Project/Seminar
3D Computer Vision & Augmented Reality

Department Augmented Vision
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Topic 1: Weighted Blended Order-Independent Transparency
(project / guided research)

• Topic:
  • Order independent transparency for 3D rendering
  • Research and Implementation on a Real-time 3D Rendering Framework (Odysseus)
  • Screen-space solution using shaders (CGFX)
Topic 1: Weighted Blended Order-Independent Transparency (project / guided research)

- Tasks:
  - Learn Odysseus transparency pipeline
  - Implementation of a Screen-space solution (following the paper) in Odysseus
  - Example/Demo is left undefined but a requirement (CAD Sample, Particle System, Game...)
- Requirements:
  - C++ Padawan
  - OpenGL and any shader language (CG and CGFX a bonus) knowledge
  - Need to be able to learn new 3D rendering framework
- Main Reference:
  - [http://jcgt.org/published/0002/02/09/paper.pdf](http://jcgt.org/published/0002/02/09/paper.pdf)
- Contact: José Henriques: [Jose.henriques@dfki.de](mailto:Jose.henriques@dfki.de) (http://av.dfki.de/~jhenriques/)
Topic: The spatiotemporal oriented energies, based on three-dimensional separable steerable filters, have been recently used in wide a variety of image processing areas such as scene understanding, image segmentation, stereo reconstruction or visual tracking. Implement and evaluate spatiotemporal oriented energy features using a tracking application.

Diagram:
- Input Video Frames
- Spatiotemporal Oriented Energy Decomposition
- Interframe Motion Estimation
Topic 2: Spatiotemporal oriented energies (project)

Tasks:

• Understanding of the tracking method and the underlying spatiotemporal oriented energy features
• Implementation of the proposed method
• Evaluation and documentation of the method

Main references:


Contact: Jan Hirzel, jan.hirzel@dfki.de
Topic 3: Survey on Image Segmentation Algorithms

Topic:
Survey on different alternatives to image segmentation using RGB images or image sequences

Tasks:
- Literature-Research for state-of-the-art algorithms
- Identify categories/classes of algorithms
- Evaluation/Rating of least one (essential) algorithm per category (Advantages, Limitations, ...)

Main references:

Contact: Jan Hirzel, jan.hirzel@dfki.de
• Dataset acquisition using heterogeneous selection of imaging devices
• Evaluation and benchmarking of different reconstruction scenarios
• Evaluation of
  • Different error measures for comparison
  • Different comparison-software
  • Possibly automatisation of dataset comparison
  • Different 3D reconstruction approaches available in the CV community

• Contact: Bernd Krolla, Bernd.Krolla@dfki.de
Current acquisition setup

- Adjustable camera stage
- Turntable
- Light cube (for diffuse light)
- Spotlight 1
- Spotlight 2 (behind the cube)
- Spotlight 3
Topic 5: Road Marking Detection (project)

http://www.youtube.com/watch?v=Ni9nAm-Thsw
Topic 5: Road Marking Detection (project)

- Tasks:
  - Implementation of an automatic road marking detection method
  - Try to improve it
  - Evaluation of the method and its limitations

- Main references:
  - P. Foucher et al. “Detection and Recognition of Urban Road Markings Using Images”
  - Image and ground truth database: [http://www.lcpc.fr/francais/produits/bases-de-donnees-de-reference/article/roma-road-markings](http://www.lcpc.fr/francais/produits/bases-de-donnees-de-reference/article/roma-road-markings)

- Contact: Stephan Krauß, Stephan.Krauss@dfki.de
Topic: Survey on different alternatives to transform a low-resolution to a high-resolution depth image

Tasks:
- Literature-Research for state-of-the-art algorithms
- Identify categories/classes of algorithms
- Evaluation/Rating of least one (essential) algorithm per category (Advantages, Limitations, ...)

Main references:

Contact: Oliver Wasenmüller, oliver.wasenmueller@dfki.de
Topic 7: GPU-based denoising of Kinect depth images (project / guided research)

- Topic:
  - Denoising of Kinect depth images / Image filtering
  - A pixel wise joint bilateral filter (JBF) smoothes depth images, while preserving sharp edges, under consideration of color images
  - JBF is computational expensive (code available for CPU), but can be speeded-up based on the GPU

Input: *Color Image*  
Input: *Depth Image*  
Output: *Expected Depth Image*
Topic 7: GPU-based denoising of Kinect depth images (project / guided research)

• Tasks:
  • Research/Identification of strategies to speed-up a joint bilateral filter based on the GPU (Several speed-up strategies of a (very) similar filter + Code can be found here: (2) )
  • Implementing different speed-up strategies
  • Comparative evaluation of implemented strategies

• Requirements:
  • Strong programming skills in C++
  • Knowledge (or intent to learn): Cuda (maybe also openCL)

• Main references:
  (2) Source Code of several speed-up strategies of a (very) similar filter: http://cs.au.dk/~staal/dpc/20072300_paper_final.pdf

• Contact: Oliver Wasenmüller, oliver.wasenmueller@dfki.de
Topic 8: Enhancing Kinect depth images  
(project / guided research)

