, where rather than solving a large linear system to perform the forementioned interpolation, the value of the interpolant at each interior pixel is given by a weighted combination of values along the boundary. More specifically, our approach is based on Mean-Value Coordinates (MVC). The use of coordinates is advantageous in terms of speed, ease of implementation, small memory footprint, and parallelizability, enabling real-time cloning of large regions, and interactive cloning of video streams. We demonstrate a number of applications and extensions of the coordinate-based framework.

Joint work with Yaron Lipman, Daniel Cohen-Or and Dani Lischinski

iWires An Analyze-and-Edit Approach to Shape Manipulation

Ran Gal, Tel-Aviv University

Man-made objects are largely dominated by a few typical features that carry special characteristics and engineered meanings. State-of-the-art deformation tools fall short at preserving such characteristic features and global structure. We introduce iWires, a novel approach based on the argument that man-made models can be distilled using a few special 1D wires and their mutual relations. We hypothesize that maintaining the properties of such a small number of wires allows preserving the defining characteristics of the entire object. We introduce an analyze-and-edit approach, where prior to editing, we perform a light-weight analysis of the input shape to extract a descriptive set of wires. Analyzing the individual and mutual properties of the wires, and augmenting them with geometric attributes makes them intelligent and ready to be manipulated. Editing the object by modifying the intelligent wires leads to a powerful editing framework that retains the original design intent and object characteristics. We show numerous results of manipulation of man-made shapes using our editing technique.

Joint work with Olga Sorkine, Niloy Mitra and Daniel Cohen-Or

Multi-operator Media Retargeting

Michael Rubinstein, IDC

Content aware resizing gained popularity lately and users can now choose from a battery of methods to retarget their media. However, no single retargeting operator performs well on all images and all target sizes. In a user study we conducted, we found that users prefer to combine seam carving with cropping and scaling to produce results they are satisfied with. This inspires us to propose an algorithm that combines different operators in an optimal manner. We define a resizing space as a conceptual multi-dimensional space combining several resizing operators, and show how a path in this space defines a sequence of operations to retarget media. We define a new image similarity measure, which we term Bi-Directional Warping (BDW), and use it with a dynamic programming algorithm to find an optimal path in the resizing space. In addition, we show a simple and intuitive user interface allowing users to explore the resizing space of various image sizes interactively. Using key-frames and interpolation we also extend our technique to retarget video, providing the flexibility to use the best combination of operators at different times in the video.

Joint work with Ariel Shamir and Shai Avidan