Implementation, evaluation and improvement of an existing algorithm

• Tasks:
  • Re-implementation of the algorithm proposed in (1)
  • Evaluation of the influence of different parameters on quality / runtime
  • Comparative evaluation against pixel wise Joint Bilateral Filter (see P/GR-1)
  • Possibly: Improvement of proposed (1) algorithm (in terms of quality)

• Requirements:
  • Strong programming skills in C++

• Main references:
  (1) Qingxiong Yang, *Spatial-Depth Super Resolution for Range Images*:  

• Contact: Oliver Wasenmüller, oliver.wasenmueller@dfki.de

07.05.2014  Seminar/project SS2014  14
SVD is a core matrix decomposition, widely used in numerous application fields (signal processing, pattern recognition, reduced order modeling, image compression and many more)

Complexity is:

\[
\begin{align*}
A &= U \Sigma V^* \\
\end{align*}
\]

Image: SVD of the matrix A (m x n) [3]
Topic 9: Singular Value Decomposition in C++ (project)

• Tasks:
  • Overview of existing algorithms for SVD
  • Choice of the algorithm to implement, which is inherently best parallelizable
  • Implementing the SVD in C++/CUDA C (in case of CPU version implementation should be suitable for further porting to GPU)

• Main references:

• Contact: Vladislav Golyanik, vladislav.golyanik@dfki.de
Goal:
To assign correspondences between two sets of points and recover the transformation that maps one point set to the other. CPD is a probabilistic method for both rigid and non-rigid point set registration.

a) an initial mesh with missing points
b) the initial mesh overlapped with a mesh containing missing points
c) registered version of two meshes

Source: [1]
Topic 10: Advanced acceleration methods for Coherent Point Drift (project)

- **Tasks:**
  - Substitute parts of matlab-code with high-performance
  - C++ functions / CUDA C kernels
  - To learn how to port matlab code into C++ and CUDA C (to GPU) : an important step in software development from a prototype towards a mature application
  - Speedup measurement, profiling, documentation directly in code

- **Main references:**

- **Contact:** Vladislav Golyanik, [vladislav.golyanik@dfki.de](mailto:vladislav.golyanik@dfki.de)
Topic 11: Effect of Head Pose on Gender Recognition
(seminar)

Topic:
• Gender recognition from face
• Head pose estimation
• Dependency between head pose and gender recognition

Tasks:
• Research state-of-the-art methods for building gender classifier taking into consideration the head pose/other dependencies
• Compare the classifiers that works best with faces taken in an uncontrolled environment “in the wild”

Main references:
(1) Juan Bekios-Calfa, Robust gender recognition by exploiting facial attributes dependencies [2014]
(2) Xiangxin Zhu, Face Detection, Pose Estimation, and Landmark Localization in the Wild [2012]

Contact: Mohamed Selim, mohamed.selim@dfki.de

07.05.2014
Topic 12: Beard and Moustache detection (seminar/project)

Topic:
• Facial hair detection (Beard/Mustache)
• Gender recognition

Tasks:
• Research state-of-the-art methods for facial hair detection/segmentation
• Evaluate the accuracy of detection on controlled datasets and “in the wild” datasets
• Evaluate the algorithms for real-time use

Main references:
(1) T. Hoang Ngan Le, *Beard and mustache segmentation using sparse classifiers on self-quotient images* [2012]  
http://www.andrew.cmu.edu/user/kseshadr/ICIP_2012_Paper_2_IEEE.pdf

(2) Jian-Gang Wang, *Real-time moustache detection by combining image decolorization and texture detection with applications to facial gender recognition* [2014]  
http://link.springer.com/content/pdf/10.1007%2Fs00138-014-0597-2.pdf

Contact: Mohamed Selim, mohamed.selim@dfki.de
Topic 13: Survey on using Video Sequences for Face Analysis (seminar)

Topic:
• Face Analysis
• Video Sequences
• Face model representation

Tasks:
• Research state-of-the-art methods for utilizing video sequences for building face models, and analyzing the generated models for gender/age/.. Classification
• Identify different face modeling techniques
• Evaluate at least one technique for gender classification and identify its limitations

Main reference:
(1) Yi-Chen Chen, *Video-based Face Recognition via Joint Sparse Representation* [2013]
(2) Abdenour Hadid, *Combining appearance and motion for face and gender recognition from videos* [2009]

Contact: Mohamed Selim, mohamed.selim@dfki.de
Topic 14: Navigation Meshes
(seminar/project/guided research)

- Topic:
  - Survey of state of the art on Navigation meshes
  - Automatic (pre-processing) creation
  - Research and Implementation on a Real-time 3D Rendering Framework (Odysseus)
• Tasks:
  • Seminar: Create a survey report on topic;
  • Project: Demo

• Requirements (Project):
  • C++ Padawan
  • OpenGL, 3D geometric algebra, 3D Mesh, COLLADA knowledge
  • Need to be able to learn new 3D rendering framework

• Contact:
  • José Henriques: Jose.henriques@dfki.de (http://av.dfki.de/~jhenriques/)